



US 20110209484A1

(19) **United States**(12) **Patent Application Publication**
Krausch et al.(10) **Pub. No.: US 2011/0209484 A1**(43) **Pub. Date: Sep. 1, 2011**(54) **CONDENSER DRYER HAVING A HEAT PUMP, AND METHOD FOR OPERATING THE SAME**(30) **Foreign Application Priority Data**

Nov. 20, 2008 (DE) 10 2008 043 920.7

(75) Inventors: **Uwe-Jens Krausch**, Brieselang (DE); **Andreas Stolze**, Falkensee (DE)**Publication Classification**(51) **Int. Cl.**
F25B 29/00 (2006.01)
F25B 27/00 (2006.01)(73) Assignee: **BSH BOSCH UND SIEMENS HAUSGERÄTE GMBH**, Munich (DE)(52) **U.S. Cl.** 62/79; 62/238.6(57) **ABSTRACT**

A condenser dryer includes a drying chamber for items to be dried; a process-air circuit including a fan; and a heat pump in which a refrigerant circulates. The heat pump has an evaporator and a condenser, with the evaporator or the condenser or both being a heat exchanger having level surfaces and including at least one endlessly folded, flattened tube to form a plurality of rows of meander stacks in laterally offset relationship.

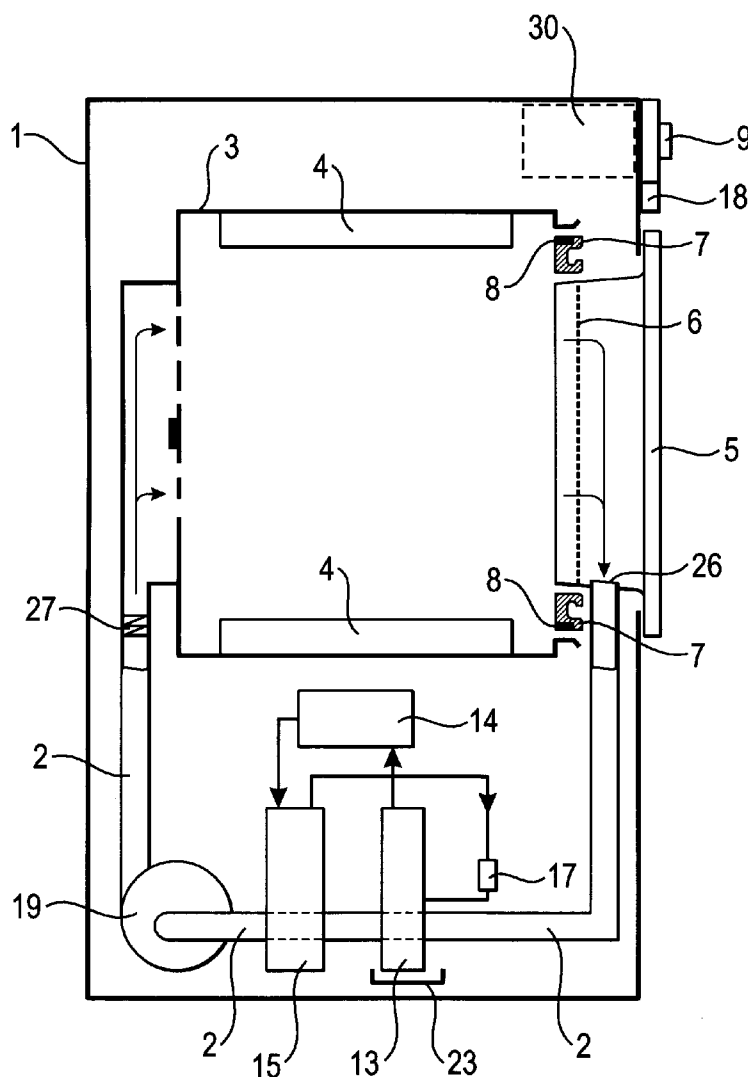
(21) Appl. No.: **13/127,997**(22) PCT Filed: **Nov. 9, 2009**(86) PCT No.: **PCT/EP09/64829**§ 371 (c)(1),
(2), (4) Date:**May 6, 2011**

Fig. 1

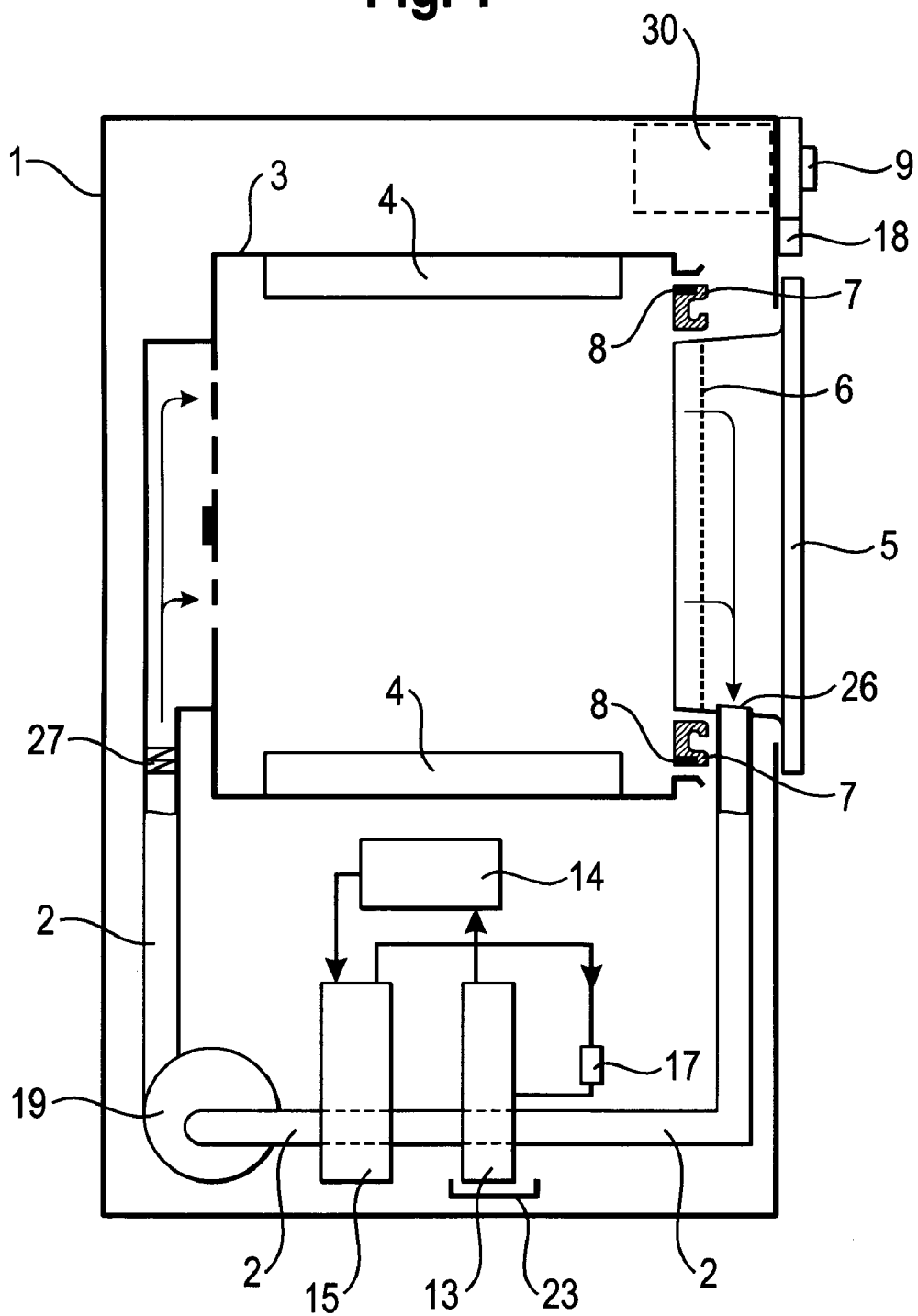


Fig. 2

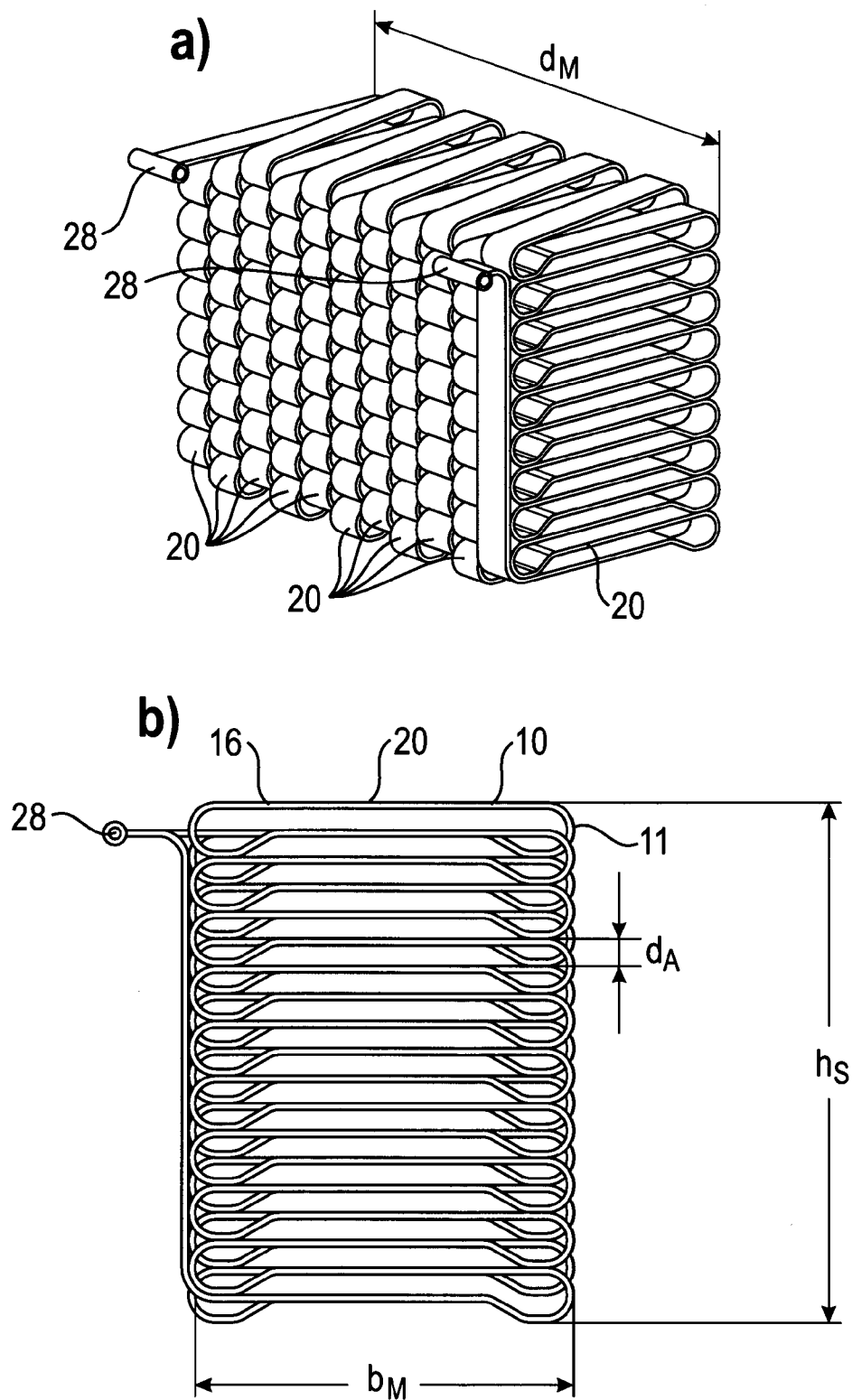


Fig. 3

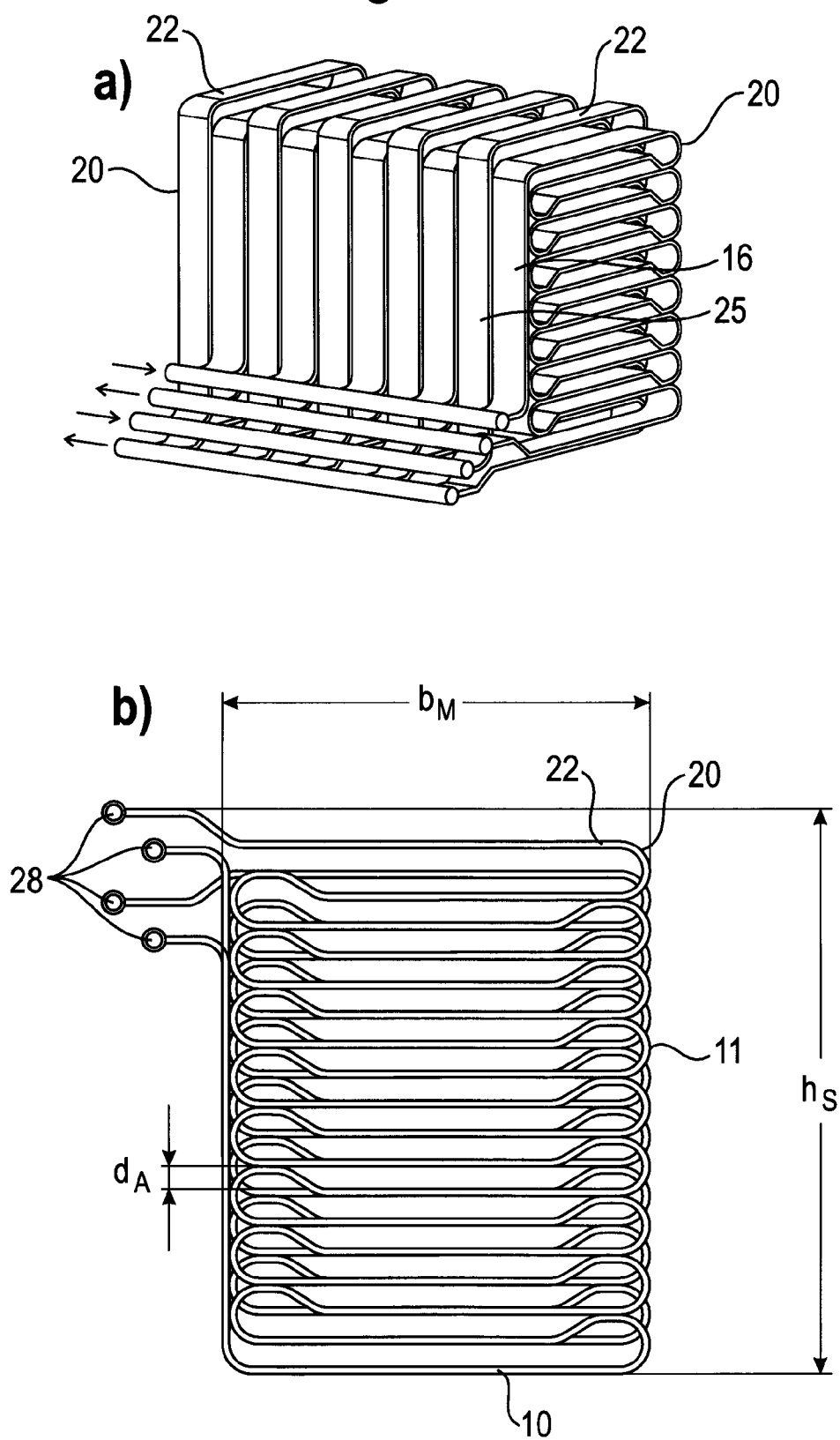
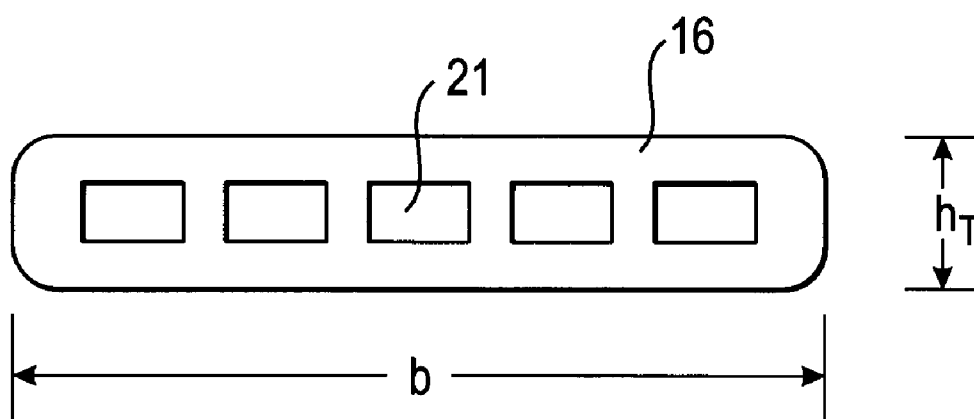


Fig. 4

**CONDENSER DRYER HAVING A HEAT
PUMP, AND METHOD FOR OPERATING THE
SAME**

[0001] The invention relates to a condenser dryer having a heat pump that includes a special evaporator and/or condenser and to a preferred method for operating the dryer.

[0002] In a condenser dryer, air (what is termed process air) is ducted by a fan over a heater into a drum containing damp laundry items and serving as a drying chamber. The hot air absorbs moisture from the laundry items requiring to be dried. Having passed through the drum the then moist process air is ducted into a heat exchanger in front of which a lint filter is as a rule connected.

[0003] That drying process is energy-intensive because when the process air is cooled in the heat exchanger the heat in the current of process air is in energy terms lost to the process with the heated current of cooling air. That energy loss can be significantly reduced by employing a heat pump. In a condenser dryer fitted with a heat pump the warm, moisture-laden process air is cooled substantially in the evaporator of the heat pump, where the transferred heat is used for evaporating a refrigerant circulating in the heat pump. The refrigerant that is evaporated through being heated is fed via a compressor to the heat pump's condenser where, owing to the gaseous refrigerant's being condensed, heat is released that is used for heating the process air before it enters the drum. The water contained in the moist process air condenses in the evaporator. The condensed water is then generally collected in a suitable container and the cooled and dried process air fed back to the heater and then to the drum.

[0004] Described in DE 40 23 000 C2 is a laundry dryer that has a heat pump and in which an air-intake opening that can be sealed by means of a controllable sealing device is located in the process-air channel between the heat source and heat sink.

[0005] Proceeding from both WO 2008/107266 A1 and WO 2008/119611 A1 is a laundry dryer having a heat pump. A heat pump in a laundry dryer is as a rule embodied as a compact unit and located beneath the drum for the laundry items requiring to be dried. There is no electric heater for the process air.

[0006] DE 20 2006 014 718 U1 relates to a laundry drier that has a heat pump that uses CO₂ as the medium and in which a heat exchanger is employed that has a plurality of heat-exchanging bodies and at least one tube—arranged to be in thermal contact with said bodies—for the medium, with a thermal conduction inside each heat-exchanging body being greater than a thermal conduction between the heat-exchanging bodies. Sections assigned to different temperature ranges of the tube are therein in contact with different heat-exchanging bodies in such a way that each heat-exchanging body is assigned to only one temperature range of the tube. The heat-exchanging bodies are formed in particular by plates, with the edges of the plates of adjacent heat-exchanging bodies being separated by a gap by means of which a thermal separation is realized. Differently sized heat-exchanging bodies are joined to the meandering tube, with its also being possible for the loop density of the meandering tube to change along the heat exchanger's length.

[0007] WO 06/101565 A1 relates to a heat-exchanger arrangement, in particular a cooling system, that includes a compressor for conveying a coolant along a flow path in at least one system operating mode and a first and second heat

exchanger, with at least one of said heat exchangers including a flat-tube heat exchanger. The flat-tube heat exchanger has a serpentine configuration defining a plurality of substantially parallel flow paths. The heat exchanger can include a plurality of rows of serpentine windings in the case of which the spacing between the rows (known as the row pitch) can be changed. The invention ought to be advantageous especially for compact commercial cooling systems such as, for instance, bottle coolers.

[0008] US 2007/0084590 A1 relates to a heat exchanger for exchanging heat between a first fluid and a second fluid, in particular a heat exchanger for motor vehicles for exchanging heat between water and a coolant. The heat exchanger includes a first flow path unit for a first fluid, which unit contains at least two return flow paths that are mutually opposed, and a second flow path unit having second flow paths in which a second fluid flows perpendicularly to the first fluid. The first flow path unit's flow paths are shaped as, for example, meandering and embodied as flat tubes. The second flow paths contain a U-shaped flow path. The heat exchanger thus consists of two flow path units that are arranged in a complex manner with respect to each other.

[0009] Every heat pump hitherto employed in a condenser dryer has heat exchangers (evaporators, condensers) that are relatively large and tend, moreover, to become soiled by lint particles carried on the process air so that the need for cleaning and maintenance is substantial. That problem along with ways and means for resolving it are presented in documents WO 2008/107266 A1 and WO 2008/119611 A1. The problem has been a pronounced one to date in particular because the tubes employed in the heat exchangers used hitherto have lamellas for efficient heat exchanging, meaning they do not have level surfaces. The air resistance is moreover high in a design of such kind and hence the process air's flow is not optimal.

[0010] The object of the invention was therefore to provide a condenser dryer having a heat pump and further to provide a method for operating the dryer by means of which dryer and method the above problems will be obviated. That is to be achieved in particular using a compact and low-maintenance heat exchanger.

[0011] Said object is inventively achieved by means of a condenser dryer having the features of the corresponding independent claims and by means of the method set out in the corresponding independent claim. Preferred embodiments of the inventive condenser dryer are listed in corresponding dependent claims. Preferred embodiments of the inventive method correspond to preferred embodiments of the inventive condenser dryer even if that is not explicitly established herein.

[0012] The subject matter of the invention is hence a condenser dryer having a drying chamber for the items requiring to be dried, a process-air circuit, a fan in the process-air circuit, and a heat pump, in which a refrigerant circulates, having an evaporator, a compressor, a throttle, and a condenser, with the evaporator and/or condenser being a heat exchanger having level surfaces and including at least one endlessly folded, flattened tube that forms a plurality of rows of mutually laterally offset meander stacks.

[0013] The term "endlessly folded, flattened tube" is also abbreviated below to "flattened tube".

[0014] "Endlessly folded" within the meaning of the invention means there are no connections, by way of braces, for example, between individual sections of the flattened tube.

[0015] “A plurality of rows of mutually laterally offset meander stacks” means there are at least two meander stacks in the heat exchanger that are mutually laterally offset, with their being “laterally offset” resulting preferably in meander stacks that are arranged substantially mutually parallel. There are preferably 3 to 30 meander stacks and particularly preferably 5 to 20 meander stacks.

[0016] “Level surface” means that the heat exchanger has no lamellas or ribs through which the tube would extend and which would serve to enlarge the heat exchanger’s surface available for heat exchanging. The surface necessary for effective heat exchanging is inventively achieved by flattening and multiply folding the tube used in the heat exchanger.

[0017] The flattened tube’s width b and height h_T , otherwise remaining the same, its length will generally depend on the evaporator’s and/or condenser’s desired heat-exchanging capacity. Because the transfer of heat is significantly better in the case of moist air, the flattened tube’s length when the heat exchanger is used as a condenser is therein preferably 1.5 to 3 times longer than when the heat exchanger is used as an evaporator. If in an embodiment of the invention the flattened tube is used both in the evaporator and in the condenser and the heights h_T and widths b of the flattened tubes respectively employed in the condenser and evaporator are different, the respective tube lengths in the condenser and evaporator will preferably be set such as to produce a value of 1.5 to 3 for the ratio between an overall tube surface A_T^C in the condenser and an overall tube surface A_T^E in the evaporator.

[0018] In a preferred embodiment of the invention the flattened tube has at least two hollow chambers extending in a longitudinal direction of the tube. The heat pump’s refrigerant is generally located in the hollow chambers. The flattened tube has preferably three to eight hollow chambers extending in a longitudinal direction of the tube.

[0019] “Flattened tube” within the meaning of the invention includes any tube whose height h_T is less than its width b . Tubes of such kind can be produced by, for example, in a manner known per se to a person skilled in the relevant art deforming a tube originally having a circular cross-section.

[0020] Preferably the ratio b/h_T between a width b and height h_T of the flattened tube is in the 4-to-25 range, preferably in the 7-to-20 range, and quite particularly preferably in the 8-to-15 range.

[0021] Used in a preferred embodiment are flattened tubes having a height h_T in the 1-to-5-mm range, preferably 1.5 to 3 mm, and a width b in the 10-to-50-mm range, preferably 15 to 30 mm.

[0022] In another preferred embodiment of the invention the evaporator and/or condenser include(s) at least two endlessly folded, flattened tubes each forming a plurality of rows of mutually laterally offset meander stacks. The respective plurality of rows of mutually laterally offset meander stacks of the at least two endlessly folded, flattened tubes have therein preferably been pushed one into the other.

[0023] In the inventively employed heat exchanger the first and, where applicable, further flattened tubes are generally suitably embodied at their ends so that when used as an evaporator and/or condenser they can be built into a heat pump.

[0024] When at least two endlessly folded, flattened tubes are used they can be connected in parallel or in series. When said tubes are connected in series, a refrigerant used in the heat pump initially flows through a first flattened tube and then through a second and, where applicable, further flattened

tube(s). When said tubes are connected in parallel, a flow of refrigerant is by contrast divided into a plurality of partial flows. Said partial flows will then be ducted through the at least two endlessly folded, flattened tubes simultaneously.

[0025] In the inventive condenser dryer it is preferred for the at least two endlessly folded, flattened tubes to be connected in parallel. Possible losses of pressure can be advantageously reduced thereby.

[0026] In a particularly preferred embodiment of the inventive condenser dryer the at least one endlessly folded, flattened tube has a level surface.

[0027] It is furthermore preferred for the endlessly folded, flattened tube to be located completely in the process-air circuit. That will be advantageous particularly when the at least one endlessly folded, flattened tube has a flat surface. “Flat” here means that the surface does not contain any substantial structures of the nature of ribs, naps, lamellas, and suchlike. It is inventively possible to achieve the desired properties in terms of heat exchanging solely through the tube’s having been flattened and multiply folded without having to use any additional components such as ribs, lamellas, and suchlike. The heat exchanger will thereby be given a particularly level surface that will in any event not favor the deposition of dirt such as lint particles and moreover be very easy to clean. Said surface can for that purpose possibly also have been provided with a dirt-repellant coating.

[0028] The flattened tube is made preferably of copper or aluminum, particularly preferably of aluminum.

[0029] In a preferred embodiment the flattened tube has straight sections and curved sections in at least one meander stack, with the straight sections being mutually parallel and a distance d_A between the straight sections and a height h_T of the flattened tube forming a d_A/h_T ratio that is preferably in the 1.5-to-10 range and particularly preferably the 2-to-7 range.

[0030] The distance d_A is preferably 3 to 10 mm and more preferably 5 to 8 mm; with a height h_T in the 1-to-5-mm range, preferably the 1.5-to-3-mm range, and a width b in the 10-to-50-mm range, preferably the 15-to-30-mm range.

[0031] Owing to the endless folding and the formation of mutually laterally offset meander stacks, the flattened tube employed in the inventive condenser dryer preferably forms approximately a cuboid having a height h_s , a width b_M , and a depth d_M . The height h_s is preferably in the 80-to-250-mm range and more preferably the 100-to-200-mm range. The width b_M is preferably in the 50-to-200-mm range and more preferably the 80-to-150-mm range. The depth d_M is preferably in the 120-to-300-mm range and more preferably the 150-to-250-mm range.

[0032] The inventive condenser dryer can be embodied as an exhaust-air dryer or a circulating-air dryer.

[0033] The process air can be heated exclusively via the heat pump’s condenser. An electric heater can, though, be employed additionally in the inventive condenser dryer. In a preferred embodiment of the invention the heat pump’s condenser is the only heater for the process air. The condenser is therein arranged preferably in the process-air circuit between the fan and an outlet of the drying chamber.

[0034] The inventive condenser dryer preferably has an acoustic and/or optical display means for displaying one or more operating statuses. An optical display means can be, for example, a liquid-crystal display on which specific requests or advisories are indicated. It is additionally or alternatively possible for light-emitting diodes to light up in one or more colors.

[0035] To better control the heat-exchanging processes in the condenser dryer the inventive condenser dryer can additionally include an air-to-air heat exchanger embodied preferably as detach-able. That will be especially advantageous because a detachable heat exchanger can be more easily cleaned of lint particles.

[0036] The refrigerant employed in the heat pump has preferably been selected from the group that includes propane, carbon dioxide, fluorohydrocarbon compounds, and mixtures of such, in particular the fluorohydrocarbon compounds R134a and R152a and the mixtures R407C and R410A.

[0037] How the hollow chambers are embodied will generally depend on what refrigerant has been selected. In particular the size of the hollow chambers, the distance of the hollow chambers from the tube surface, and the distance between the hollow chambers themselves will depend on the refrigerant. Small distances or, as the case may be, thin walls are possible in the case of refrigerants having a relatively low vapor pressure so that the portion of the hollow chambers' cross-section referred to the flattened tube's overall cross-section can be large.

[0038] Alongside an evaporator, a condenser, and a compressor, the heat pump in the inventive condenser dryer has in the refrigerant's direction of flow between the condenser and evaporator a throttle, in particular an expansion valve, a restrictor, or a capillary.

[0039] The refrigerant employed in the heat pump circulates preferably with a turbulent flow. A turbulent flow can be set by means of a structurally suitably embodied flow channel and/or by means of suitable drive means (for example a compressor).

[0040] The temperature of the heat pump's refrigerant, in particular in the condenser, is kept within the permissible range generally via the heat pump's controller and, where applicable, an additional air-to-air heat exchanger. If there is an additional heater for the condenser dryer in the process-air circuit, controlling of the heat pump will preferably be coordinated with that of the heater.

[0041] It is inventively preferred for process air and cooling air or, as the case may be, process air and refrigerant in the heat pump to be ducted in each case by a cross-flow or, as the case may be, counter-current method through the corresponding heat exchangers.

[0042] If alongside the heat pump another heater is employed in the inventive condenser dryer, said heater will preferably be a two-stage heater. Because the energy needed for drying decreases with the advancing degree of dryness of the items requiring to be dried in the condenser dryer, it is expedient to regulate the heater accordingly, meaning to lessen its heating power as the degree of dryness advances in order to maintain an equilibrium between the drying energy supplied and that which is necessary.

[0043] A lesser heating power or even an increasing cooling power of the heat pump will hence be necessary with the advancing degree of dryness of the items requiring to be dried, laundry in particular. Particularly the temperature in the process-air circuit would rise sharply after a concluded drying phase. The heat pump and, where applicable, an additional heater in the condenser dryer will therefore generally be regulated such that a maximum permissible temperature will not be exceeded in the drying chamber.

[0044] Temperature sensors known per se to a person skilled in the relevant art are generally employed in the heat pump and/or process-air circuit for monitoring the tempera-

ture of the refrigerant or as the case may be, heat pump and, where applicable, the temperature of the process air.

[0045] The invention relates also to a method for operating a condenser dryer having a drying chamber for the items requiring to be dried, a process-air circuit, a fan in the process-air circuit, and a heat pump, in which a refrigerant circulates, having an evaporator, a compressor, a throttle, and a condenser, with the evaporator and/or condenser being a heat exchanger having level surfaces and including at least one endlessly folded, flattened tube that forms a plurality of rows of mutually laterally offset meander stacks, with a refrigerant being ducted through the flattened tube and causing an exchange of heat with a process air.

[0046] The invention has the advantage that compact and easy-to-maintain heat exchangers capable, moreover, of being produced economically can be used as evaporators and/or condensers in the condenser dryer. The flow of the process air through the heat pump's heat exchanger(s) is furthermore improved in the inventive condenser dryer. The heat exchanger employed in the inventive condenser dryer has a low flow resistance. Unlike a conventional condenser dryer, the inventive condenser dryer has a heat exchanger even around whose curved region process air can flow with no loss of performance. The result is a condenser dryer having improved heat-exchanging efficiency.

[0047] Further details of the invention will emerge from the following description of non-limiting exemplary embodiments of the inventive condenser dryer and of a method employing said condenser dryer. Reference is therein made to FIGS. 1 to 4.

[0048] FIG. 1 shows a vertical section through a condenser dryer fitted with a heat pump.

[0049] FIG. 2 shows a first embodiment of a heat exchanger employed in the condenser dryer and having a single endlessly folded, flattened tube. FIG. 2a) is a perspective view and FIG. 2b) a lateral view.

[0050] FIG. 3 shows a second embodiment of a heat exchanger employed in the condenser dryer and having two endlessly folded, flattened tubes. FIG. 3a) is a perspective view and FIG. 3b) a lateral view.

[0051] FIG. 4 shows a cross-section through a flattened tube employed in an embodiment of the condenser dryer.

[0052] FIG. 1 shows a vertical section through a condenser dryer 1 (abbreviated below to "dryer" 1) fitted with a heat pump. Dryer 1 has a drum 3, which can be turned around a horizontal axis, serving as a drying chamber 3 secured inside which are agitators 4 for moving laundry while the drum is turning. Process air is ducted by means of a fan 19 through a drum 3 and a heat pump 13, 14, 15, 17 in an air channel 2 in a closed circuit (process-air circuit 2). The moist, warm process air is cooled after passing through drum 3 then heated up again when the moisture contained in the process air has condensed. Heated air is therein ducted from behind, meaning from the side of drum 3 opposite a door 5, through a perforated base into drum 3, makes contact there with the laundry requiring to be dried, and flows through the loading opening of drum 3 to a lint filter 6 inside a door 5 that seals the loading opening. The air current is then redirected downward in door 5 and ducted in air channel 2 via an outlet 26 to evaporator 13 of heat pump 13, 14, 15, 17 where it is cooled. The heat pump's refrigerant therein evaporated in evaporator 13 is ducted via a compressor 14 to condenser 15. The refrigerant condenses in condenser 15, therein giving off heat to the process air. The refrigerant now existing in liquid form is then

ducted back to evaporator 13 via a throttle 17, as a result of which the refrigerant circuit will have been closed. Below evaporator 13 is a condensate tray 23 in which the condensate produced as the moist, warm process air cools is collected. The condensate can be safely removed through mechanical emptying, for example, or by being pumped out of condensate tray 23.

[0053] Both evaporator 13 and condenser 15 have an endlessly folded, smooth, flattened tube not shown in further detail in FIG. 1.

[0054] In the embodiment shown in FIG. 1, drum 3 is supported on the rear base by means of a pivot bearing and at the front by means of an end shield 7, with drum 3 resting with a flange on a glide strip 8 on end shield 7 and being thus retained on the front end. The condenser dryer 1 is controlled via a controller 10 that can be regulated by the user via a control unit 9. Different statuses of condenser dryer 1 can be optically or acoustically indicated by means of a display device 18.

[0055] Dryer 1 shown in FIG. 1 has an electric supplementary heater 27.

[0056] FIG. 2 shows a first embodiment of a heat exchanger that is employed in condenser dryer 1 and has level surfaces and a single endlessly folded, flattened tube 16 forming eleven laterally offset meander stacks 20. FIG. 2a) is a perspective view and FIG. 2b) a lateral view. 10 signifies a straight section of flattened tube 16 and 11 a curved section of flattened tube 16. d_M is the depth, h_S is the height, and b_M is the width of the heat exchanger. d_A is a distance between two straight sections 10. 28 signifies terminals for feeding a refrigerant in and out.

[0057] FIG. 3 shows a second embodiment of a heat exchanger that is employed in condenser dryer 1 and has level surfaces and two endlessly folded, flattened tubes 16 and 25. Flattened tube 16 forms five meander stacks 20 and flattened tube 25 forms five meander stacks 22. FIG. 3a) is a perspective view and FIG. 3b) a lateral view. 10 signifies a straight section of flattened tubes 16 and 25 and 11 a curved section of flattened tubes 16 and 25. d_A is a distance between two straight sections 10. 28 signifies terminals for feeding a refrigerant in and out. The open arrows indicate the direction in which the refrigerant flows in flattened tubes 16 and 25.

[0058] FIG. 4 shows a cross-section through a flattened tube 16 used in an embodiment of condenser dryer 1. Five hollow chambers 21 extend in a longitudinal direction of flattened tube 16 in the embodiment shown here. Flattened tube 16 has a height h_T and a width b .

[0059] The refrigerant is ducted through flattened tube 16 and an exchange of heat with the process air effected when said condenser dryer 1 in which evaporator 13 and/or condenser 15 is a heat exchanger 13, 15 having level surfaces and including at least one endlessly folded, flattened tube 16 that forms a plurality of rows of mutually laterally offset meander stacks 20 is operating.

[0060] Compact and easy-to-maintain heat exchangers 13, 15 that have level surfaces and are capable, moreover, of being produced economically are hence employed in condenser dryer 1. The flow of the process air through heat exchanger(s) 13, 15 of heat pump 13, 14, 15, 17 is furthermore improved because a heat exchanger 13, 15 of such kind has a low flow resistance. Process air can flow around heat exchanger 13, 15 even in the curved region of flattened tube 16 with no loss of performance. The result is a condenser dryer 1 having improved heat-exchanging efficiency.

1-13. (canceled)

14. A condenser dryer, comprising:

a drying chamber for items to be dried;
a process-air circuit including a fan; and
a heat pump in which a refrigerant circulates, said heat pump having an evaporator and a condenser, said evaporator or said condenser, or both, being a heat exchanger having level surfaces and including at least one endlessly folded, flattened tube to form a plurality of rows of meander stacks in laterally offset relationship.

15. The condenser dryer of claim 14, wherein said flattened tube has at least two hollow chambers extending in a longitudinal direction of the tube.

16. The condenser dryer of claim 15, wherein the flattened tube has three to eight hollow chambers extending in a longitudinal direction of the tube.

17. The condenser dryer of claim 14, wherein the flattened tube is defined by a ratio between a width and height in a range of 4 to 25.

18. The condenser dryer of claim 14, wherein one of the evaporator or condenser, or both, includes at least two endlessly folded, flattened tubes, each tube forming a plurality of rows of mutually laterally offset meander stacks.

19. The condenser dryer of claim 18, wherein each plurality of rows of mutually laterally offset meander stacks of the at least two endlessly folded, flattened tubes have been pushed one into another of said pluralities.

20. The condenser dryer of claim 18, wherein at least two endlessly folded, flattened tubes are connected in parallel.

21. The condenser dryer of claim 18, wherein at least two endlessly folded, flattened tubes are connected in series.

22. The condenser dryer of claim 18, wherein the at least one endlessly folded, flattened tube has a flat surface.

23. The condenser dryer of claim 18, wherein the endlessly folded, flattened tube is located completely in the process-air circuit.

24. The condenser dryer of claim 18, wherein the flattened tube is made of copper or aluminum.

25. The condenser dryer of claim 18, wherein the flattened tube has straight sections and curved sections in at least one meander stack, said straight sections extending in parallel relationship at a distance, with a ratio of the distance between the straight sections and a height of the tube being defined by a range from 1.5 to 10.

26. A method for operating a condenser dryer having a drying chamber for items requiring to be dried, a process-air circuit, a fan in the process-air circuit, and a heat pump in which a refrigerant circulates, the heat pump having an evaporator, a compressor, a throttle, and a condenser, the evaporator and/or condenser being a heat exchanger, said method comprising the steps of:

providing level surfaces on the heat exchanger and at least one endlessly folded, flattened tube that forms a plurality of rows of meander stacks in laterally offset relationship;
ducting a refrigerant through the flattened tube; and
ducting the process air over the flattened tube so as to cause an exchange of heat between the refrigerant and the process air.

27. The method of claim 26, wherein a turbulent flow of refrigerant is provided in the step of ducting refrigerant through the flattened tube.

28. The method of claim 26, wherein the refrigerant is ducted by a cross-flow method, relative to the process air.

29. The method of claim **26**, wherein a turbulent flow of refrigerant is ducted by a counter-current method, relative to the process air.

30. The method of claim **26**, wherein the condenser dryer also has an air-to-air heat exchanger, said method further comprising the step of coordinating the control of the heat pump with the control of the air-to-air heat exchanger so as to keep the temperature of the refrigerant in the heat pump within a predetermined range.

31. The method of claim **30**, wherein the step of coordinating control of the heat pump with the control of the air-to-air

heat exchanger lessens the heating power of the air-to-air heat exchanger as the degree of dryness of the items requiring to be dried in the condenser dryer advances.

32. The method of claim **30**, wherein the step of coordinating control of the heat pump with the control of the air-to-air heat exchanger increases the cooling power of the heat pump as the degree of dryness of the items requiring to be dried in the condenser dryer advances.

* * * * *