



(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.11.2017 Bulletin 2017/48

(51) Int Cl.:

D06F 58/20^(2006.01) D06F 58/02^(2006.01)

(21) Application number: 17166069.9

(22) Date of filing: 11.04.2017

<div>(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 Designated Validation States: MA MD</div> <div>(30) Priority: 27.05.2016 CN 201610369195</div> <div>(71) Applicant: Hangzhou Sanhua Home Appliance Thermal Management System Co., Ltd. 310018 Hangzhou Zhejiang (CN)</div>	<div>(72) Inventors:</div> <div> <ul style="list-style-type: none"> CUI, Kai Zhejiang, Zhejiang 310018 (CN) WANG, Yiming Zhejiang, Zhejiang 310018 (CN) GAO, Pengfei Zhejiang, Zhejiang 310018 (CN) HUANG, Linjie 310018 Zhejiang (DE) </div> <div>(74) Representative: Zimmermann, Tankred Klaus et al Schoppe, Zimmermann, Stöckeler Zinkler, Schenk & Partner mbB Patentanwälte Radtkoferstrasse 2 81373 München (DE)</div>
--	--

(54)

CLOTHES DRYER

(57)

A clothes dryer (100) is provided, comprising a casing (4); a drying drum (1) provided with a drying cavity therein and provided with an air outlet (12) and a return air inlet (11) which are in communication with the drying cavity, wherein the drying drum (1) is disposed in the casing (4) and an air duct (2) is defined between the drying drum (1) and the casing (4), wherein two ends of the air duct (2) are in communication with the return air inlet (11) and the air outlet (12) respectively; a heat pump system disposed in the casing, comprising a compressor (31), a condenser (32), a throttling element (33), a multi-channel evaporator (34) and a tube-fin evaporator (35) which form a circulation loop of refrigerant, wherein the

multi-channel evaporator (34) and the tube-fin evaporator (35) are in parallel connection or in series connection, and the condenser (32), the multi-channel evaporator (34) and the tube-fin evaporator (35) are disposed in the air duct (2), wherein in a flowing direction of the air of the air duct (2), the tube-fin evaporator (35) is located upstream of the multi-channel evaporator (34). In the clothes dryer (100) according to the present disclosure, the evaporator (34, 35) is easy to clean, and the heat exchange efficiency of the evaporator (34, 35) may be improved, thus improving the working efficiency of the clothes dryer (100).

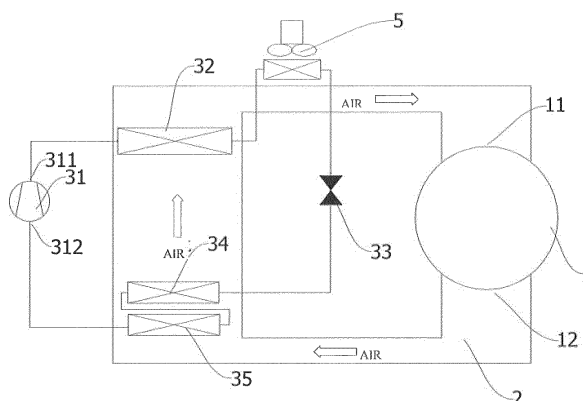


Fig. 3

Description

FIELD

[0001] The present disclosure relates to a technical field of electric appliances, and more particularly to a clothes dryer.

BACKGROUND

[0002] A clothes dryer in the related art is generally provided with a tube-fin evaporator or a multi-channel evaporator.

[0003] With regard to the clothes dryer having the multi-channel evaporator, fins of the multi-channel evaporator have a high density, so that the multi-channel evaporator has high heat exchange efficiency. However in use of the clothes dryer, matters on the clothes such as dust and fluff flow along with air and accumulate on the multi-channel evaporator, making it difficult to clean the multi-channel evaporator. Coupled with that water condenses on a surface of the multi-channel evaporator and water, dust and fluff tend to be solidified on the surface of the multi-channel evaporator, a resistance of heat transfer between the fin and air is increased, and a heat transfer coefficient of the multi-channel evaporator is reduced, moreover a wind resistance of an air duct of the clothes dryer is increased and a circulating air rate is reduced, which are adverse to an improvement of working efficiency of the clothes dryer.

SUMMARY

[0004] Embodiments of the present disclosure seek to solve at least one of the problems existing in the related art to at least some extent. To this end, a clothes dryer is provided by the present disclosure, which may not only facilitate cleaning of an evaporator, but also may improve heat exchange efficiency, being beneficial for improving working efficiency of the clothes dryer.

[0005] The clothes dryer according to embodiments of the present disclosure includes: a casing; a drying drum provided with a drying cavity therein and provided with an air outlet and a return air inlet which are in communication with the drying cavity, in which the drying drum is disposed in the casing and an air duct is defined between the drying drum and the casing, in which two ends of the air duct are in communication with the return air inlet and the air outlet respectively; a heat pump system disposed in the casing, including a compressor, a condenser, a throttling element, a multi-channel evaporator and a tube-fin evaporator which form a circulation loop of refrigerant, in which the multi-channel evaporator and the tube-fin evaporator are in parallel connection or in series connection, and the condenser, the multi-channel evaporator and the tube-fin evaporator are disposed in the air duct, in which in a flowing direction of the air in the air duct, the tube-fin evaporator is located upstream of the multi-

channel evaporator.

[0006] In the clothes dryer according to embodiments of the present disclosure, the heat pump system includes the multi-channel evaporator and the tube-fin evaporator at the same time, and the multi-channel evaporator and the tube-fin evaporator are in parallel connection or in series connection, the condenser, the multi-channel evaporator and the tube-fin evaporator are disposed in the air duct, moreover in the flowing direction of the air in the air duct, the tube-fin evaporator is located upstream of the multi-channel evaporator. Thus, by disposing the multi-channel evaporator and the tube-fin evaporator at the same time, the heat exchange efficiency of the evaporator may be improved, thus improving the working efficiency of the clothes dryer. Moreover in the flowing direction of the air in the air duct, the tube-fin evaporator is located upstream of the multi-channel evaporator, thus the wet air discharged out from the air outlet may firstly run through the tube-fin evaporator and exchange heat with the tube-fin evaporator, and may subsequently continue to flow through the multi-channel evaporator. By this way, the fluff in the air discharged out from the air outlet accumulates on the tube-fin evaporator not on the multi-channel evaporator, not only the fluff on the tube-fin evaporator is easy to clean, but also the multi-channel evaporator is easy to clean, and at the same time the problems, such as an increase of resistance of heat transfer between the multi-channel evaporator 34 and the air, a decrease of heat transfer coefficient of the multi-channel evaporator 34, an increase of wind resistance in the air duct 2 and a decrease of circulation air, caused by the fluff solidified on the multi-channel evaporator 34 in the related art are avoided.

[0007] According to some embodiments of the present disclosure, the multi-channel evaporator and the tube-fin evaporator are in parallel connection, the clothes dryer further includes a resistance element in series connection with the tube-fin evaporator and configured to increase a flow resistance of the refrigerant.

[0008] Specifically, the resistance element is configured as a capillary tube, a counterbalance valve, a pressure regulating valve or an electronic expansion valve.

[0009] Specifically, the resistance element is located at an outlet side of the tube-fin evaporator.

[0010] According to some embodiments of the present disclosure, a flowing direction of the refrigerant between the multi-channel evaporator and the tube-fin evaporator is reverse to a flowing direction of the air in the air duct, and the multi-channel evaporator includes a plurality of rows of heat exchange tubes, optionally flat tubes, in which a flowing direction of the refrigerant between the plurality of rows of heat exchange tubes is reverse to the flowing direction of the air in the air duct.

[0011] According to some embodiments of the present disclosure, the multi-channel evaporator is disposed obliquely with respect to a horizontal plane.

[0012] According to some embodiments of the present disclosure, the multi-channel evaporator is configured as

a parallel flow multi-channel evaporator or a snakelike multi-channel evaporator.

[0013] According to some embodiments of the present disclosure, a distance between a fin and an adjacent fin of the tube-fin evaporator has a value range of 0.5mm-5mm.

[0014] According to some embodiments of the present disclosure, the flat tubes of the multi-channel evaporator are disposed at an included angle having a value range of 60-90° relative to the horizontal plane.

[0015] According to some embodiments of the present disclosure, a flat tube of the multi-channel evaporator has a width of 8-30mm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] These and other aspects and advantages of embodiments of the present disclosure will become apparent and more readily appreciated from the following descriptions made with reference to the drawings, in which:

Fig. 1 is a schematic view of a condenser with a tube-fin evaporator and a multi-channel evaporator according to some embodiments of the present disclosure;

Fig. 2 is a schematic view of a partial structure of a clothes dryer according to some embodiments of the present disclosure;

Fig. 3 is a schematic view of a clothes dryer according to some embodiments of the present disclosure;

Fig. 4 is a schematic view of a condenser with a tube-fin evaporator and a multi-channel evaporator according to some other embodiments of the present disclosure;

Fig. 5 is a schematic view of a partial structure of a clothes dryer according to some other embodiments of the present disclosure;

Fig. 6 is a schematic view of a clothes dryer according to some other embodiments of the present disclosure;

Fig. 7 is a schematic view of a condenser with a tube-fin evaporator and a multi-channel evaporator according to some further embodiments of the present disclosure;

Fig. 8 is a schematic view of a clothes dryer according to some further embodiments of the present disclosure.

Reference numerals:

[0017]

clothes dryer 100;
drying drum 1; air outlet 12; return air inlet 11;
air duct 2;
compressor 31; gas outlet 311; return gas inlet 312;
condenser 32; throttling element 33; multi-channel

evaporator 34; tube-fin evaporator 35; resistance element 351;

casing 4; fan 5.

DETAILED DESCRIPTION

[0018] Reference will be made in detail to embodiments of the present disclosure. The embodiments described herein with reference to drawings are explanatory, illustrative, and used to generally understand the present disclosure. The embodiments shall not be construed to limit the present disclosure.

[0019] In the specification, it is to be understood that terms such as "central," "longitudinal," "lateral," "length," "width," "thickness," "upper," "lower," "front," "rear," "left," "right," "vertical," "horizontal," "top," "bottom," "inner," "outer," "clockwise," and "counterclockwise" should be construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience of description and do not require that the present invention be constructed or operated in a particular orientation. In the description of the present invention, "a plurality of" means two or more than two, unless specified otherwise.

[0020] In the present invention, unless specified or limited otherwise, the terms "mounted," "connected," "coupled," "fixed" and the like are used broadly, and may be, for example, fixed connections, detachable connections, or integral connections; may also be mechanical or electrical connections; may also be direct connections or indirect connections via intervening structures; may also be inner communications of two elements, which can be understood by those skilled in the art according to specific situations.

[0021] A clothes dryer 100 according to embodiments of the present disclosure will be described in the following with reference to Figs. 1-8. The clothes dryer 100 may be used for drying clothes, towels and the like. It should be noted herein that, the clothes dryer 100 may be configured to have merely a single drying function, and certainly the clothes dryer 100 may also be configured to have drying and washing functions at the same time.

[0022] As shown in Figs. 1-8, the clothes dryer 100 according to embodiments of the present disclosure may include a casing 4, a drying drum 1 and a heat pump system. In which, the drying drum 1 and the heat pump system may be disposed in the casing 4 at the same time. On one hand, the casing 4 may play a role in supporting the drying drum 1 and the heat pump system, and on the other hand, the casing 4 may also play a role in optimizing an appearance of the clothes dryer 100.

[0023] The drying drum 1 is provided with a drying cavity therein, clothes and towels and the like to be dried may be put in the drying cavity. Specifically, the drying drum 1 is provided with an air outlet 12 and a return air inlet 11 which are in communication with the drying cavity. Air may enter the drying cavity from the return air inlet 11 and flow out of the drying cavity from the air outlet 12.

[0024] An air duct 2 is defined between the drying drum 1 and the casing 4. Two ends of the air duct 2 are in communication with the return air inlet 11 and the air outlet 12 respectively. Thus, air in the air duct 2 may enter the drying cavity from the return air inlet 11, so as to dry the clothes, towels and the like in the drying cavity. Subsequently the air may be discharged out from the air outlet 12.

[0025] The heat pump system includes a compressor 31, a condenser 32, a throttling element 33, a multi-channel evaporator 34 and a tube-fin evaporator 35 forming a circulation loop of refrigerants. Thus, by integrating the multi-channel evaporator 34 and the tube-fin evaporator 35 with the clothes dryer 100 at the same time, a heat exchange effect of the evaporator may be improved, so as to improve drying efficiency of the clothes dryer 100.

[0026] The condenser 32, the multi-channel evaporator 34 and the tube-fin evaporator 35 are disposed in the air duct 2. In a flowing direction of the air in the air duct 2, the tube-fin evaporator 35 is located upstream of the multi-channel evaporator 34. Thus, the wet air discharged out from the air outlet 12 may run through the tube-fin evaporator 35 firstly and exchange heat with the tube-fin evaporator 35, then continue to flow through the multi-channel evaporator 34. In this way, the fluff in the air discharged out from the air outlet 12 accumulates on the tube-fin evaporator 35 not on the multi-channel evaporator 34, not only the fluff on the tube-fin evaporator 35 is easy to clean, but also the multi-channel evaporator 34 is easy to clean, and at the same time the problems, such as an increase of resistance of heat transfer between the multi-channel evaporator 34 and the air, a decrease of heat transfer coefficient of the multi-channel evaporator 34, an increase of wind resistance in the air duct 2 and a decrease of circulation air, caused by the fluff solidified on the multi-channel evaporator 34 in the related art are avoided.

[0027] Specifically, the compressor 31 has a gas outlet 311 and a return gas inlet 312. After heat exchange, the refrigerant may return to the compressor 31 from the return gas inlet 312, and after being compressed by the compressor 31, the refrigerant may be discharged out from the gas outlet 311.

[0028] One end (for example, a left end shown in Figs. 2, 5 and 8) of the condenser 32 is connected to the gas outlet 311 of the compressor 31, the other end (for example, a right end shown in Figs. 2, 5 and 8) of the condenser 32 is connected to the throttling element 33. The refrigerant discharged out from the gas outlet 311 of the compressor 31 may flow to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air, subsequently the refrigerant flows to the throttling element 33 which may throttle the refrigerant and reduce pressure of the refrigerant.

[0029] As shown in Fig. 1-Fig. 8, the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection or in series connection. Specifically,

when the multi-channel evaporator 34 and the tube-fin evaporator 35 are in series connection, one end (for example a right end shown in Fig. 3) of the tube-fin evaporator 35 is connected to one end (for example a left end shown in Fig. 3) of the multi-channel evaporator 34, the other end (for example the left end shown in Fig. 3) of the tube-fin evaporator 35 is connected to the return gas inlet 312, and the other end (for example the right end shown in Fig. 3) of the multi-channel evaporator 34 is connected to the throttling element 33. The refrigerant at a high temperature and high pressure discharged out from the gas outlet 311 of the compressor 31 may flow to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air. After heat exchange, the refrigerant flows to the throttling element 33, and after throttling and pressure reduction by the throttling element 33, the refrigerant then flows to the multi-channel evaporator 34 and the tube-fin evaporator 35 in sequence. The refrigerant exchanges heat with the surrounding air in the multi-channel evaporator 34 and the tube-fin evaporator 35 so as to condense the water vapor in the surrounding wet air, and subsequently the refrigerant returns to the compressor 31 through the return gas inlet 312 of the compressor 31, so as to form the refrigerant circulation. The air in the air duct 2 becomes hot air after exchanging heat with the condenser 32 and flows into the drying cavity through the return air inlet 11 so as to dry the clothes, towel and the like in the drying cavity, the hot air takes the moisture in the clothes, towel and the like away, becomes wet air and is discharged out from the air outlet 12. The wet air discharged out from the air outlet 12 firstly runs through the tube-fin evaporator 35 and exchanges heat with the tube-fin evaporator 35, and subsequently continues to flow through the multi-channel evaporator 34 and exchanges heat with the multi-channel evaporator 34, so as to condense the water vapor in the wet air into the condensed water, and then the dry air continues to flow to the condenser 32, so as to form the circulation in the air duct.

[0030] When the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection, the throttling element 33 is connected to one end (for example the right end shown in Fig. 6 and Fig. 8) of the tube-fin evaporator 35 and one end (for example the right end shown in Fig. 6 and Fig. 8) of the multi-channel evaporator 34 at the same time, and the return gas inlet 312 is connected to the other end (for example the left end shown in Fig. 6 and Fig. 8) of the tube-fin evaporator 35 and the other end (for example the left end shown in Fig. 6 and Fig. 8) of the multi-channel evaporator 34 at the same time. The refrigerant at a high temperature and high pressure discharged out from the gas outlet 311 of the compressor 31 flows to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air. After heat exchange, the refrigerant flows to the throttling element 33, and after throttling and

pressure reduction by the throttling element 33, the refrigerant then flows to the multi-channel evaporator 34 and the tube-fin evaporator 35 at the same time. The refrigerant exchanges heat with the surrounding air in the multi-channel evaporator 34 and the tube-fin evaporator 35 so as to condense the water vapor in the surrounding wet air, and subsequently the refrigerant is discharged out from the multi-channel evaporator 34 and the tube-fin evaporator 35 and returns to the compressor 31 through the return gas inlet 312 of the compressor 31, so as to form the refrigerant circulation. The air in the air duct 2 becomes hot air after exchanging heat with the condenser 32 and flows into the drying cavity through the return air inlet 11 so as to dry the clothes, towel and the like in the drying cavity, the hot air takes the moisture in the clothes, towel and the like away, becomes wet air and is discharged out from the air outlet 12. The wet air discharged out from the air outlet 12 firstly runs through the tube-fin evaporator 35 and exchanges heat with the tube-fin evaporator 35, and subsequently continues to flow through the multi-channel evaporator 34 and exchanges heat with the multi-channel evaporator 34, so as to condense the water vapor in the wet air, and then the dry air continues to flow to the condenser 32, so as to form the circulation in the air duct.

[0031] In the clothes dryer 100 according to embodiments of the present disclosure, the heat pump system includes the multi-channel evaporator 34 and the tube-fin evaporator 35 at the same time, the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection or in series connection, the condenser 32, the multi-channel evaporator 34 and the tube-fin evaporator 35 are disposed in the air duct 2, moreover in the flowing direction of the air of the air duct 2, the tube-fin evaporator 35 is located upstream of the multi-channel evaporator 34. Thus, by disposing the multi-channel evaporator 34 and the tube-fin evaporator 35 at the same time, the heat exchange efficiency of the evaporator may be improved, which facilitates improvement of the working efficiency of the clothes dryer 100. Moreover in the flowing direction of the air of the air duct 2, the tube-fin evaporator 35 is located upstream of the multi-channel evaporator 34, thus the wet air discharged out from the air outlet 12 may firstly run through the tube-fin evaporator 35 and exchange heat with the tube-fin evaporator 35, and then subsequently continue to flow through the multi-channel evaporator 34. By this way, the fluff in the air discharged out from the air outlet 12 accumulates on the tube-fin evaporator 35 not on the multi-channel evaporator 34, not only the fluff on the tube-fin evaporator 35 is easy to clean, but also the multi-channel evaporator 34 is easy to clean, and at the same time the problems, such as an increase of resistance of heat transfer between the multi-channel evaporator 34 and the air, a decrease of heat transfer coefficient of the multi-channel evaporator 34, an increase of wind resistance in the air duct 2 and a decrease of circulation air, caused by the fluff solidified on the multi-channel evaporator 34 in the

related art are avoided.

[0032] Specifically, a water container (not shown in the drawings) may be disposed under the multi-channel evaporator 34 and the tube-fin evaporator 35, so as to collect the condensed water generated by the wet air running through the tube-fin evaporator 35 and the multi-channel evaporator 34. Furthermore, the clothes dryer 100 also includes a water tank (not shown in the drawings), the water tank is disposed above the tube-fin evaporator 35 and the multi-channel evaporator 34. Water in the water container may flow into the water tank, and when the multi-channel evaporator 34 and the tube-fin evaporator 35 need to be cleaned, water in the water tank may be sprayed on the multi-channel evaporator 34 and the tube-fin evaporator 35 under an action of gravity, so as to clean the multi-channel evaporator 34 and the tube-fin evaporator 35.

[0033] In some embodiments of the present disclosure, the clothes dryer 100 further includes a fan 5. The fan 5 may blow the air in the air duct 2 to the condenser 32 so as to expedite the heat exchange between the condenser 32 and the air, so that after heat exchange, the air can conveniently flow to the drying cavity through the return air inlet 11, thereby improving the drying efficiency of the clothes dryer 100.

[0034] According to some embodiments of the present disclosure, as shown in Fig. 7-Fig. 8, the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection, the clothes dryer 100 further includes a resistance element 351 which is in series connection with the tube-fin evaporator 35 and configured to increase the flow resistance of the refrigerant. Specifically, when the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection, the refrigerant in the multi-channel evaporator 34 has a flow resistance different from that in the tube-fin evaporator 35. In general, the refrigerant in the multi-channel evaporator 34 has a flow resistance greater than that in the tube-fin evaporator 35, and as the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection, the refrigerant flux in the multi-channel evaporator 34 is lower. The resistance element 351 is configured to reduce the refrigerant flux in the tube-fin evaporator 35, so that the refrigerant fluxes in the multi-channel evaporator 34 and the tube-fin evaporator 35 are equilibrated, thereby further optimizing the effects of heat exchange in the multi-channel evaporator 34 and the tube-fin evaporator 35.

[0035] Specifically, the resistance element 351 may be configured as a capillary tube, a counterbalance valve, a pressure regulating valve or an electronic expansion valve, thus the structure is simple and reliable.

[0036] Furthermore, as shown in Fig. 8, the resistance element 351 is located at an outlet side of the tube-fin evaporator 35. Certainly, the present disclosure is not limited to this. In other embodiments, the resistance element 351 may also be disposed at other positions of the tube-fin evaporator 35, for example the resistance element 351 may be located at an inlet side of the tube-

fin evaporator 35 as long as the resistance element 351 can increase the flow resistance of the refrigerant in the tube-fin evaporator 35.

[0037] According to some embodiments of the present disclosure, in the flowing direction of the air in the air duct, an inlet end of the tube-fin evaporator 35 is located downstream of an outlet end of the tube-fin evaporator 35, and an inlet end of the multi-channel evaporator 34 is located downstream of an outlet end of the multi-channel evaporator 34. Thus, both the flowing directions of the refrigerant in the tube-fin evaporator 35 and in the multi-channel evaporator 34 are reverse to the flowing direction of the air in the air duct 2. Specifically, the general flowing direction of the refrigerant in the tube-fin evaporator 35 and in the multi-channel evaporator 34 is roughly reverse to the general flowing direction of the air in the air duct 2, and the flowing direction of the refrigerant between the multi-channel evaporator 34 and the tube-fin evaporator 35 is reverse to the flowing direction of the air in the air duct. For example, the multi-channel evaporator 34 includes a plurality of rows of heat exchange tubes such as flat tubes, and the flowing direction of the refrigerant among the plurality of rows of heat exchange tubes is reverse to the flowing direction of the air in the air duct. The tube-fin evaporator 35 includes a plurality of rows of heat exchange tubes, and the flowing direction of the refrigerant among the plurality of rows of heat exchange tubes is reverse to the flowing direction of the air in the air duct, which facilitates improvement of the effect of heat exchange between the air and the tube-fin evaporator 35 and between the air and the multi-channel evaporator 34.

[0038] In some embodiments of the present disclosure, the multi-channel evaporator 34 is disposed obliquely with respect to a horizontal plane, so that the multi-channel evaporator 34 is easy to clean.

[0039] Optionally, the multi-channel evaporator 34 is configured as a parallel flow multi-channel evaporator 34 or a snakelike multi-channel evaporator 34, thus the structure is simple and reliable.

[0040] According to some embodiments of the present disclosure, a distance between a fin and an adjacent fin of the tube-fin evaporator 35 has a value range of 0.5mm-5mm. Preferably, the distance between the fin and the adjacent fins of the tube-fin evaporator 35 has a value range of 1mm-1.5mm.

[0041] Specifically, the fin of the tube-fin evaporator 35 may be configured as a flat fin, a wavy fin, a louvered fin or a slit fin. Preferably, the fin of the tube-fin evaporator 35 may be configured as a flat fin.

[0042] Optionally, the tube-fin evaporator 35 may have 1-5 rows of the tubes. Preferably, the tube-fin evaporator 35 has 1-2 rows of the tubes.

[0043] It should be noted that, all the other structures and relevant parameters of the tube-fin evaporator 35 are the prior art, which will not be elaborated herein.

[0044] In some embodiments of the present disclosure, the flat tubes of the multi-channel evaporator 34

are disposed at an included angle having a value range of 60-90° relative to the horizontal plane. Specifically, the flat tubes of the multi-channel evaporator 34 are disposed at the included angle having the value range of 60-90° relative to the horizontal plane, and the flat tubes of the multi-channel evaporator 34 are disposed along a flowing direction of the air. Optionally, the multi-channel evaporator 34 may have 1-4 rows of flat tubes. Preferably, the multi-channel evaporator 34 has 2-3 rows of flat tubes.

[0045] Optionally, the flat tube of the multi-channel evaporator 34 may have a width of 8-30mm. Preferably, the flat tube of the multi-channel evaporator 34 has the width of 12-20mm.

[0046] Specifically, the multi-channel evaporator 34 includes a header, and the flat pipes are fixed to the header. Optionally, the header is disposed along the horizontal direction.

[0047] Optionally, the multi-channel evaporator 34 has 10-18 fins per inch. Preferably, the multi-channel evaporator 34 has 12.7 or 14 fins per inch.

[0048] It should be noted that, all the other structures and relevant parameters of the multi-channel evaporator 34 are the prior art, which will not be elaborated herein.

[0049] The specific structures of the clothes dryer 100 according to embodiments of the present disclosure will be described in detail in the following with reference to Figs. 1-8.

Embodiment 1

[0050] As shown in Figs. 1-3, the clothes dryer 100 according to the embodiment of the present disclosure includes the casing 4, the drying drum 1, the water tank, the fan 5 and the heat pump system. In which, the drying drum 1, the fan 5, the water tank and the heat pump system are all disposed in the casing 4 at the same time.

[0051] The drying cavity is disposed in the drying drum 1, and the clothes, towels and the like to be dried may be put in the drying cavity. Specifically, the drying drum 1 is provided with the air outlet 12 and the return air inlet 11 which are in communication with the drying cavity. The air may enter the drying cavity from the return air inlet 11 and flow out of the drying cavity from the air outlet 12.

[0052] The air duct 2 is defined between the drying drum 1 and the casing 4. Two ends of the air duct 2 are in communication with the return air inlet 11 and the air outlet 12 respectively. Thus, the air in the air duct 2 may enter the drying cavity from the return air inlet 11, so as to dry the clothes, towels and the like in the drying cavity. Subsequently the air may be discharged out from the air outlet 12.

[0053] The heat pump system includes the compressor 31, the condenser 32, the throttling element 33, the multi-channel evaporator 34 and the tube-fin evaporator 35 forming the circulation loop of refrigerants. Thus, by integrating the multi-channel evaporator 34 and the tube-fin evaporator 35 on the clothes dryer 100 at the same

time, the heat exchange effect of the evaporator may be improved, being beneficial for improving the drying efficiency of the clothes dryer 100.

[0054] The fan 5, the condenser 32, the multi-channel evaporator 34 and the tube-fin evaporator 35 are disposed in the air duct 2. In the flowing direction of the air in the air duct 2, the tube-fin evaporator 35 is located upstream of the multi-channel evaporator 34. Thus, the wet air discharged out from the air outlet 12 may run through the tube-fin evaporator 35 firstly and exchange heat with the tube-fin evaporator 35, then continue to flow through the multi-channel evaporator 34. In this way, the fluff in the air discharged out from the air outlet 12 accumulates on the tube-fin evaporator 35 not on the multi-channel evaporator 34, not only the fluff on the tube-fin evaporator 35 is easy to clean, but also the multi-channel evaporator 34 is easy to clean, and at the same time the problems, such as an increase of resistance of heat transfer between the multi-channel evaporator 34 and the air, a decrease of heat transfer coefficient of the multi-channel evaporator 34, an increase of wind resistance in the air duct 2 and a decrease of circulation air, caused by the fluff that is solidified on the multi-channel evaporator 34 in the related art are avoided..

[0055] Specifically, the compressor 31 has the gas outlet 311 and the return gas inlet 312. After heat exchange, the refrigerant may return to the compressor 31 from the return gas inlet 312, and after compression by the compressor 31, the refrigerant may be discharged out from the gas outlet 311.

[0056] One end of the condenser 32 is connected to the gas outlet 311 of the compressor 31, the other end of the condenser 32 is connected to the throttling element 33, thus, the refrigerant discharged out from the gas outlet 311 of the compressor 31 may flow to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air, subsequently the refrigerant flows to the throttling element 33 which throttles the refrigerant and reduces the pressure of the refrigerant.

[0057] As shown in Fig. 3, the multi-channel evaporator 34 and the tube-fin evaporator 35 are in series connection. Specifically, one end of the tube-fin evaporator 35 is connected to one end of the multi-channel evaporator 34, the other end of the tube-fin evaporator 35 is connected to the return gas inlet 312, and the other end of the multi-channel evaporator 34 is connected to the throttling element 33. The refrigerant at a high temperature and high pressure discharged out from the gas outlet 311 of the compressor 31 flows to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air. After heat exchange, the refrigerant flows to the throttling element 33, and after throttling and pressure reduction by the throttling element 33, the refrigerant then flows to the multi-channel evaporator 34 and the tube-fin evaporator 35 in sequence. The refrigerant exchanges heat with the surrounding air in the mul-

ti-channel evaporator 34 and the tube-fin evaporator 35 so as to condense the water vapor in the surrounding wet air, and subsequently the refrigerant returns to the compressor 31 through the return gas inlet 312 of the compressor 31, so as to form the refrigerant circulation. The air in the air duct 2 becomes hot air after exchanging heat with the condenser 32 and flows into the drying cavity through the return air inlet 11 so as to dry the clothes, towels and the like in the drying cavity, the hot air takes the moisture in the clothes, towels and the like away and becomes the wet air which is discharged out from the air outlet 12. The wet air discharged out from the air outlet 12 firstly runs through the tube-fin evaporator 35 and exchanges heat with the tube-fin evaporator 35, and subsequently continues to flow through the multi-channel evaporator 34 and exchanges heat with the multi-channel evaporator 34, so as to condense the water vapor in the wet air into the condensed water, and then the dry air continues to flow to the condenser 32, so as to form the circulation in the air duct.

[0058] Specifically, the water container (not shown in the drawings) is disposed under the multi-channel evaporator 34 and the tube-fin evaporator 35, so as to collect the condensed water generated by the wet air running through the tube-fin evaporator 35 and the multi-channel evaporator 34. The water tank is disposed above the tube-fin evaporator 35 and the multi-channel evaporator 34. Water in the water container may flow into the water tank, and when the multi-channel evaporator 34 and the tube-fin evaporator 35 need to be cleaned, water in the water tank may be sprayed on the multi-channel evaporator 34 and the tube-fin evaporator 35 under the action of gravity, so as to clean the multi-channel evaporator 34 and the tube-fin evaporator 35.

[0059] The fan 5 may blow the air in the air duct 2 to the condenser 32 so as to expedite the heat exchange between the condenser 32 and the air, so that after heat exchange, the air can conveniently flow to the drying cavity through the return air inlet 11, thereby improving the drying efficiency of the clothes dryer 100.

[0060] Specifically, both the flowing directions of the refrigerant in the tube-fin evaporator 35 and in the multi-channel evaporator 34 are reverse to the flowing direction of the air in the air duct 2, which facilitates improvement of the effect of the heat exchange between the air and the tube-fin evaporator 35 and between the air and the multi-channel evaporator 34.

[0061] The multi-channel evaporator 34 is disposed obliquely with respect to the horizontal plane, so that the multi-channel evaporator 34 is easy to clean.

[0062] Specifically, the multi-channel evaporator 34 is configured as the parallel flow multi-channel evaporator 34 or the snakelike multi-channel evaporator 34, thus the structure is simple and reliable.

Embodiment 2

[0063] As shown in Figs. 4-6, the clothes dryer 100

according to the embodiment of the present disclosure includes the casing 4, the drying drum 1, the water tank, the fan 5 and the heat pump system. In which, the drying drum 1, the fan 5, the water tank and the heat pump system are all disposed in the casing 4 at the same time.

[0064] The drying cavity is disposed in the drying drum 1, and the clothes, towels and the like to be dried may be put in the drying cavity. Specifically, the drying drum 1 is provided with the air outlet 12 and the return air inlet 11 which are in communication with the drying cavity. The air may enter the drying cavity from the return air inlet 11 and flow out of the drying cavity from the air outlet 12.

[0065] The air duct 2 is defined between the drying drum 1 and the casing 4. Two ends of the air duct 2 are in communication with the return air inlet 11 and the air outlet 12 respectively. Thus, the air in the air duct 2 may enter the drying cavity from the return air inlet 11, so as to dry the clothes, towels and the like in the drying cavity. Subsequently the air may be discharged out from the air outlet 12.

[0066] The heat pump system includes the compressor 31, the condenser 32, the throttling element 33, the multi-channel evaporator 34 and the tube-fin evaporator 35 forming the circulation loop of refrigerants. Thus, by integrating the multi-channel evaporator 34 and the tube-fin evaporator 35 on the clothes dryer 100 at the same time, the heat exchange effect of the evaporator may be improved, being beneficial for improving the drying efficiency of the clothes dryer 100.

[0067] The fan 5, the condenser 32, the multi-channel evaporator 34 and the tube-fin evaporator 35 are disposed in the air duct 2. In the flowing direction of the air in the air duct 2, the tube-fin evaporator 35 is located upstream of the multi-channel evaporator 34. Thus, the wet air discharged out from the air outlet 12 may run through the tube-fin evaporator 35 firstly and exchange heat with the tube-fin evaporator 35, then continue to flow through the multi-channel evaporator 34. In this way, the fluff in the air discharged out from the air outlet 12 accumulates on the tube-fin evaporator 35 not on the multi-channel evaporator 34, not only the fluff on the tube-fin evaporator 35 is easy to clean, but also the multi-channel evaporator 34 is easy to clean, and at the same time the problems, such as an increase of resistance of heat transfer between the multi-channel evaporator 34 and the air, a decrease of heat transfer coefficient of the multi-channel evaporator 34, an increase of wind resistance in the air duct 2 and a decrease of circulation air, caused by the fluff that is solidified on the multi-channel evaporator 34 in the related art are avoided..

[0068] Specifically, the compressor 31 has the gas outlet 311 and the return gas inlet 312. After heat exchange, the refrigerant may return to the compressor 31 from the return gas inlet 312, and after compression by the compressor 31, the refrigerant may be discharged out from the gas outlet 311.

[0069] One end of the condenser 32 is connected to

the gas outlet 311 of the compressor 31, the other end of the condenser 32 is connected to the throttling element 33, thus, the refrigerant discharged out from the gas outlet 311 of the compressor 31 may flow to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air, subsequently the refrigerant flows to the throttling element 33 which throttles the refrigerant and reduces the pressure of the refrigerant.

[0070] As shown in Fig. 6, the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection. Specifically, the throttling element 33 is connected to one end of the tube-fin evaporator 35 and one end of the multi-channel evaporator 34 at the same time, and the return gas inlet 312 is connected to the other end of the tube-fin evaporator 35 and the other end of the multi-channel evaporator 34 at the same time. The refrigerant at high temperature and high pressure discharged out from the gas outlet 311 of the compressor 31 flows to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air. After heat exchange, the refrigerant flows to the throttling element 33, and after throttling and pressure reduction by the throttling element 33, the refrigerant then flows to the multi-channel evaporator 34 and the tube-fin evaporator 35 at the same time. The refrigerant exchanges heat with the surrounding air in the tube-fin evaporator 35 and the multi-channel evaporator 34 so as to condense the water vapor in the surrounding wet air, and subsequently the refrigerant is discharged out from the tube-fin evaporator 35 and the multi-channel evaporator 34 and returns to the compressor 31 through the return gas inlet 312 of the compressor 31, so as to form the refrigerant circulation.

The air in the air duct 2 becomes hot air after exchanging heat with the condenser 32 and flows into the drying cavity through the return air inlet 11 so as to dry the clothes, towels and the like in the drying cavity, the hot air takes the moisture in the clothes, towels and the like away and becomes wet air which is discharged out from the air outlet 12. The wet air discharged out from the air outlet 12 firstly runs through the tube-fin evaporator 35 and exchanges heat with the tube-fin evaporator 35, and subsequently continues to flow through the multi-channel evaporator 34 and exchanges heat with the multi-channel evaporator 34, so as to condense the water vapor in the wet air, and then the dry air continues to flow to the condenser 32, so as to form the circulation in the air duct.

[0071] Specifically, the water container (not shown in the drawings) is disposed under the multi-channel evaporator 34 and the tube-fin evaporator 35, so as to collect the condensed water generated by the wet air running through the tube-fin evaporator 35 and the multi-channel evaporator 34. The water tank is disposed above the tube-fin evaporator 35 and the multi-channel evaporator 34. Water in the water container may flow into the water tank, and when the multi-channel evaporator 34 and the tube-fin evaporator 35 need to be cleaned, water in the

water tank may be sprayed on the multi-channel evaporator 34 and the tube-fin evaporator 35 under the action of gravity, so as to clean the multi-channel evaporator 34 and the tube-fin evaporator 35.

[0072] The fan 5 may blow the air in the air duct 2 to the condenser 32 so as to expedite the heat exchange between the condenser 32 and the air, so that after heat exchange, the air can conveniently flow to the drying cavity through the return air inlet 11, thereby improving the drying efficiency of the clothes dryer 100.

[0073] Specifically, both the flowing directions of the refrigerant in the tube-fin evaporator 35 and in the multi-channel evaporator 34 are reverse to the flowing direction of the air in the air duct 2, which facilitates improvement of the effect of the heat exchange between the air and the tube-fin evaporator 35 and between the air and the multi-channel evaporator 34.

[0074] The multi-channel evaporator 34 is disposed obliquely with respect to the horizontal plane, so that the multi-channel evaporator 34 is easy to clean.

[0075] Specifically, the multi-channel evaporator 34 is configured as the parallel flow multi-channel evaporator 34 or the snakelike multi-channel evaporator 34, thus the structure is simple and reliable.

Embodiment 3

[0076] As shown in Figs. 7-8, the clothes dryer 100 according to the embodiment of the present disclosure includes the casing 4, the drying drum 1, the water tank, the fan 5, the resistance element 351 and the heat pump system. In which, the drying drum 1, the fan 5, the water tank and the heat pump system are all disposed in the casing 4 at the same time.

[0077] The drying cavity is disposed in the drying drum 1, and the clothes, towels and the like to be dried may be put in the drying cavity. Specifically, the drying drum 1 is provided with the air outlet 12 and the return air inlet 11 which are in communication with the drying cavity. The air may enter the drying cavity from the return air inlet 11 and flow out of the drying cavity from the air outlet 12.

[0078] The air duct 2 is defined between the drying drum 1 and the casing 4. Two ends of the air duct 2 are in communication with the return air inlet 11 and the air outlet 12 respectively. Thus, the air in the air duct 2 may enter the drying cavity from the return air inlet 11, so as to dry the clothes, towels and the like in the drying cavity. Subsequently the air may be discharged out from the air outlet 12.

[0079] The heat pump system includes the compressor 31, the condenser 32, the throttling element 33, the multi-channel evaporator 34 and the tube-fin evaporator 35 forming the circulation loop of refrigerants. Thus, by integrating the multi-channel evaporator 34 and the tube-

fin evaporator 35 on the clothes dryer 100.

[0080] The fan 5, the condenser 32, the multi-channel evaporator 34 and the tube-fin evaporator 35 are disposed in the air duct 2. In the flowing direction of the air in the air duct 2, the tube-fin evaporator 35 is located upstream of the multi-channel evaporator 34. Thus, the wet air discharged out from the air outlet 12 may run through the tube-fin evaporator 35 firstly and exchange heat with the tube-fin evaporator 35, then continue to flow through the multi-channel evaporator 34. In this way, the fluff in the air discharged out from the air outlet 12 accumulates on the tube-fin evaporator 35 not on the multi-channel evaporator 34, not only the fluff on the tube-fin evaporator 35 is easy to clean, but also the multi-channel evaporator 34 is easy to clean, and at the same time the problems, such as an increase of resistance of heat transfer between the multi-channel evaporator 34 and the air, a decrease of heat transfer coefficient of the multi-channel evaporator 34, an increase of wind resistance in the air duct 2 and a decrease of circulation air, caused by the fluff that is solidified on the multi-channel evaporator 34 in the related art are avoided..

[0081] Specifically, the compressor 31 has the gas outlet 311 and the return gas inlet 312. After heat exchange, the refrigerant may return to the compressor 31 from the return gas inlet 312, and after compression by the compressor 31, the refrigerant may be discharged out from the gas outlet 311.

[0082] One end of the condenser 32 is connected to the gas outlet 311 of the compressor 31, the other end of the condenser 32 is connected to the throttling element 33, thus, the refrigerant discharged out from the gas outlet 311 of the compressor 31 may flow to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air, subsequently the refrigerant flows to the throttling element 33 which throttles the refrigerant and reduces the pressure of the refrigerant.

[0083] As shown in Fig. 8, the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection. Specifically, the throttling element 33 is connected to one end of the tube-fin evaporator 35 and one end of the multi-channel evaporator 34 at the same time, and the return gas inlet 312 is connected to the other end of the tube-fin evaporator 35 and the other end of the multi-channel evaporator 34 at the same time. The refrigerant at high temperature and high pressure discharged out from the gas outlet 311 of the compressor 31 flows to the condenser 32, and the refrigerant exchanges heat with the surrounding air in the condenser 32 so as to raise the temperature of the surrounding air. After heat exchange, the refrigerant flows to the throttling element 33, and after throttling and pressure reduction by the throttling element 33, the refrigerant then flows to the tube-fin evaporator 35 and the multi-channel evaporator 34 at the same time. The refrigerant exchanges heat with the surrounding air in the tube-fin evaporator 35 and the multi-channel evaporator 34 so as to condense the water

vapor in the surrounding wet air, and subsequently the refrigerant is discharged out from the tube-fin evaporator 35 and the multi-channel evaporator 34 and returns to the compressor 31 through the return gas inlet 312 of the compressor 31, so as to form the refrigerant circulation. The air in the air duct 2 becomes hot air after exchanging heat with the condenser 32 and flows into the drying cavity through the return air inlet 11 so as to dry the clothes, towels and the like in the drying cavity, the hot air takes the moisture in the clothes, towels and the like away and becomes wet air which is discharged out from the air outlet 12. The wet air discharged out from the air outlet 12 firstly runs through the tube-fin evaporator 35 and exchanges heat with the tube-fin evaporator 35, and subsequently continues to flow through the multi-channel evaporator 34 and exchanges heat with the multi-channel evaporator 34, so as to condense the water vapor in the wet air, and then the dry air continues to flow to the condenser 32, so as to form the circulation in the air duct.

[0084] The resistance element 351 is in series connection with the tube-fin evaporator 35 so as to increase the flow resistance of the refrigerant. As shown in Fig. 8, the resistance element 351 is located at the outlet side of the tube-fin evaporator 35. Specifically, when the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection, the refrigerant in the multi-channel evaporator 34 has a flow resistance different from that in the tube-fin evaporator 35. In general, the refrigerant in the multi-channel evaporator 34 has a flow resistance greater than that in the tube-fin evaporator 35, and as the multi-channel evaporator 34 and the tube-fin evaporator 35 are in parallel connection, the refrigerant flux in the multi-channel evaporator 34 is lower. The resistance element 351 is configured to reduce the refrigerant flux in the tube-fin evaporator 35, so that the refrigerant fluxes in the multi-channel evaporator 34 and the tube-fin evaporator 35 are equilibrated, thereby further optimizing the effects of heat exchange in the multi-channel evaporator 34 and the tube-fin evaporator 35.

[0085] Specifically, the resistance element 351 is configured as a capillary tube, a counterbalance valve, a pressure regulating valve or an electronic expansion valve, thus the structure is simple and reliable.

[0086] Specifically, the water container (not shown in the drawings) is disposed under the multi-channel evaporator 34 and the tube-fin evaporator 35, so as to collect the condensed water generated by the wet air running through the tube-fin evaporator 35 and the multi-channel evaporator 34. The water tank is disposed above the tube-fin evaporator 35 and the multi-channel evaporator 34. Water in the water container may flow into the water tank, and when the multi-channel evaporator 34 and the tube-fin evaporator 35 need to be cleaned, water in the water tank may be sprayed on the multi-channel evaporator 34 and the tube-fin evaporator 35 under the action of gravity, so as to clean the multi-channel evaporator 34 and the tube-fin evaporator 35.

[0087] The fan 5 may blow the air in the air duct 2 to

the condenser 32 so as to expedite the heat exchange between the condenser 32 and the air, so that after heat exchange, the air can conveniently flow to the drying cavity through the return air inlet 11, thereby improving the drying efficiency of the clothes dryer 100.

[0088] Specifically, both the flowing directions of the refrigerant in the tube-fin evaporator 35 and in the multi-channel evaporator 34 are reverse to the flowing direction of the air in the air duct 2, which facilitates improvement of the effect of the heat exchange between the air and the tube-fin evaporator 35 and between the air and the multi-channel evaporator 34.

[0089] The multi-channel evaporator 34 is disposed obliquely with respect to the horizontal plane, so that the multi-channel evaporator 34 is easy to clean.

[0090] Specifically, the multi-channel evaporator 34 is configured as the parallel flow multi-channel evaporator 34 or the snakelike multi-channel evaporator 34, thus the structure is simple and reliable.

[0091] In the present invention, unless specified or limited otherwise, a structure in which a first feature is "on" or "below" a second feature may include an embodiment in which the first feature is in direct contact with the second feature, and may also include an embodiment in which the first feature and the second feature are not in direct contact with each other, but are contacted via an additional feature formed therebetween. Furthermore, a first feature "on," "above," or "on top of" a second feature may include an embodiment in which the first feature is right or obliquely "on," "above," or "on top of" the second feature, or just means that the first feature is at a height higher than that of the second feature; while a first feature "below," "under," or "on bottom of" a second feature may include an embodiment in which the first feature is right or obliquely "below," "under," or "on bottom of" the second feature, or just means that the first feature is at a height lower than that of the second feature.

[0092] Reference throughout this specification to "an embodiment," "some embodiments," "one embodiment," "another example," "an example," "a specific example," or "some examples," means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. Thus, the appearances of the phrases such as "in some embodiments," "in one embodiment," "in an embodiment," "in another example," "in an example," "in a specific example," or "in some examples," in various places throughout this specification are not necessarily referring to the same embodiment or example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

[0093] Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that the above embodiments cannot be construed to limit the present disclosure, and changes,

alternatives, and modifications can be made in the embodiments without departing from spirit, principles and scope of the present disclosure.

Claims

1. A clothes dryer (100) comprising:

a casing (4);
a drying drum (1) provided with a drying cavity therein and provided with an air outlet (12) and a return air inlet (11) which are in communication with the drying cavity, wherein the drying drum (1) is disposed in the casing (4) and an air duct (2) is defined between the drying drum (1) and the casing (4), and two ends of the air duct (2) are in communication with the return air inlet (11) and the air outlet (12) respectively;
a heat pump system, disposed in the casing (4), comprising a compressor (31), a condenser (32), a throttling element (33), a multi-channel evaporator (34) and a tube-fin evaporator (35) which form a circulation loop of a refrigerant, wherein the multi-channel evaporator (34) and the tube-fin evaporator (35) are in parallel connection or in series connection, and the condenser (32), the multi-channel evaporator (34) and the tube-fin evaporator (35) are disposed in the air duct, and in a flowing direction of air in the air duct (2), the tube-fin evaporator (35) is located upstream of the multi-channel evaporator (34).

2. The clothes dryer (100) according to claim 1, wherein the multi-channel evaporator (34) and the tube-fin evaporator (35) are in parallel connection, and the clothes dryer (100) further comprises a resistance element (351) in series connection with the tube-fin evaporator (35) and configured to increase a flow resistance of the refrigerant.

3. The clothes dryer (100) according to claim 2, wherein the resistance element (351) is configured as a capillary tube, a counterbalance valve, a pressure regulating valve or an electronic expansion valve.

4. The clothes dryer (100) according to claim 2 or 3, wherein the resistance element (351) is located at an outlet side or an inlet side of the tube-fin evaporator (35).

5. The clothes dryer according to any one of claims 1-4, wherein a flowing direction of the refrigerant between the multi-channel evaporator (34) and the tube-fin evaporator (35) is reverse to a flowing direction of the air in the air duct (2), and the multi-channel evaporator (34) comprises a plurality of rows of heat ex-

change tubes, optionally flat tubes, a flowing direction of the refrigerant between the plurality of rows of heat exchange tubes is reverse to the flowing direction of the air in the air duct.

6. The clothes dryer (100) according to any one of claims 1-5, wherein the multi-channel evaporator (34) is disposed obliquely with respect to a horizontal plane.

7. The clothes dryer (100) according to any one of claims 1-6, wherein the multi-channel evaporator (34) is configured as a parallel flow multi-channel evaporator (34) or a snakelike multi-channel evaporator.

8. The clothes dryer (100) according to any one of claims 1-7, wherein a distance between a fin and an adjacent fin of the tube-fin evaporator (35) has a value range of 0.5mm-5mm, preferably 1-1.5mm.

9. The clothes dryer (100) according to claim 6, wherein the flat tubes of the multi-channel evaporator (34) are disposed at an included angle having a value range of 60-90° relative to the horizontal plane, and particularly the flat tubes of the multi-channel evaporator (34) are disposed along a flowing direction of the air.

10. The clothes dryer (100) according to any one of claims 1-9, wherein a flat tube of the multi-channel evaporator (34) has a width of 8-30mm, preferably 12-20mm.

11. The clothes dryer (100) according to any one of claims 1-10, wherein the tube-fin evaporator (35) has 1-5 rows, preferably 1-2 rows, of tubes.

12. The clothes dryer (100) according to any one of claims 1-11, wherein the multi-channel evaporator (34) has 1-4 rows, preferably 2-3 rows, of flat tubes.

13. The clothes dryer (100) according to any one of claims 1-12, wherein the multi-channel evaporator (34) comprises a header, and the flat pipes are fixed to the header, optionally, the header is disposed along the horizontal direction.

14. The clothes dryer (100) according to any one of claims 1-13, wherein the multi-channel evaporator (34) has 10-18 fins, preferably 12.7 or 14, per inch.

15. The clothes dryer (100) according to any one of claims 1-14, further comprising:

a fan (5);
a water container disposed under the multi-channel evaporator (34) and the tube-fin evaporator (35).

orator (35); and
a water tank disposed above the tube-fin evaporator (35) and the multi-channel evaporator (34).

5

10

15

20

25

30

35

40

45

50

55

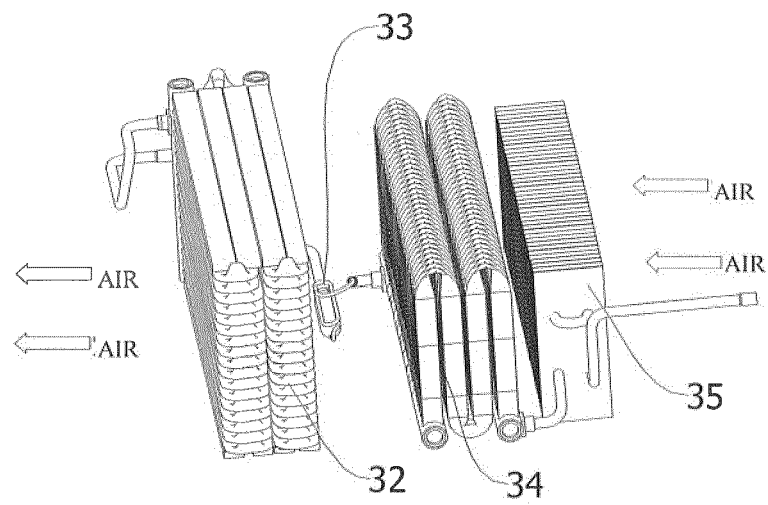


Fig. 1

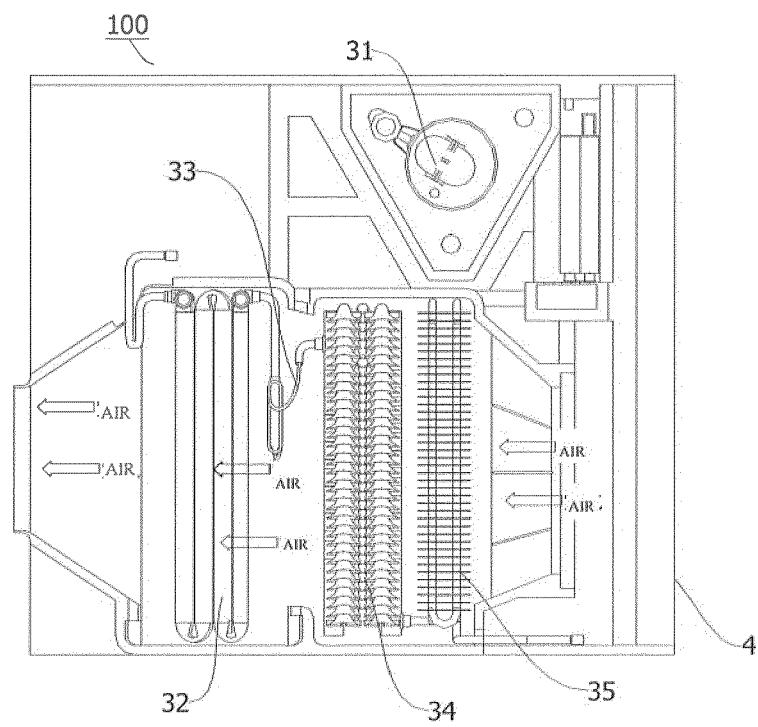


Fig. 2

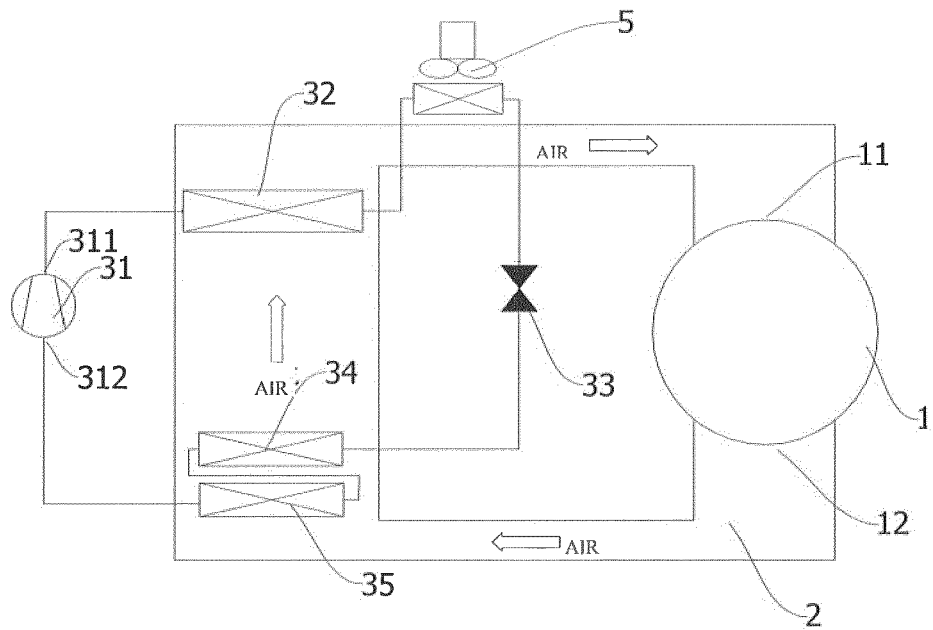


Fig. 3

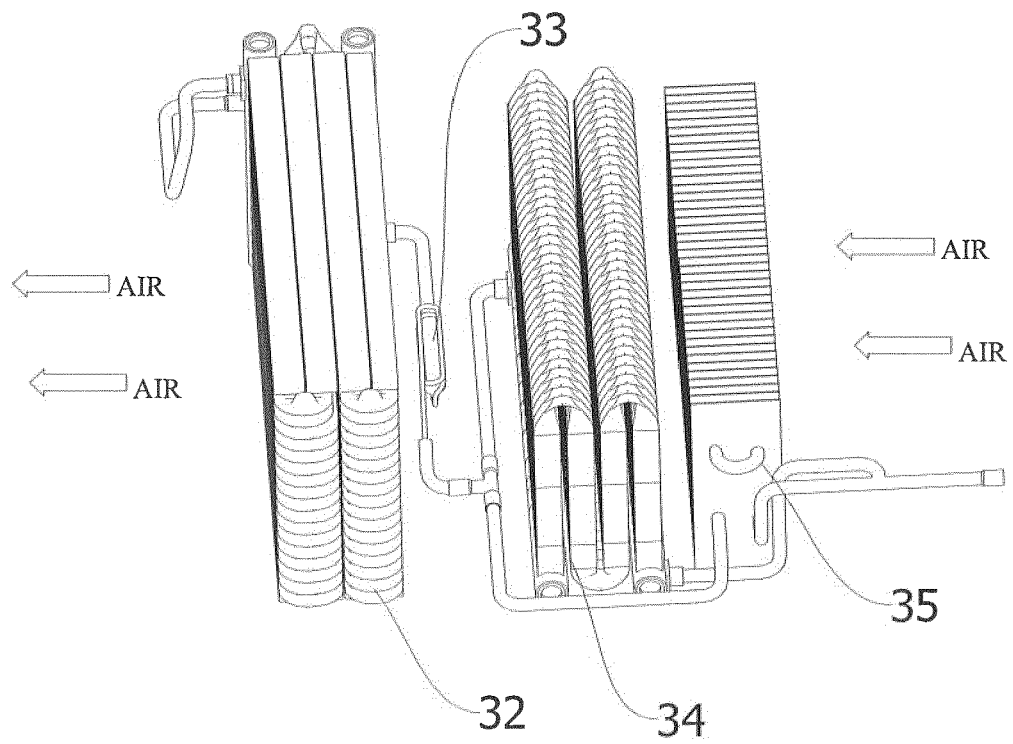


Fig. 4

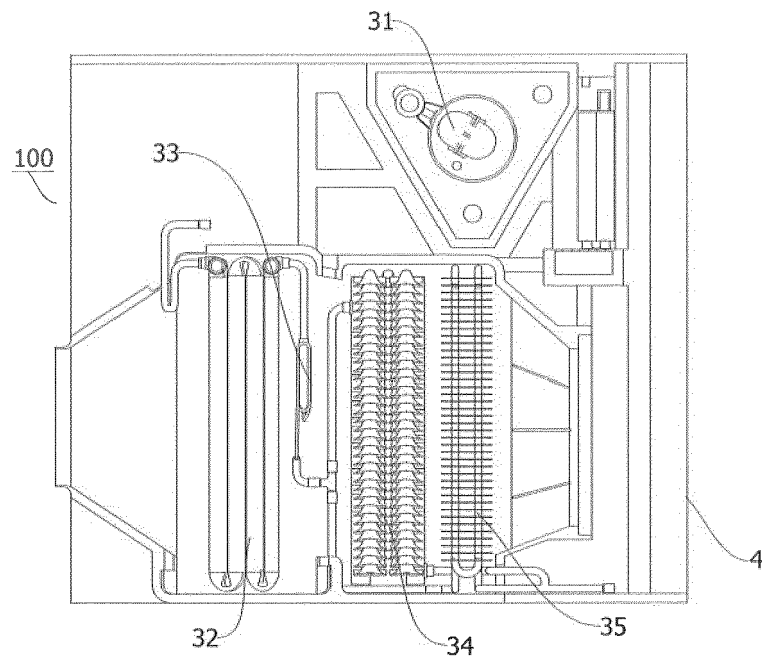


Fig. 5

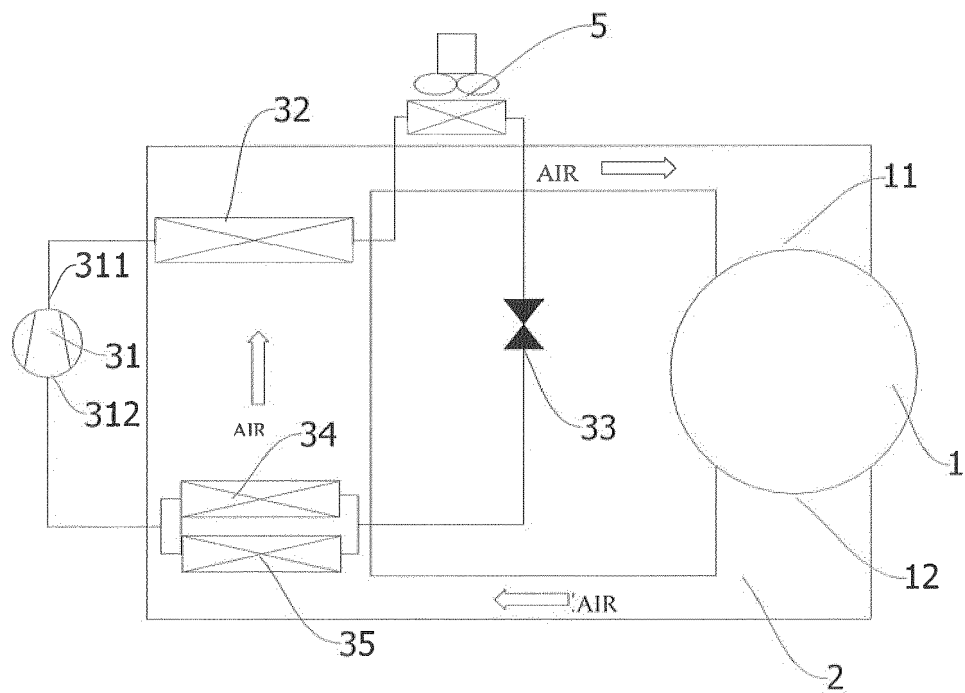


Fig. 6

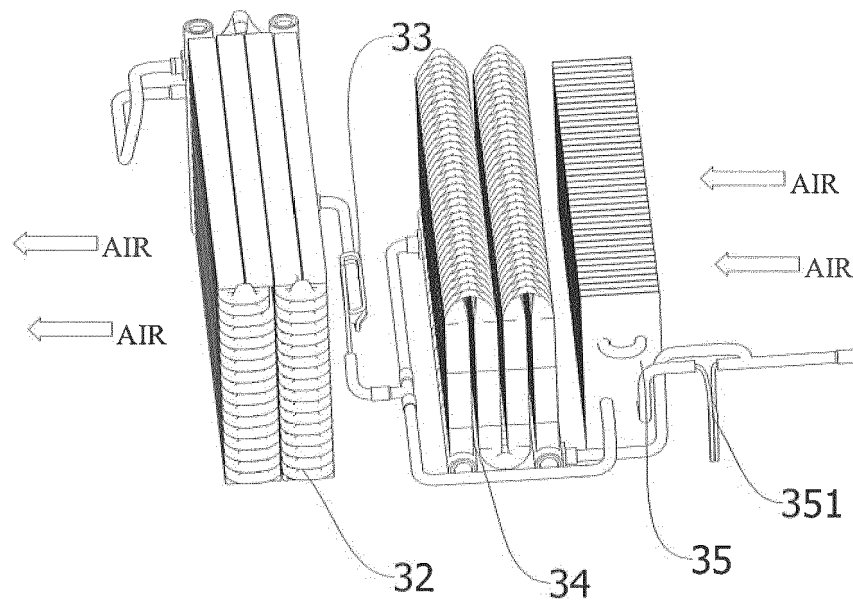


Fig. 7

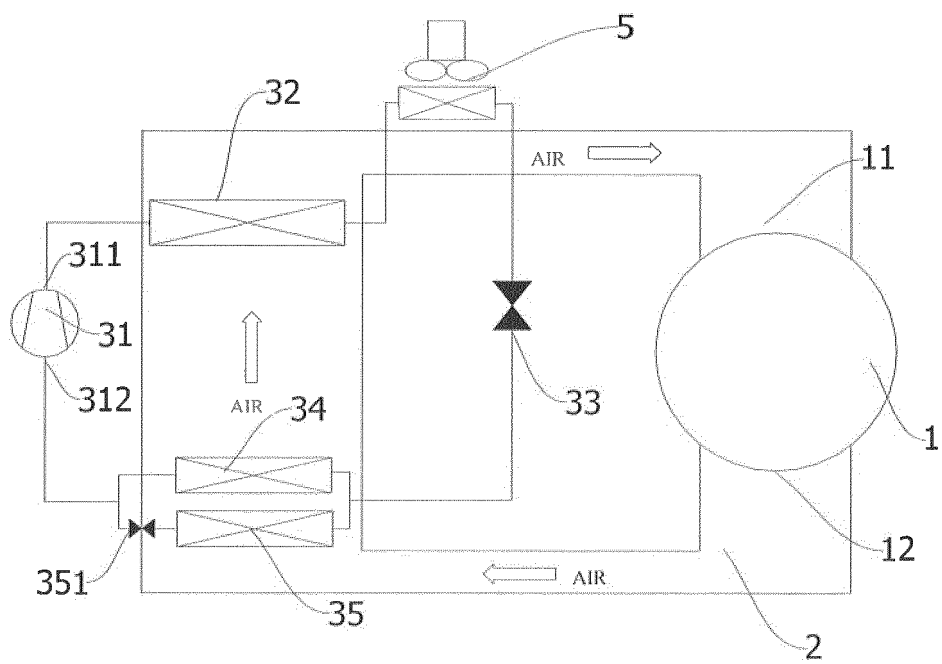


Fig. 8



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 16 6069

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2009/223077 A1 (GRUNERT KLAUS [DE] ET AL) 10 September 2009 (2009-09-10)	1,5-15	INV. D06F58/20 D06F58/02
A	* paragraphs [0008], [0009], [0024], [0026]; figures 1, 2 *	2-4	
Y	EP 2 930 453 A1 (HANGZHOU SANHUA RES INST CO LTD [CN]) 14 October 2015 (2015-10-14)	1,5-15	
A	* paragraph [0028]; figure 11 *	2-4	
A	US 8 695 230 B2 (HYUN WOO NOH [KR] ET AL) 15 April 2014 (2014-04-15)	1-5	1,5-7, 12,13,15
A	* figures 1, 7, 8 *		
	US 2015/345866 A1 (YU ZHIJIE [CN] ET AL) 3 December 2015 (2015-12-03)		
	* paragraphs [0040], [0041], [0042]; figures 1, 3 *		
			TECHNICAL FIELDS SEARCHED (IPC)
			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 August 2017	Examiner Kirner, Katharina
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 03.02 (P04C01)

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

EP 17 16 6069

5

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.

07-08-2017

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009223077 A1	10-09-2009	DE 102005062940 A1	05-07-2007
		EP 1974088 A1	01-10-2008
		KR 20080081936 A	10-09-2008
		US 2009223077 A1	10-09-2009
		WO 2007077084 A1	12-07-2007

EP 2930453 A1	14-10-2015	CN 104976823 A	14-10-2015
		EP 2930453 A1	14-10-2015

US 8695230 B2	15-04-2014	AU 2011245855 A1	06-12-2012
		CN 102859063 A	02-01-2013
		EP 2565322 A2	06-03-2013
		RU 2012150857 A	10-06-2014
		US 2011289794 A1	01-12-2011
		WO 2011136592 A2	03-11-2011

US 2015345866 A1	03-12-2015	CN 105220425 A	06-01-2016
		DE 102015209113 A1	03-12-2015
		US 2015345866 A1	03-12-2015
