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(54) CLOTHES DRYING DEVICE

(57) A clothes drying device includes a housing, a drying system, and a drum (11), and the drying system and the drum (11) are arranged in the housing. The drying system includes a compressor (21), a draught fan (31), a casing (3), a throttling device, an evaporator (23) and a condenser (22). The casing (3) includes an inducing pipe (30) and a main body portion, the main body portion of the casing (3) includes a draught fan fixing portion (331), a condenser accommodating portion (321) and an evaporator accommodating portion (322). The evaporator (23) is arranged at an angle with respect to a horizontal direction, the condenser (22) is arranged in the condenser accommodating portion of the casing at an angle with respect to the horizontal direction, and the evaporator (23) is located between the draught fan (31) and the condenser (22). The evaporator (23) and the condenser (22) are located laterally above the drum (11); and the casing (3) has a high point A at a portion where the condenser accommodating portion is arranged and a high point B at a portion where the evaporator accommodating portion is arranged, and the high point A is approximately same as the high point B. The drying system has a relatively small volume, and is easy to install.

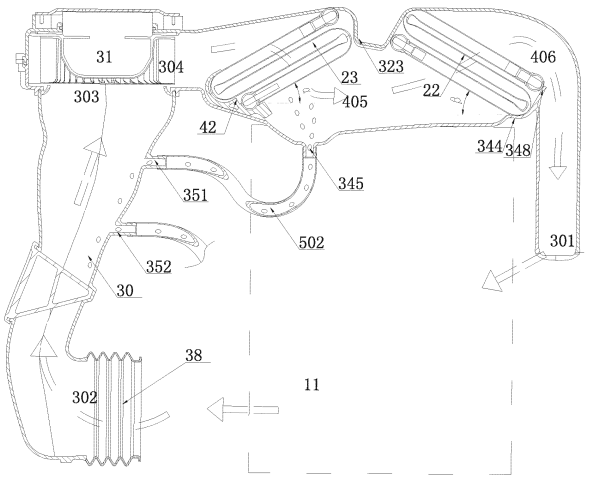

Fig. 3

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Description

FIELD

[0001] The present application relates to a clothes drying device, and particularly to a clothes drying device with a heat pump.

BACKGROUND

[0002] With the continuous improvement of people's living standards, a washing machine only having the washing function has already failed to meet people's requirements, and the washing machine is required to have a drying function or to be equipped with a dryer to dry clothes, shoes, hats or other stuffs after these stuffs are washed. A washer-dryer or the dryer generally includes the following drying modes: an electrical-heating water condensation type drying system, an electric-heating wind condensation type drying system, and a heat pump heating type drying system using evaporator condensation and condenser heating. Compared with the first two drying modes, the heat pump heating type drying system uses a heat pump for drying, which is relatively energy-saving, thus has a wide market application prospect.

[0003] The clothes drying device, such as a heat pump type washer-dryer, usually includes a drum, a heat pump system, a drainage pump, and etc. The heat pump system includes a compressor, an evaporator and a condenser which are connected via refrigerant connecting pipelines. Since the bottom of the heat pump type washer-dryer generally has a large available space, components of the heat pump system including the compressor, the evaporator and the condenser are generally arranged at the bottom of the heat pump type washer-dryer. However, with this arrangement, it is inconvenient to discharge water, the condensate water cannot flow into a main drainage pump spontaneously under the action of the gravity, and one additional drainage pump has to be provided to discharge the condensate water, which results in the increasing of parts and a complicated structure. Secondly, in the case that the heat pump system is arranged at the bottom of the heat pump type washer-dryer, a long ventilation pipeline is required to induce air in the drum to the heat pump system and induce the hot air from the heat pump system back to the drum. This ventilation pipeline generates a large wind resistance, which may adversely affect the operation of the heat pump system and cause a high cost.

[0004] Therefore, a technical problem to be addressed urgently in the field is to design a drying system and a clothes drying device, which have a good energy efficiency and prevent the condensate water from dropping back into the drum via an air inlet under the circumstance of having a limited space.

SUMMARY

[0005] An object of the present application is to provide a clothes drying device, such as a washer-dryer, which facilitates discharging water and has a high energy efficiency.

[0006] The following technical solutions are provided according to the present application.

[0007] A clothes drying device includes a housing, a drying system, and a drum, the drying system and the drum are arranged in the housing, and the drying system includes a compressor, a draught fan, a casing, a throttling device, an evaporator and a condenser; the casing includes an inducing pipe and a main body portion, the main body portion of the casing includes a draught fan fixing portion, a condenser accommodating portion and an evaporator accommodating portion, the condenser is fixedly arranged at the condenser accommodating portion, the evaporator is fixedly arranged at the evaporator accommodating portion; the evaporator is arranged at an angle with respect to a horizontal direction, that is obliquely arranged, the condenser is arranged in the condenser accommodating portion of the casing at an angle with respect to the horizontal direction, that is obliquely arranged, and the evaporator is located between the draught fan and the condenser; the evaporator and the condenser are located laterally above the drum; and the casing has a high point A at an outer side of a portion where the condenser accommodating portion is arranged and a high point B at an outer side of a portion where the evaporator accommodating portion is arranged, and the high point A is approximately same as the high point B.

[0008] Each of the evaporator and the condenser is a micro-channel heat exchanger, the evaporator is a multi-layer heat exchanger with at least two layers, the evaporator includes at least two headers, and flat tubes each having two ends in communication with the headers respectively, each of the flat tubes includes a main body portion, and fins configured to perform heat exchange are arranged between each adjacent portions of the main body portions of the flat tubes; the headers of the evaporator are approximately horizontally arranged, and an oblique angle α formed between the evaporator and the horizontal direction satisfies the relationship: 28 degrees$\leq\alpha\leq$40 degrees.

[0009] The condenser is a multi-layer heat exchanger with at least two layers, the condenser includes at least two headers, and flat tubes each having two ends in communication with the headers respectively, each of the flat tubes includes a main body portion, fins configured to perform heat exchange are arranged between each adjacent portions of the main body portions of the flat tubes; and an oblique angle β formed between the condenser and the horizontal direction satisfies the relationship: 28 degrees$\leq\beta\leq$40 degrees.

[0010] A lower end of the evaporator is close to the draught fan and away from the condenser, and another

end, which is higher, of the evaporator is close to the condenser; a lower end of the condenser is away from the evaporator, and another end, which is higher, of the condenser is close to the evaporator; and the casing is provided with a recess portion sunken inward between the evaporator accommodating portion and the condenser accommodating portion.

[0011] The main body portion of the casing includes a casing base and a casing cover which are fixed via a screw or a buckle; an evaporator supporting portion is provided in the casing base at a portion where the evaporator is arranged; evaporator position-limiting portions are provided on two sides of the casing base at portions close to the casing cover, and a lower portion of the evaporator is supported on the evaporator supporting portion; a condenser supporting portion is provided in the casing base at a portion where the condenser is arranged; condenser position-limiting portions are provided on two sides of the casing base at portions close to the casing cover, and a lower portion of the condenser is supported on the condenser supporting portion.

[0012] The main body portion of the casing includes a casing base and a casing cover which are fixed via a screw or a buckle; an evaporator base is further provided in the main body portion of the casing, the evaporator base is provided with a supporting portion for supporting the evaporator, a lower portion of the evaporator is supported on the evaporator base; evaporator position-limiting portions are provided on two sides of the casing base at portions close to the casing cover; a condenser supporting portion is provided in the casing base at a portion where the condenser is arranged; condenser position-limiting portions are provided on two sides of the casing base at portions close to the casing cover, and a lower portion of the condenser is supported on the condenser supporting portion.

[0013] A drainage port is provided in the main body portion of the casing, and the drainage port is located in the casing base at a position below the evaporator or laterally below the evaporator. The evaporator base is supported on the casing base and provided with a supporting foot configured to cooperate with the casing base, and is further provided with at least one flow guiding hole configured to allow condensate water at this portion to flow out to the casing base via the flow guiding hole; and one or more corresponding flow guiding portions are provided in the casing base at corresponding portions, and are configured to allow the condensate water to flow out through the flow guiding portions and flow to the drainage port along an inner wall portion of the casing base.

[0014] The inducing pipe is located below the draught fan fixing portion, and is fixed to the main body portion of the casing via a screw or a buckle; the inducing pipe is arranged approximately perpendicularly to the main body portion of the casing, an air inlet of the draught fan is located at the inducing pipe, and an air outlet of the draught fan is located at the main body portion of the casing.

[0015] The clothes drying device further includes a draught fan fixing plate; the draught fan fixing plate is provided with a first fixing portion configured to fixedly connect the draught fan, and a second fixing portion configured to be cooperatively assembled to the casing cover, the draught fan is fixedly connected to the draught fan fixing plate, and the draught fan fixing plate is fixedly connected to the casing cover.

[0016] The clothes drying device is a heat pump type washer-dryer; two ends of the casing are connected to the drum, the inducing pipe is in communication with an air outlet at a rear side of the drum via a connecting pipe, and another end of the casing is in communication with an air inlet of the drum; the draught fan is located laterally above the drum and close to a rear wall portion of a housing of the heat pump type washer-dryer, and the condenser is arranged in the housing of the heat pump type washer-dryer at a position close to a front end portion having a door.

[0017] A drainage port may be provided in the main body portion of the casing, the drainage port is located in the casing base at a position below the evaporator or laterally below the evaporator; a position of the drainage port is lower than the evaporator; a drainage port is provided in the inducing pipe, the drainage port of the inducing pipe and the drainage port of the main body portion of the casing are connected via a drainage pipe, the drainage port of the main body portion of the casing is higher than the drainage port of the inducing pipe, and one section of the drainage pipe is lower than the drainage port of the inducing pipe.

[0018] The inducing pipe may include an inducing-pipe first portion and an inducing-pipe second portion, and the inducing-pipe first portion and the inducing-pipe second portion are assembled in a left-right direction; the inducing pipe is located below the draught fan fixing portion, and is fixed to the main body portion of the casing via a screw or a buckle; an air inlet of the draught fan is located at or toward the inducing pipe, an air outlet of the draught fan is located at the main body portion of the casing and faces the evaporator, the inducing pipe is in communication with the drum via a connecting pipe, a position of the drainage port of the inducing pipe is higher than a position where the inducing pipe is connected to the drum, and a drainage pump configured to discharge condensate water is not provided in the pipeline between the drainage port of the main body portion of the casing and the drainage port of the inducing pipe.

[0019] The inducing pipe is provided with a water inlet and a filter screen frame, and a filter screen is provided in the filter screen frame, and the filter screen is arranged between the air outlet of the drum and the air inlet of the draught fan; the water inlet is connected to water source via a water pipe, the water inlet is located above the filter screen frame, and the drainage port is located above the water inlet.

[0020] In the present application, the evaporator and the condenser of the heat pump are obliquely arranged

in the casing, and the draught fan, the condenser and evaporator are arranged in a space laterally above the drum, the casing of a substantially L shape is arranged in an unoccupied position of the clothes drying device, thus under the circumstance of ensuing the same energy efficiency, the clothes drying device in the present application is small, or compared with a conventional electrical heating clothes drying device, the clothes drying device in the present application has an improved energy efficiency ratio in the drying process while having the approximately same volume. And the evaporator is arranged close to the draught fan, and the drying system is close to the drum, thus there is no need to provide long air ducts to induce air into or out of the drum, thereby improving the energy efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Figure 1 is a schematic view showing an internal arrangement of a heat pump type clothes drying device with a part of a housing being removed.

Figure 2 is a perspective exploded schematic view showing several parts related to a casing of a drying system and air ducts according to an embodiment of the heat pump type clothes drying device, wherein a throttling device and refrigerant connecting pipelines between the parts are not shown.

Figure 3 is a sectional schematic view showing an air supply system and the air duct according to an embodiment of the heat pump type clothes drying device, wherein broken lines roughly indicate the flowing of the airflow.

Figure 4 is a partially schematic view showing the casing of the heat pump of the heat pump type clothes drying device when an upper cover of the casing is opened and mainly showing the arrangements of two heat exchangers and a draught fan of the heat pump.

Figure 5 is a top view showing the casing of the drying system of the heat pump type clothes drying device when an upper cover of the casing is opened.

Figure 6 is a schematic view showing the assembling of components of the heat exchanger, wherein the upper cover of the casing of the heat pump in Figure 4 is opened.

Figure 7 is a schematic view showing the assembling of the draught fan, the upper cover of the casing, and a fixing plate of the draught fan of the heat pump type clothes drying device in Figure 4.

Figure 8 is a schematic view showing the arrangement of pipelines of the heat pump of the heat pump type clothes drying device, wherein components such as a drum are removed.

Figure 9 is a sectional schematic view showing an air supply system and the air ducts according to other embodiments of the heat pump type clothes drying device, wherein broken lines roughly indicate the flowing of airflow.

DETAILED DESCRIPTION

[0022] A drum-type washer-dryer is described hereinafter as an embodiment. Referring to Figures 1 to 9, a washer-dryer according to the present application includes a washer-dryer housing, a drying system and a drum 11 installed in the washer-dryer housing. The washer-dryer housing includes a front end portion 101 with a door, a side wall portion 102 and a rear wall portion 103. The drying system includes a draught fan 31, a casing 3, and a heat pump connected in the drying system via pipelines, for example refrigerant connecting pipelines. The casing 3 is approximately of an L shape, and includes an inducing pipe 30, and a main body portion arranged approximately transversely. The main body portion of the casing includes a casing base 34 and a casing cover 33, and the casing base 34 and the casing cover 33 are of an assembly combined in an up-down direction and fixed via a screw or a buckle. The inducing pipe 30 includes an inducing-pipe first portion 35 and an inducing-pipe second portion 36. The drum 11 is relatively fixed with the washer-dryer housing by a drum hook 501, specifically the drum hook 501 is hooked with a side wall portion of the washer-dryer housing, and the washer-dryer housing is provided with an inward sunken portion at one side thereof for arranging the drum hook 501. The casing 3 further includes a filter screen frame 37 fixed with the inducing-pipe second portion 36. The inducing-pipe first portion 35 and the inducing-pipe second portion 36 act as one part of the inducing pipeline and are fixed then connected to an air outlet of the drum 11 via a connecting pipe 38, and the air outlet of the drum 11 is arranged at a rear side of the drum 11. The main body portion of the casing 3 is provided with an evaporator accommodating portion 322, a condenser accommodating portion 321 and a draught fan fixing portion 331, and a recess portion 323 is concaved inwardly and provided between the evaporator accommodating portion 322 and the condenser accommodating portion 321. An evaporator 23 and a condenser 22 are provided in the evaporator accommodating portion 322 and the condenser accommodating portion 321 respectively, the main body portion has a high point A outside the portion where the condenser 22 is located and a high point B outside the portion where the evaporator 23 is located, and the high point A is approximately same as the high point B. The "approximately same" here refers to that a height difference is

within 8mm. An overall height of the casing 3 can be reduced by configuring the two points A and B to have the approximately same heights, and the drying device can be arranged in the small space of the casing. The evaporator 23 is located at one side of the recess portion 323, and the condenser 22 is located at another side of the recess portion 323. The inducing pipe 30 is located below the draught fan fixing portion 331, and is fixed to the main body portion of the casing 3 via a screw or a buckle. An air inlet 302 and an air outlet 301 of the casing 3 are arranged at two ends of the casing respectively, the air inlet 302 is in communication with the air outlet at the rear side of the drum 11 via the connecting pipe 38, and the air outlet 301 is in communication with an air inlet of the drum 11. The air outlet 301 of the casing 3 is in communication with the drum 11 via a door seal, and air from the air outlet of the casing to the drum is in direct contact with clothes inside the drum 11, thus may realize the circulating and drying of air in the drum 11. In this way, the drying device can induce air from the drum 11, and dehumidify and heat the air by the heat pump and then deliver the dry and hot air into the drum 11, thereby completing a drying process. Besides, a filter may be provided in the pipelines to filter fluffs in the air, to ensure the cleanliness of the drying air. For example, the filter screen frame 37 on the inducing-pipe second portion 36 may be installed with a filter screen to filter the air passing therethrough.

[0023] The evaporator 23 and the condenser 22 in this embodiment are both embodied as a micro-channel heat exchanger, in this way, the heat exchanger has a small volume and has a heat exchanging efficiency meeting the requirement, thus the evaporator 23 and the condenser 22 can be arranged laterally above the drum 11. The evaporator 23 is embodied as a multi-layer heat exchanger, for example a heat exchanger with two layers or more than three layers. The evaporator 23 includes at least two headers, and flat tubes each having two ends in communication with the headers respectively. The flat tube of the evaporator includes a main body portion and a bent portion, and fins for heat exchanging are arranged between each adjacent flat tubes of the main body portion. Similarly, the condenser 22 is embodied as a multi-layer heat exchanger, for example a heat exchanger with two layers or more than three layers. The condenser 22 includes at least two headers, and flat tubes each having two ends in communication with the headers respectively. The flat tube of the condenser 22 includes a main body portion and a bent portion, and fins for heat exchanging are arranged between each adjacent flat tubes of the main body portion.

[0024] In this embodiment, the draught fan 31 is arranged at one end of the casing and close to the rear wall portion of the casing 3, the evaporator 23 is arranged close to the draught fan 31 with respect to the condenser 22, and the condenser 22, the evaporator 23 and the draught fan 31 are arranged in order.

[0025] The condenser 22 and the evaporator 23 are both obliquely arranged. At least one of the headers of the evaporator 23 is located at a low position, and at least one reversing portion of the flat tubes is located at a high position, that is, the evaporator 23 is obliquely arranged, and each of the headers of the evaporator 23 is approximately horizontally arranged, which refers to that an angle formed between the header of the evaporator 23 and the horizontal plane ranges from minus 3 degrees to plus 3 degrees. The main body portions of the flat tubes of the evaporator 23 is partially obliquely arranged, which may increase a heat exchanging area and may be adapted to a space requirement of the main body portion. Similarly, at least one of the headers of the condenser 22 is located at a low position, and at least one reversing portion of the flat tubes is located at a high position, that is, the condenser 22 is obliquely arranged, each of the headers of the condenser 22 is substantially horizontally arranged, which refers to that an angle formed between the header of the condenser and the horizontal plane ranges from 3 degrees to plus 3 degrees, and the main body portion of the flat tubes of the condenser 22 is partially obliquely arranged. An oblique angle β formed between the condenser 22 and the horizontal direction satisfies the relationship: 25 degrees$\leq\beta\leq$50 degrees, an oblique angle α formed between the evaporator 23 and the horizontal direction satisfies the relationship: 25 degrees$\leq\alpha\leq$50 degrees, more appropriately, the oblique angle β formed between the condenser 22 and the horizontal direction satisfies the relationship: 28 degrees$\leq\beta\leq$40 degrees, and the oblique angle α formed between the evaporator 23 and the horizontal direction satisfies the relationship: 28 degrees$\leq\alpha\leq$40 degrees. Since the height of the casing 3 is limited, if the oblique angle α of the evaporator 23 or the oblique angle β of the condenser 22 is too small, an angle of air flowing through the fins of the evaporator or the condenser may be too large, thus a wind field is not uniform, a resistance is large, and the performance of a heat exchanger core of the evaporator or the condenser cannot be performed, and the drying system cannot normally operate. If the oblique angle α of the evaporator 23 or the oblique angle β of the condenser 22 is 90 degrees, the wind field is good, however in a space of the casing with a limited height, the length of each of the flat tubes is limited and is too short, and the heat exchanging area is very small, thus the heat exchanging performance of the heat exchanger core is obviously not strong enough, which may fail to meet the requirements of the drying system. In the case that the oblique angle ranges from 25 degrees to 50 degrees, the heat exchanging area of the heat exchanger core is greatly increased, although the heat exchanging performance of the heat exchanger core cannot fully performed, the performance reduction of the heat exchanger core is not obvious, and a heat exchanging capacity needed to dry the clothes may be reached. In this case, the requirement of the height arrangement of a heat pump type drying device can be satisfied without increasing the height of the heat pump, besides, the wind

resistances of the evaporator 23 and the condenser 22 are appropriate, thereby realizing the effect of having large volume and high efficiency. With the height of the casing is enough, as shown in Figure 9, the oblique angle α formed between the evaporator 23 and the horizontal direction may also satisfy the relationship: 50 degrees$\leq\alpha\leq$65 degrees, in this case the heat exchanging area of the evaporator 23 is relatively increased, and the wind field is improved, which may reach the heat exchanging capacity needed to dry the clothes. Further, the oblique angle α formed between the evaporator 23 and the horizontal direction is greater than the oblique angle β formed between the condenser 22 and the horizontal direction, since the oblique angle α is large, the heat exchanging efficiency is high, thus the heat exchanging efficiency can be improved by arranging the evaporator 23 at the above oblique angle with the allowable space. If the evaporator 23 is limited to the space and height, the number of layers of the flat tubes of the evaporator 23 may be increased, which still allows the evaporator 23 to form a large oblique angle as described above to improve the heat exchanging efficiency. The oblique angle of the condenser 22 is smaller than the oblique angle of the evaporator 23, and the heat exchanging capacity of the condenser 22 is greater than that of the evaporator 23, which may help to improve the performance of the drying system. The oblique angles between the two heat exchangers and the horizontal direction refer to an angle formed between the main body portion of the flat tubes of the condenser 22 and the horizontal direction and an angle formed between the main body portion of the flat tubes of the evaporator 23 and the horizontal direction, which may refer to Figure 3.

[0026] The heat pump of the drying system includes a compressor 21, the condenser 22, the evaporator 23, a throttling device, refrigerant connecting pipelines, and refrigerant configured to be filled in the drying system. As shown in Figure 8, the throttling device may be a mechanical throttle, an electronic expansion valve, a thermal expansion valve, a throttling solenoid valve and etc. The throttling device is embodied as a capillary 24. The condenser 22, the evaporator 23 and the fraught fan 31 are arranged in the main body portion of the casing 3, and the condenser 22 and the evaporator 23 are arranged laterally above the drum 11, that is in their corresponding accommodating portions of the main body portion of the casing 1, thus, the condenser 22 and the evaporator 23 are not arranged right above the middle of the drum 11 but are slightly inclined to the side wall portion 102. Besides, the draught fan 31 is arranged laterally above the drum 11 and close to the rear wall portion 103, thus the space formed between the drum 11, a top wall portion (not shown), the side wall portion 102 and the rear wall portion 103 may be fully utilized, and since the draught fan 31 is arranged at this position, an air inlet 303 and an air outlet 304 of the draught fan 31 are respectively located in the air duct, thus an additional air pipe is not required to connect the air inlet 303 and the air outlet 304 to the air duct, which allows the air duct to be short. The heat pump herein refers to a component which can use a compressor to absorb heat in a low-temperature environment and release heat to a high-temperature environment.

[0027] When the drying system is in operation, the heat pump and the compressor 21 start to work, refrigerant comes out via a compressor outlet 212, and enters the condenser 22 via a condenser inlet 222 and releases heat to heat air in the air duct, to allow the air passing through the condenser 22 to become the air 406 with a relatively high temperature. Then the refrigerant cooled by the condenser 22 flows out via a condenser outlet 221, flows through a dryer 25, and then is throttled by the capillary 24 to become the refrigerant with a low temperature. The throttled refrigerant with the low temperature flows into the evaporator 23 via an evaporator inlet 232 to be evaporated, and since the temperature at the surface of the evaporator 23 is low, the air around the evaporator 23 may be condensed to separate out moisture in the air, that is, the air passing through the evaporator 23 may be cooled and dehumidified to become cold air 405 with a low moisture content. After the refrigerant is evaporated by the evaporator 23, the refrigerant flows out via an evaporator outlet 231 to flow into the compressor 21 via a compressor inlet 213 to be compressed again, thereby completing a heat pump cycle. For cooling the compressor 21, the heat pump may be further provided with a compressor-assisting draught fan 211. The compressor 21 and the compressor-assisting draught fan 211 may be fixedly arranged at the rear wall portion 103 of the washer-dryer housing. An air supply system and the air duct of the heat pump type washer-dryer are shown in Figure 3, when the heat pump is in operation, the compressor 21 works, and also the draught fan 31 is in a working state. The wet air flows out via an air outlet of the drum 11, enters the air inlet 302 of the casing 3 via the connecting pipe 38 to flow into the casing 3, passes through the filter screen frame 37 to be filtered, and then is pressurized by the draught fan 31, the pressure of the air reaching the air outlet 304 of the draught fan 31 is higher than the pressure of the air at the air inlet 303 of the draught fan 31, and then the wet air flows through the surface of the evaporator 23, and since the heat pump is working, the temperature of the surface of the evaporator 23 is low, and condensate water may be separated out when the wet air is in contact with the outer surface of the evaporator 23, and the condensate water formed when the air flows through the evaporator 23 may drop onto a low position. At the same time, the temperature of the air flowing through the evaporator 23 may be decreased, that is, the airflow becomes the dry airflow 405 with a low temperature, and then the airflow 405 passes through the condenser 22, at this time the refrigerant with a high temperature and a high pressure is flowing through the condenser 22, thus the surface of the condenser 22 has a high temperature, the dry airflow 405 with the low temperature passes through the

condenser 22 and becomes the dry airflow 406 with a high temperature and then the dry airflow 406 flows through the door seal into the drum 11 via the air outlet 301, to be used for drying the clothes inside the drum 11. The air absorbs the moisture in the clothes inside the drum 11 and is cooled, and then flows out via the air outlet of the drum 11 under a pressure difference formed by the draught fan 31, and then proceeds with a next cycle. In this embodiment, the condensate water formed when the airflow flows through the evaporator 23 may drop and gather to a drainage port 345 of the main body portion of the casing 3, and flows through a drainage pipe 502 connected to the drainage port 345 to flow to a drainage port 351 on the inducing pipe 30, and flows downward along a wall portion of the inducing pipe 30, and the temperature of the condensate water is obviously lower than the temperature of the airflow flowing upward. The temperature of the air flowing to the inducing pipe 30 from the drum 11 is lower than the temperature of the air of the air inlet of the drum 11, but still higher than the temperature of the condensate water, therefore when the air flows toward the draught fan 31 through the inducing pipe 30, the air may exchange heat with the condensate water flowing downward, and in this process, the wet air with a high temperature may be condensed when in contact with the condensate water with a low temperature, which reduces a humidity of the air reaching the air inlet 303 of the draught fan 31, thereby improving the efficiency of the heat pump. In this embodiment, the drainage port 351 of the inducing pipe 30 is arranged close to the draught fan 31 and lower than the air inlet 303 of the draught fan 31, the drainage port 345 of the main body portion of the casing 3 is higher than the drainage port 351 of the inducing pipe 30, and the drainage pipe 502 is a flexible pipe, the lowest position of which is lower than the position where the drainage port 351 is arranged. In this way, one section of the drainage pipe 502 contains water in the clothes drying process, the water is formed by condensing the wet air through the evaporator 23, and with the condensate water formed by condensing the wet air becoming more and more, the condensate water may overflow via the drainage port 351 of the inducing pipe 30, and then flows downward along the inducing pipe 30 to flow back to the drum 11 of the washer-dryer. Since one section of the drainage pipe 502 contains water, a water seal may be formed, which may prevent the airflow from directly flowing to the main body portion of the casing 3 via the drainage pipe, that is directly flowing to the position where the drainage port 345 is located. Since the main body portion of the casing 3 is located above the drum 11 or laterally above the drum 11, the position where the drainage port 345 is located is higher than the position where the drainage port 351 of the inducing pipe 30 is located, in this way, there is no need to arrange a drainage pump to discharge water, and also the effect of preliminary dehumidifying the airflow via the condensate water can be realized.

[0028] In addition, the inducing pipe 30 is further provided with a water inlet 352, which is in communication with a water source for washing through a water pipe (not shown), the water inlet 352 is located above the filter screen frame 37, and a switchable switch control valve is provided in the pipeline of the water pipe.

[0029] The casing base 34, the casing cover 33, the inducing-pipe first portion 35, and the inducing-pipe second portion 36 may be each embodied as a plastic piece, such as a plastic piece formed by injection molding with thermoplastic material. In this embodiment, the casing base 34 and the casing cover 33 are substantially arranged in an up-down direction, and grooves may be provided at the matching portions of the casing base 34 and the casing cover 33 and a seal strip is in the grooves to seal the matching portions, thereby preventing the air leakage; or, after the casing base 34 is assembled with the casing cover 33, a plastic welding may be performed to prevent the air leakage. The inducing-pipe second portion 36, the inducing-pipe first portion 35, and the casing base 34 may be fixed together via multiple screws, buckles or by plastic welding, and the seal strips may be similarly provided at the connecting portions. The condenser 22 and the evaporator 23 are relatively fixedly arranged in the main body portion of the casing 3, "the condenser 22 and the evaporator 23 are relatively fixedly arranged in the casing 3" here refers to that position-limiting arrangements preventing the condenser 22 and the evaporator 23 from moving over a certain distance are arranged in the casing 3, and does not refer to that the condenser 22 and the evaporator 23 are not allowed to move at all. An evaporator base 42 is further provided in the casing 3, the surface of the evaporator base 42 fits with the surface of the casing base 34, and a lower end of the evaporator 23 abuts against the evaporator base 42. Moreover, for ensuring that the evaporator 23 is better positioned with respect to the casing base 34, in addition to using the evaporator base 42 as a supporting portion of the evaporator 23, a second supporting portion may be further provided by the casing base 34, and the shape of the second supporting portion matches with the shape of a portion, corresponding to the second supporting portion, of the evaporator 23. For example, in the case that a portion supported by the second supporting portion is the header of the evaporator 23, the shape of the second supporting portion may be a circular arc-shaped surface. Besides, the evaporator 23 may also directly abut against the casing base 34 and be supported thereon, that is, it is only required to arrange a supporting portion for supporting the evaporator 23 at a corresponding portion of the casing base 34. At the same time, evaporator position-limiting portions 341 are provided at two sides of the casing base 34 at portions relatively close to the casing cover 33, thus the oblique angle of the evaporator 23 arranged in the casing 3 can be ensured. Similarly, for relatively fixing the condenser 22, a condenser supporting portion 344 and condenser position-limiting portions 343 are also provided on the casing base 34, to ensure the oblique angle of the condenser 22 arranged in the

casing 3.

[0030] Moreover, for reducing the air passing through finless areas at two ends of each of the evaporator 23 and the condenser 22 as much as possible, wind shielding portions are provided along a flowing direction of the air at two sides of the casing 3 in the height direction, such as, the recess portion 323 of the casing cover 33 may prevent air from passing through the finless area at a higher side of the evaporator 23, and a wind shielding board 424 provided on the evaporator base 42 may prevent the air from passing through the finless area of the lower side of the evaporator 23. At the same time, the recess portion 323 of the casing cover 33 may prevent air from passing through the finless area at a higher side of the condenser 22, a wind shielding board 348 provided on the casing base 34 may prevent the air from passing through the finless area of the lower side of the condenser 22, and the wind shielding board 348 on the casing base 34 may be embodied as an extension portion laterally above the supporting portion 344 of the condenser 22, and the extension portion may be formed integrally with the casing base 34, or may be a separate structure fastened to the casing base 34. Referring to Figure 9, in this embodiment, the casing cover 33 may be provided with a position-limiting plate 324 as the wind shielding portion, the position-limiting plate 324 is provided between the evaporator accommodating portion 322 and the condenser accommodating portion 321, and can prevent air from passing through both the finless area of the higher side of the evaporator 23 and the finless area at the higher side of the condenser 22. The position-limiting plate 324 are provided with a first abutting surface and a second abutting surface at two sides thereof respectively, the evaporator 23 abuts against the first abutting surface, and the condenser 22 abuts against the second abutting surface, thereby retaining the positions of the higher sides of the evaporator 23 and the condenser 22. The position of a portion of the casing base 34 where the evaporator base 42 is arranged is slightly lower than the position of an inner wall portion of a portion of the casing base 34 where the casing base 34 is in communication with the outlet of the draught fan 31, thus when the air flows out from the draught fan 31, the air passing through the finless area at the lower side of the evaporator 23 is little, and most of the air passes through finned areas, besides such an arrangement may prevent the condensate water at the evaporator base 42 from flowing to the portion where the draught fan 31 is arranged. A supporting foot 421 for cooperating with the casing base 34 is provided on the evaporator base 42, and multiple flow guiding holes 423 are also provided in the evaporator base 42, which allows the condensate water at the evaporator base 42 to flow out to the casing base 34 via the flow guiding holes 423, and at the same time, the casing is provided with one or more corresponding flow guiding portions 346 corresponding to the casing base 34, thus this part of condensate water may flow out through the flow guiding portion 346 and flow to the drainage port 345 along an inner wall portion of the casing base 34. The drainage port 345 may be arranged in the casing base 34 at a position below the evaporator 23 or laterally below the evaporator 23 that is a position below the evaporator 23 and slightly deflected to the condenser 22.

[0031] During the assembly, a casing base assembly is firstly assembled. The evaporator 23 and the evaporator base 42 are assembled together and form an evaporator assembly, and then the evaporator assembly and the condenser 22 are mounted at corresponding positions of the casing base 34, thereby forming the casing base assembly. The inducing-pipe first portion 35 and the inducing-pipe second portion 36 are assembled together to form an inducing pipe assembly, and then the assembled inducing pipe assembly and the casing base assembly are assembled together. Moreover, the inducing-pipe first portion 35 and the inducing-pipe second portion 36 may be assembled together, then the assembled inducing pipe 30 and the casing base 34 are assembled together, and then the evaporator assembly and the condenser 22 are mounted onto the casing base 34.

[0032] An air inlet 349 of the draught fan 31 is provided in the casing base 34 at a position corresponding to the draught fan 31, and the casing cover 33 is provided with a draught fan mounting portion 331 and a through-hole portion 333. An annular groove 3313 is provided in an inner wall portion of the through-hole portion 333 and is configured to install a seal ring, the draught fan mounting portion 331 includes multiple protruding portions 3311, and the number of the protruding portions 3311 is four in this embodiment or other number. The heat pump type dryer further includes a draught fan fixing plate 41, the draught fan fixing plate 41 is provided with multiple first fixing portions 411 fixedly connected to the draught fan 31, and multiple second fixing portions 412 for cooperatively assembled to the casing cover 33. During the assembly process, the number of the first fixing portions 411 is determined by the requirement for fixing the draught fan 31, and the number of the second fixing portions 412 corresponds to the number of the protruding portions 3311. A base portion of the draught fan fixing plate 41 in this embodiment is an annular plate or other configuration, and the annular plate has multiple first fixing portions 411 extending inwards and fours of the second fixing portions 412 extending outwards. During the assembly process, the seal ring is mounted into the annular groove 3313 in the inner wall portion of the through-hole portion 333 of the casing cover 33, a small end 311 of the draught fan 31 is guided to pass through the through-hole portion 333 of the casing cover 33, thus a relative seal between the draught fan 31 and the through-hole portion 333 of the casing cover 33 can be realized by the seal ring arranged in the annular groove 3313. Then, the draught fan 31 is fixedly connected to the draught fan fixing plate 41 via screws, and the draught fan fixing plate 41 is fixed to the protruding portions 3311 of the casing cover 33 via the second fixing portions 412, to fix an assembly of the draught fan 31 and the draught

fan fixing plate 41 to the casing cover 33, thereby forms a casing cover assembly. And then the casing cover assembly is assembled and fixed to the casing base assembly to form the casing 3.

[0033] It should be noted that, only the embodiments of the heat pump type washer-dryer are described above, similarly, the technical solutions of the present application can be applied in other clothes drying devices, such as a clothes dryer or a drying machine. Besides, the above embodiments are only intended to describe the present application, and should not be interpreted as limitation to the technical solution of the present application. For example, the nouns of locality, such as front, rear, left, right, up, and down, are only for facilitating understanding the content of the present application and should not be regarded as limitation to the present. Although the present application is described in details in conjunction with the above embodiments, it should be understood that, for those skilled in the art, a few of combinations, modifications or equivalent substitutions may be made to the present application by those skilled in the art, and any technical solutions and the improvements thereof without departing from the spirit and scope of the present application are also deemed to fall into the scope of the present application defined by the claims.

Claims

1. A clothes drying device, comprising a housing, a drying system, and a drum (11), the drying system and the drum (11) being arranged in the housing, wherein the drying system comprises a compressor (21), a draught fan (31), a casing (3), a throttling device, an evaporator (23) and a condenser (22); the casing (3) comprises an inducing pipe (30) and a main body portion, the main body portion of the casing (3) comprises a draught fan fixing portion (331), a condenser accommodating portion (321) and an evaporator accommodating portion (322), the condenser (22) is arranged at the condenser accommodating portion (321), the evaporator (23) is arranged at the evaporator accommodating portion (322); the evaporator (23) is arranged at an angle with respect to a horizontal direction, that is obliquely arranged, the condenser (22) is arranged at an angle with respect to the horizontal direction, that is obliquely arranged, and the evaporator (23) is located between the draught fan (31) and the condenser (22); the evaporator (23) and the condenser (22) are located laterally above the drum (11); and the casing (3) has a high point A at an outer side of a portion where the condenser accommodating portion (321) is located and a high point B at an outer side of a portion where the evaporator accommodating portion (322) is located, and the high point A is approximately same as the high point B.

2. The clothes drying device according to claim 1, wherein each of the evaporator (23) and the condenser (22) is a micro-channel heat exchanger, the evaporator (23) is a multi-layer heat exchanger with at least two layers, the evaporator (23) comprises at least two headers, and flat tubes each having two ends in communication with the headers respectively, each of the flat tubes comprises a main body portion, and fins configured to perform heat exchange are arranged between each adjacent portions of the main body portions of the flat tubes; the headers of the evaporator (23) are approximately horizontally arranged, and an oblique angle α formed between the evaporator (23) and the horizontal direction satisfies the relationship: 28 degrees$\leq\alpha\leq$40 degrees.

3. The clothes drying device according to claim 1, wherein each of the evaporator (23) and the condenser (22) is a micro-channel heat exchanger, the evaporator (23) is a multi-layer heat exchanger with at least two layers, the evaporator (23) comprises at least two headers, and flat tubes each having two ends in communication with the headers respectively, each of the flat tubes comprises a main body portion, and fins configured to perform heat exchange are arranged between each adjacent portions of the main body portions of the flat tubes; the headers of the evaporator (23) are approximately horizontally arranged, and an oblique angle α formed between the evaporator (23) and the horizontal direction satisfies the relationship: 28 degrees$\leq\alpha\leq$65 degrees.

4. The clothes drying device according to claim 2 or claim 3, wherein the condenser (22) is a multi-layer heat exchanger with at least two layers, the condenser (22) comprises at least two headers, and flat tubes each having two ends in communication with the headers respectively, each of the flat tubes comprises a main body portion, fins configured to perform heat exchange are arranged between each adjacent portions of the main body portions of the flat tubes; and an oblique angle β formed between the condenser (22) and the horizontal direction satisfies the relationship: 28 degrees$\leq\beta\leq$50 degrees.

5. The clothes drying device according to claim 4, wherein the oblique angle α formed between the evaporator (23) and the horizontal direction is greater than the oblique angle β formed between the condenser (22) and the horizontal direction, and the oblique angle α formed between the evaporator (23) and the horizontal direction satisfies the relationship: 40 degrees$\leq\alpha\leq$65 degrees.

6. The clothes drying device according to any one of claims 1 to 5, wherein a lower end of the evaporator (23) is close to the draught fan (31) and away from the condenser (22), and another end, which is high-

er, of the evaporator (23) is close to the condenser (22); a lower end of the condenser (22) is away from the evaporator (23), and another end, which is higher, of the condenser (22) is close to the evaporator (23); and the casing (3) is provided with an recess portion (323) sunken inward between the evaporator accommodating portion (322) and the condenser accommodating portion (321), the evaporator (23) is located at one side of the recess portion (323), and the condenser (22) is located at another side of the recess portion (323).

7. The clothes drying device according to any one of claims 1 to 5, wherein a lower end of the evaporator (23) is close to the draught fan (31) and away from the condenser (22), and another end, which is higher, of the evaporator (23) is close to the condenser (22); a lower end of the condenser (22) is away from the evaporator (23), and another end, which is higher, of the condenser (22) is close to the evaporator (23); the casing (3) is provided with a position-limiting plate (324) between the evaporator accommodating portion (322) and the condenser accommodating portion (321), two sides of the position-limiting plate (324) are provided with a first abutting surface and a second abutting surface, the evaporator (23) abuts against the first abutting surface, and the condenser (22) abuts against the second abutting surface.

8. The clothes drying device according to claim 6 or claim 7, wherein the main body portion of the casing (3) comprises a casing base (34) and a casing cover (33) which are fixed with the casing base; an evaporator supporting portion is provided in the casing base (34) at a portion where the evaporator (23) is arranged; evaporator position-limiting portions (341) are provided on two sides of the casing base (34) at portions close to the casing cover (33), and a lower portion of the evaporator (23) is supported on the evaporator supporting portion; a condenser supporting portion (344) is provided in the casing base (34) at a portion where the condenser (22) is arranged; condenser position-limiting portions (343) are provided on two sides of the casing base (34) at portions close to the casing cover (33), and a lower portion of the condenser (22) is supported on the condenser supporting portion (344).

9. The clothes drying device according to claim 6 or claim 7, wherein the main body portion of the casing (3) comprises a casing base (34) and a casing cover (33) which are fixed with the casing base; an evaporator base (42) is further provided in the main body portion of the casing (3), the evaporator base (42) is provided with a supporting portion for supporting the evaporator (23), a lower portion of the evaporator (23) is supported on the evaporator base (42); evaporator position-limiting portions (341) are provided on two sides of the casing base (34) at portions close to the casing cover (33); a condenser supporting portion (344) is provided in the casing base (34) at a portion where the condenser (22) is arranged; condenser position-limiting portions (343) are provided on two sides of the casing base (34) at portions close to the casing cover (33), and a lower portion of the condenser (22) is supported on the condenser supporting portion (344).

10. The clothes drying device according to claim 9, wherein a drainage port (345) is provided in the main body portion of the casing (3), and the drainage port (345) is located in the casing base (34) at a position below the evaporator (23) or laterally below the evaporator (23).

11. The clothes drying device according to claim 10, wherein the evaporator base (42) is supported on the casing base (34) and provided with a supporting foot (421) configured to cooperate with the casing base (34), and is further provided with at least one flow guiding hole (423) configured to allow condensate water at this portion to flow out to the casing base (34) via the flow guiding hole (423); and the casing (3) is provided with one or more corresponding flow guiding portions (346) corresponding to the casing base (34), and the flow guiding portions (346) are configured to allow the condensate water to flow out through the flow guiding portions (346) and flow to the drainage port (345) along an inner wall portion of the casing base (34).

12. The clothes drying device according to any one of claims 1 to 11, wherein the inducing pipe (30) is located below the draught fan fixing portion (331), and is fixed to the main body portion of the casing (3); the inducing pipe (30) is arranged approximately perpendicularly to the main body portion of the casing (3), an air inlet (303) of the draught fan (31) is located at the inducing pipe (30), and an air outlet (304) of the draught fan (31) is located at the main body portion of the casing (3).

13. The clothes drying device according to claim 12, wherein the clothes drying device further comprises a draught fan fixing plate (41); the draught fan fixing plate (41) is provided with a first fixing portion (411) configured to fixedly connect the draught fan (31), and a second fixing portion (412) configured to be cooperatively assembled to the casing cover (33), the draught fan (31) is fixedly connected to the draught fan fixing plate (41), and the draught fan fixing plate (41) is fixedly connected to the casing cover (33).

14. The clothes drying device according to any one of claims 1 to 11, wherein the clothes drying device is

a heat pump type washer-dryer; two ends of the casing (3) are connected to the drum (11), the inducing pipe (30) is in communication with an air outlet (304) at a rear side of the drum (11) via a connecting pipe, and another end of the casing (3) is in communication with an air inlet of the drum (11); the draught fan (31) is located laterally above the drum (11) and close to a rear wall portion of a housing of the heat pump type washer-dryer, and the condenser (22) is arranged in the housing of the heat pump type washer-dryer at a position close to a front end portion (101) having a door.

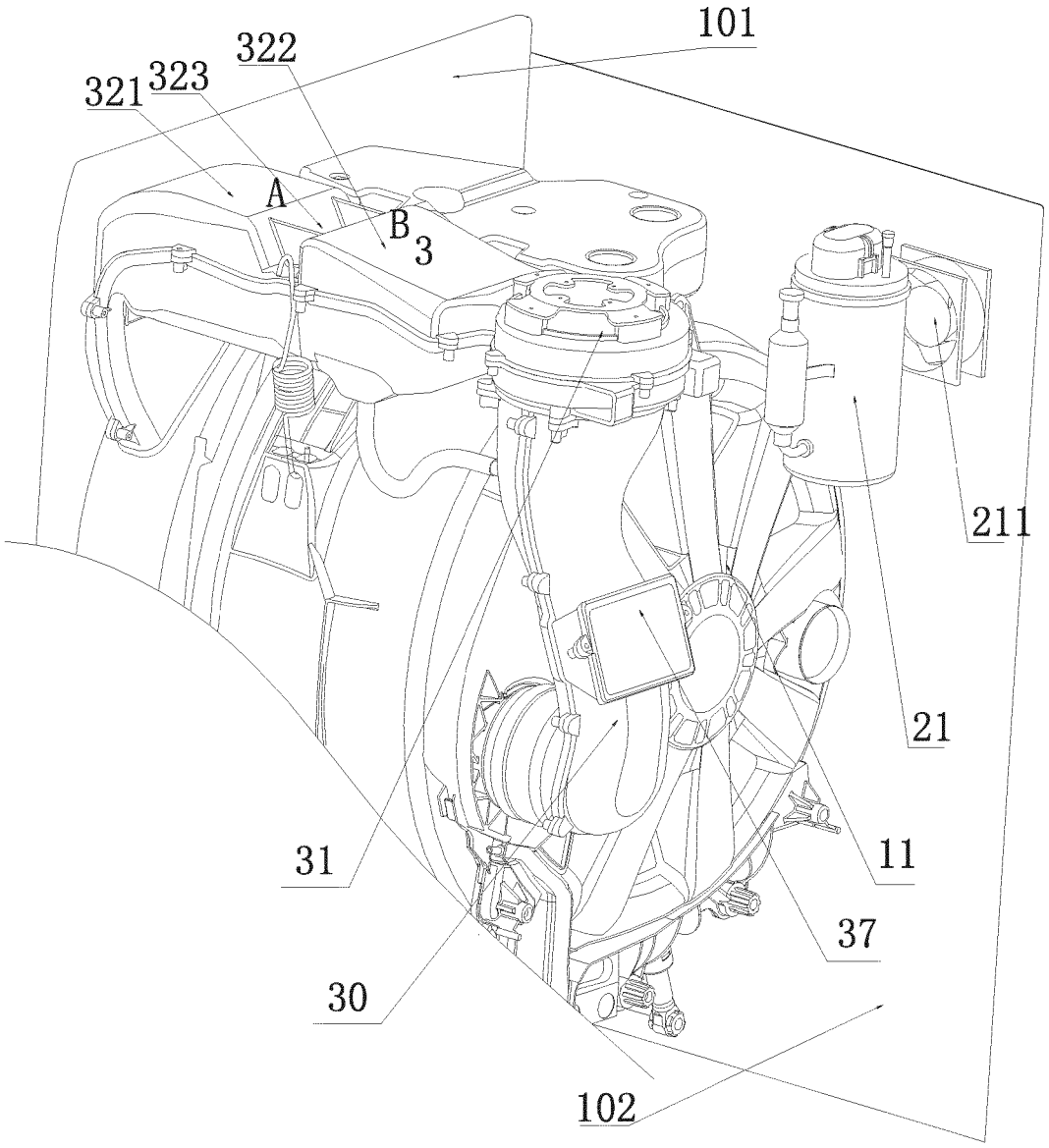

Fig. 1

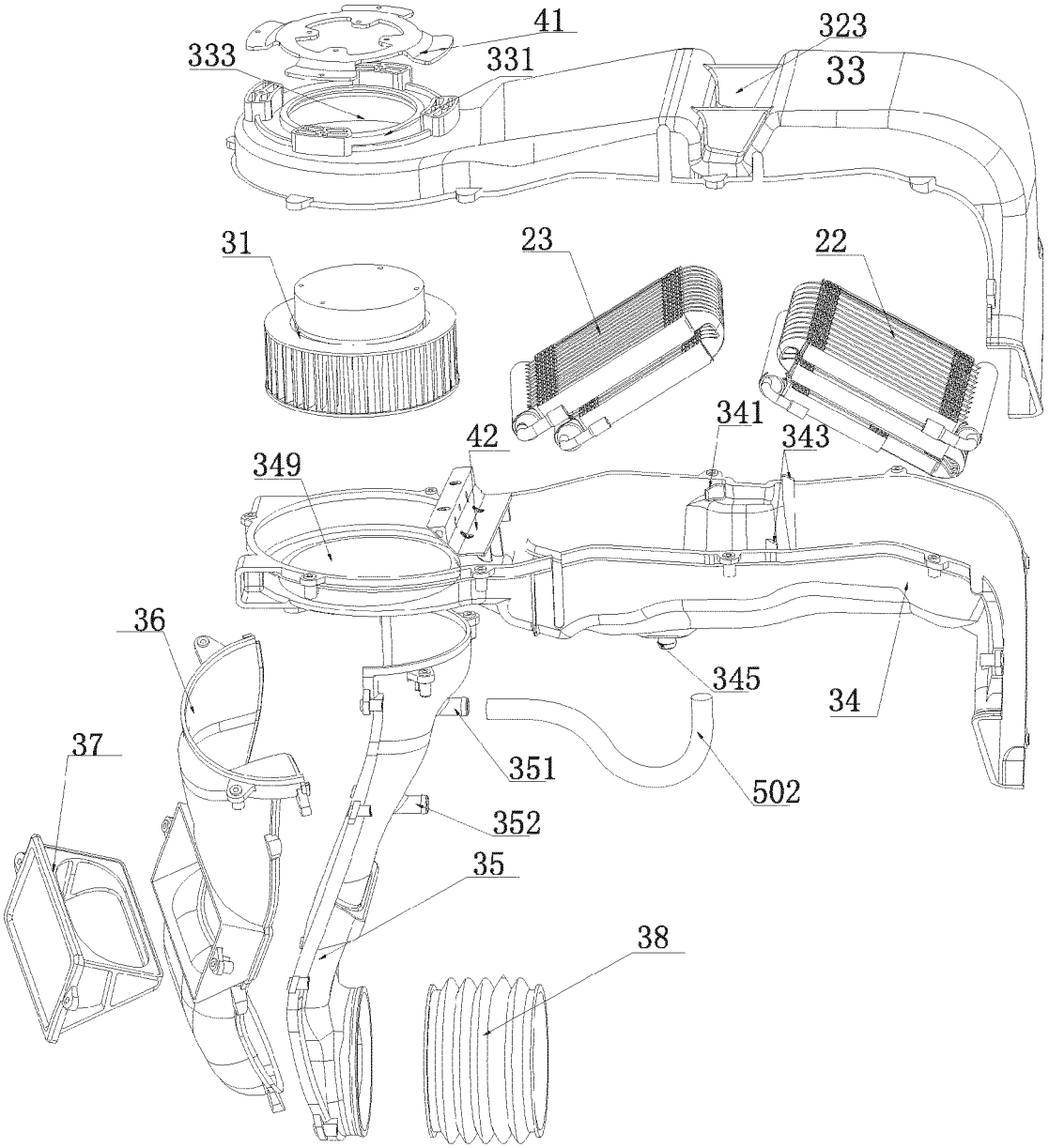
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Fig. 2

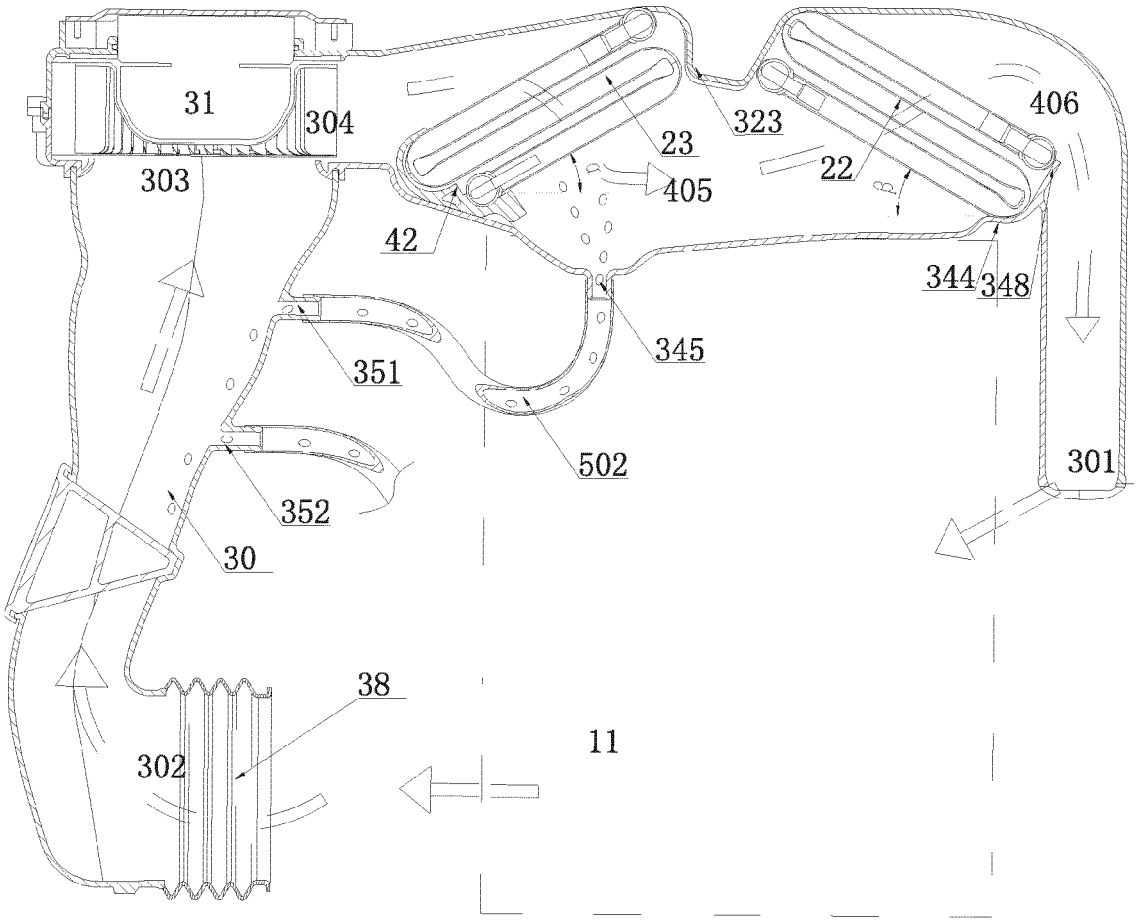
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Fig. 3

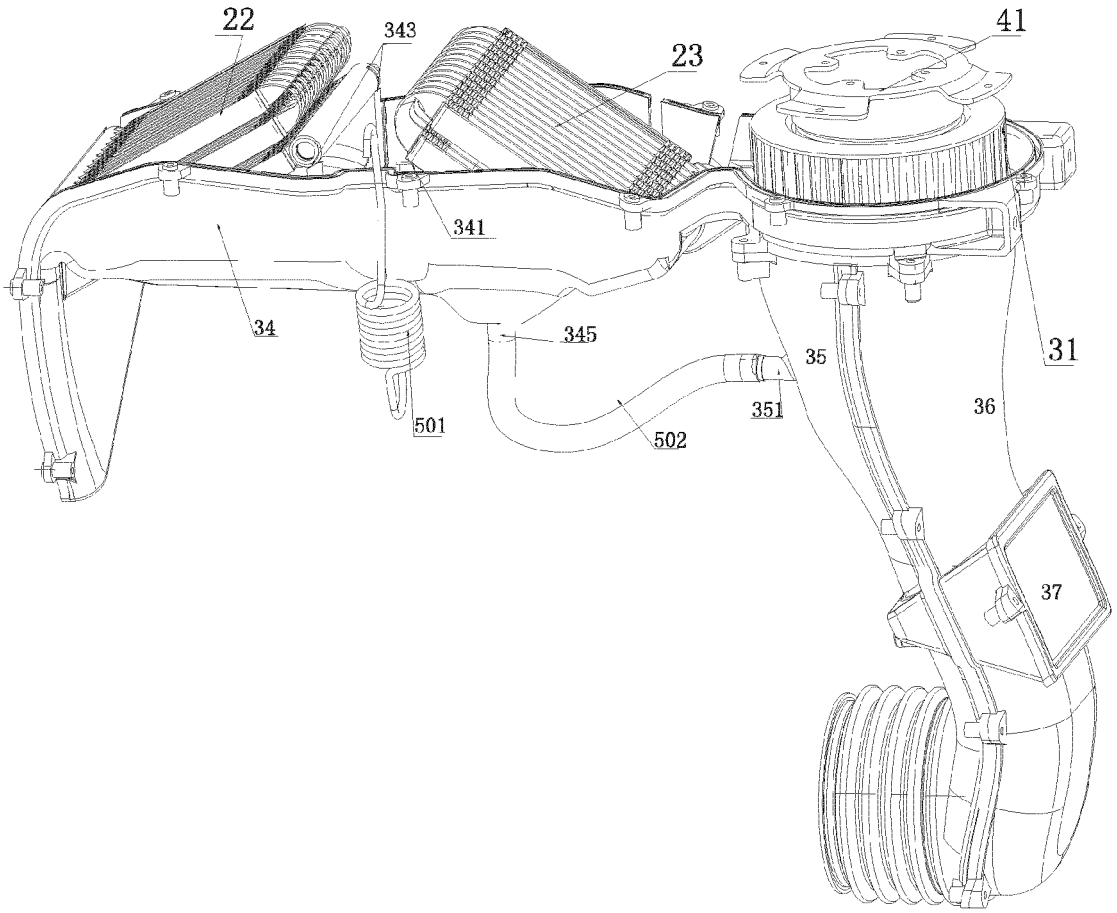

Fig. 4

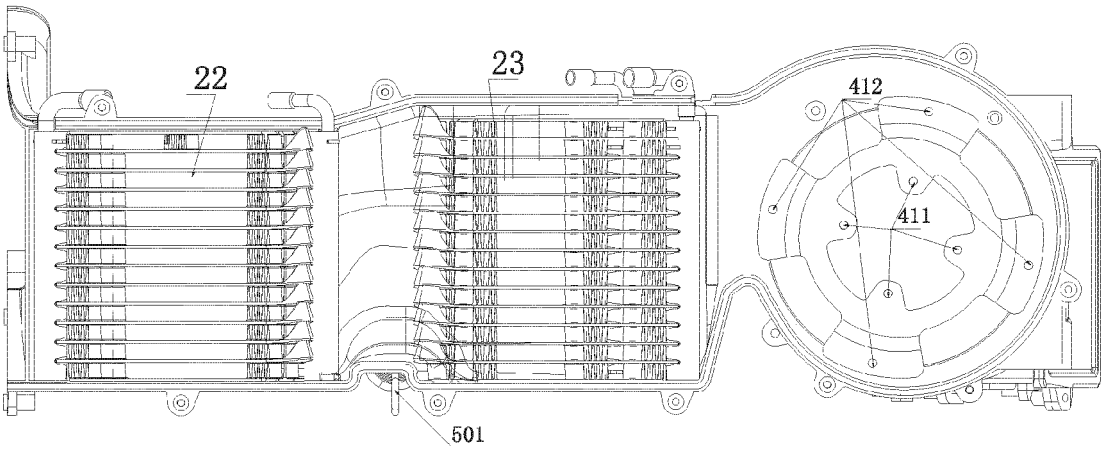

Fig. 5

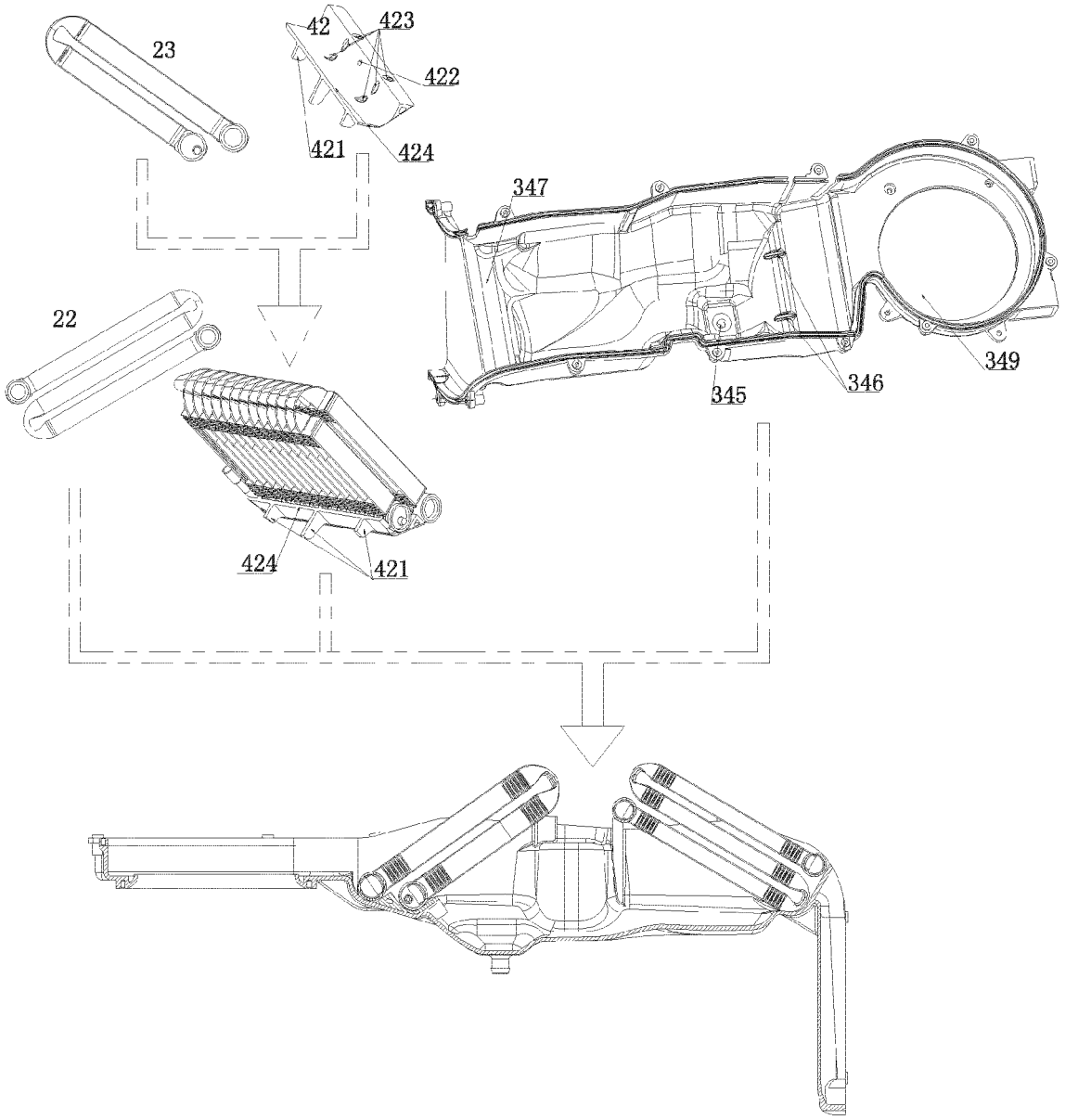

Fig. 6

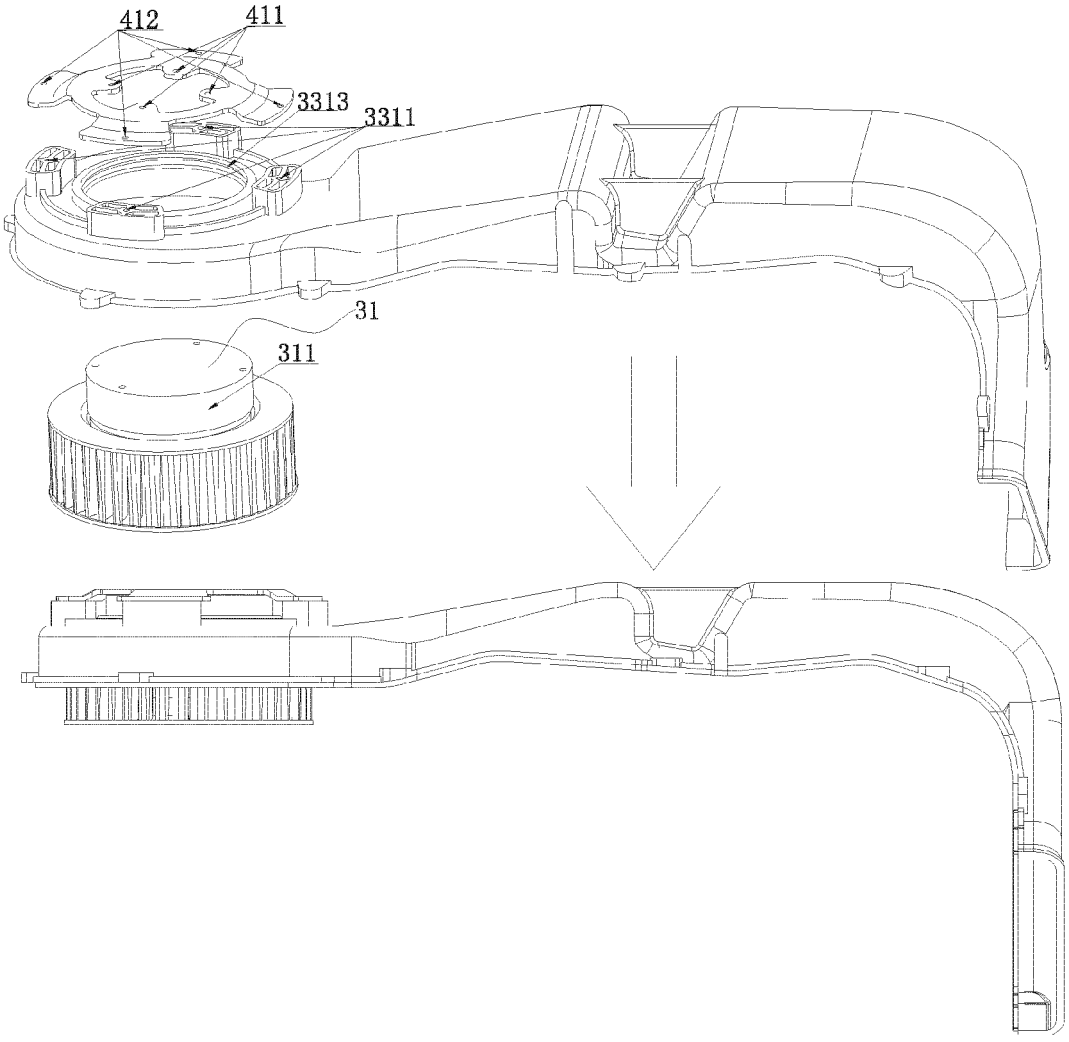

Fig. 7

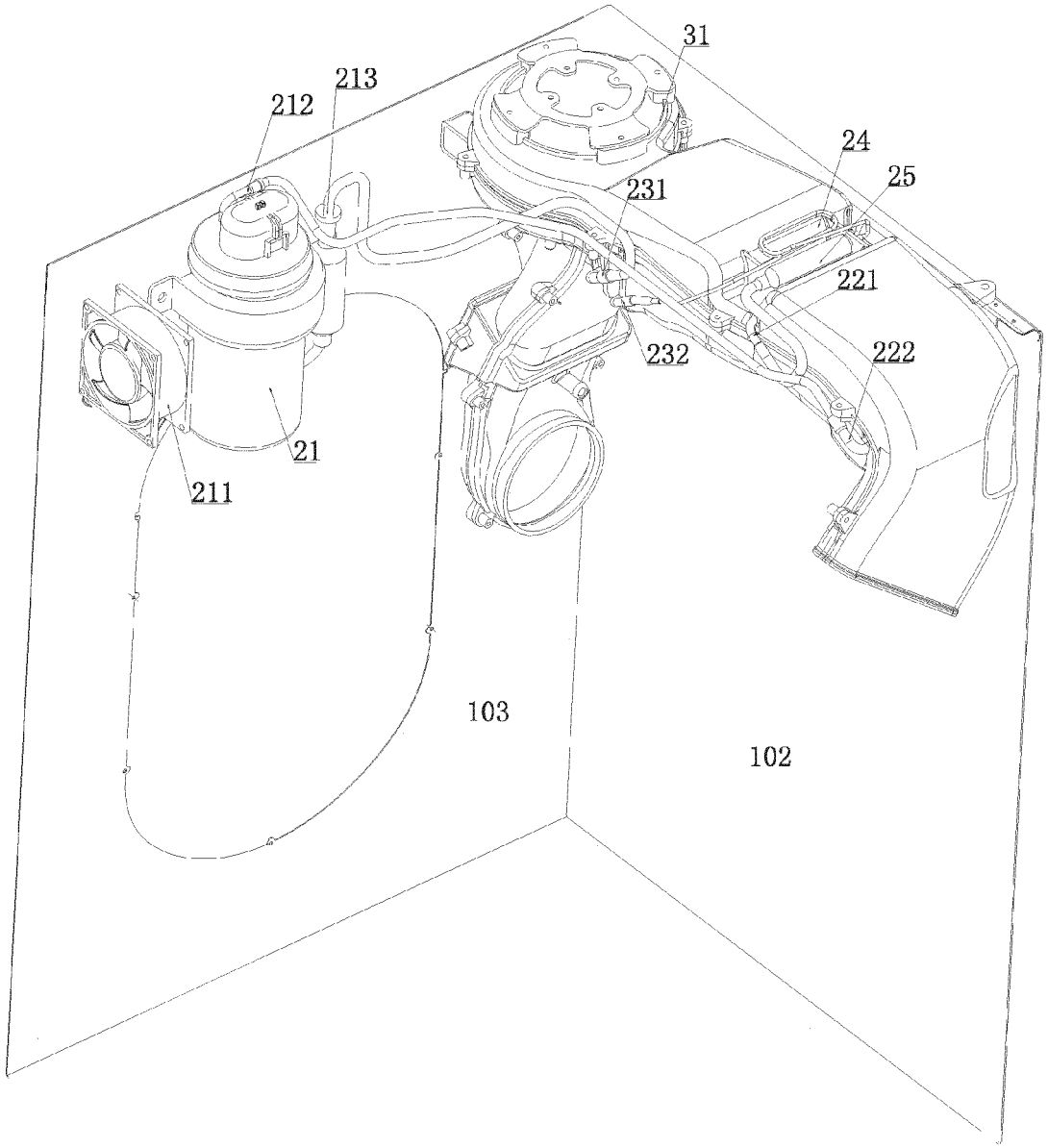

Fig. 8

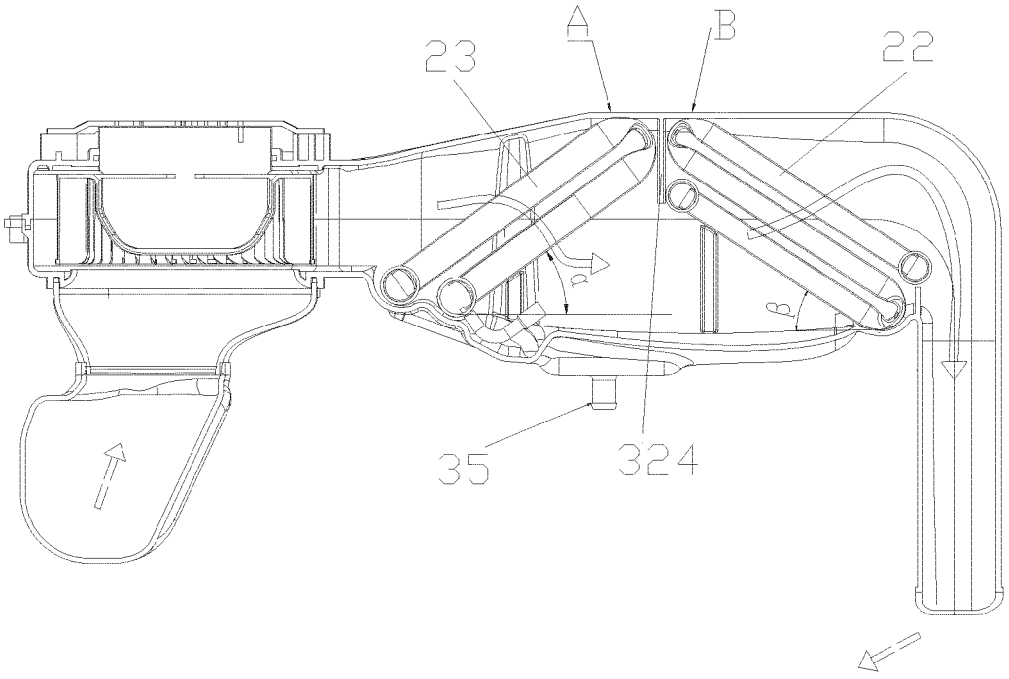

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 5330

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A	* paragraph [0013] - paragraph [0017] * * figures 1-12 *	7,11	ADD. D06F58/24 D06F25/00

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A	* figure 6 *	1,5,6	

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D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 March 2016	Bermejo, Marco

CATEGORY OF CITED DOCUMENTS

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