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(54) **A CLOTHES DRYER**

WÄSCHETROCKNER

SÈCHE-LINGE

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EP 3 224 403 B1

Description

Field of the Invention

[0001] The invention relates to clothes dryers.

Prior Art Discussion

[0002] At present the clothes dryers available on the market are mainly of the tumble dryer type. Air is drawn in by a fan and is blown across an electrical heating element and into a drum. The air flow into the drum is typically via an array of holes in a plate at the back of the drum.

[0003] The invention is directed towards providing an improved clothes dryer with less energy input and cost. Another objective is to minimise changes to the shape and configuration and parts of typical "standard" dryers - for ease of manufacture, maintenance, and fitting into available spaces.

[0004] Irish Patent No. S86294 describes a dryer which uses heat energy from a water heating system, and so reduces electrical power consumption. However it involves considerable change in the arrangement of the standard known dryer, and is complex. US6941680 describes a dryer which is linked to a heating system. An assembly of a fan, a filter, and a heat exchanger is mounted on the back of the unit, and the fan blows air through the heat exchanger and into a drum. EP0430197 also describes use of a connection to the hot water system of a household for a tumble dryer.

[0005] Despite knowledge of the principle of using heat supplied from a household hot water system since at least 1991 this principle has not been put to use in commercially available household products to the knowledge of the inventor. It appears that this is due to the complexity of the known approaches and non-conformance with well-established dryer sizes (such as under counter fitting) and/or achieving a machine which is simple enough to be reliable and have a low manufacturing cost.

[0006] The invention addresses this problem.

SUMMARY OF THE INVENTION

[0007] According to the invention there is provided a clothes dryer as set out in claim 1.

[0008] The heat exchanger may be supplied with heat energy from a building's central heating system, or external heat generation units including district heating systems.

[0009] In one embodiment, the air fan is arranged to pull air through the heat exchanger. In one embodiment, the air fan is a centrifugal fan having curved blades with convex surfaces facing in a direction or rotation. In one embodiment, the air fan is arranged to axially pull air through the heat exchanger and into an internal volume of said air fan.

[0010] In one embodiment, the air fan is in a manifold mounted adjacent the heat exchanger and is arranged to pull air through the heat exchanger and into the manifold through a manifold inlet in said first pass, and to blow heated air through a manifold outlet and into the heat exchanger in said further pass.

[0011] In one embodiment, the air fan and the manifold are arranged to draw ambient air through a portion of the heat exchanger and into the manifold, and blow said air back into a different portion of the heat exchanger. In one embodiment, said portions are spaced apart in a lateral dimension across the dryer.

[0012] In one embodiment, the air fan and the heat exchanger are arranged to provide sufficient air pressure to cause air in said further pass to spread through at least part of the heat exchanger before exiting at an upper heat exchanger outlet.

[0013] In one embodiment, the air fan is a centrifugal fan mounted to draw said first pass air axially into a volume of the fan, and to blow it laterally within the manifold with sufficient pressure to exhaust
the manifold and enter the heat exchanger in said further pass. In one embodiment, said manifold inlet has a larger cross-sectional area than said manifold outlet. In one embodiment, the manifold outlet has a cross-sectional area in the range of 25% to 90% of the cross-sectional area of the manifold inlet.

[0014] In one embodiment, the air fan and the heat exchanger are arranged to allow some first pass air to mix with further pass air. In one embodiment, the dryer comprises a diverter for diverting further pass air across the heat exchanger and into a path of said first pass air. Preferably, the diverter comprises a plate bordering or spaced apart from the heat exchanger. In one embodiment, the plate is normal to a direction of said further pass air flow through the heat exchanger.

[0015] In one embodiment, the heat exchanger comprises elongate parallel elements, and the diverter is spaced apart from said elongate parallel elements to define a volume within which said second pass air can flow alongside and perpendicular to said elongate parallel elements until it is drawn into volumes between said elongate parallel elements by said first pass air. In one embodiment, the diverter is located on a side of the heat exchanger opposed to the fan.

[0016] In one embodiment, the diverter includes an aperture for flow of first pass air into the heat exchanger.

[0017] In one embodiment, the heater includes an electrical element, and the controller is configured to operate the electric element if heat is not available to the heat exchanger. In one embodiment, the electric element is in a drum air inlet manifold of said drum hot air inlet.

[0018] In one embodiment, the heat exchanger is below and operatively connected to the drum inlet manifold. In one embodiment, the heat exchanger comprises heat exchange tubes extending through fins. In one embodiment, the fins are arranged in a direction aligned with the drum hot air inlet.

[0019] In one embodiment, the air fan is arranged to

be driven by the drum drive mechanism. In one embodiment, the air fan is on an outlet shaft of a motor of said drum drive mechanism.

[0020] In one embodiment, the dryer further comprises a valve for blocking flow of hot water to the heat exchanger for part of a drying cycle. In one embodiment, the controller is arranged to control operation of said valve, for a phase of operation such as a cooling down period.

Additional Statements

[0021] According to the invention, there is provided a clothes dryer comprising a controller, a housing, a drum, a drum drive mechanism, a drum hot air inlet, and an air fan for pumping air through a heater *en route* to the drum hot air inlet, wherein the heater includes a heat exchanger having a coupling for connection to a supply of hot water or other liquid.

[0022] In one embodiment, the housing has the general configuration of a conventional clothes dryer. In one embodiment, the heater includes an electrical element, and the controller is configured to operate the element if heat is not available to the heat exchanger. In one embodiment, the element is in a drum inlet manifold. In one embodiment, in the heat exchanger is below the drum inlet manifold.

[0023] In one embodiment, the fan is arranged to draw air in through the heat exchanger. In one embodiment, the fan is in a manifold arranged to direct air in back into the heat exchanger. In one embodiment, the heat exchanger is arranged to allow some pumped air to mix with inlet air so that it is re-circulated through the heat exchanger. In one embodiment, the dryer comprises a diverter for diverting air which has been pumped back into the heat exchanger in a further pass back into the heat exchanger. In one embodiment, the diverter comprises a plate bordering or spaced apart from the heat exchanger. Preferably, the plate is normal to a direction of air flow through the heat exchanger.

[0024] In one embodiment, the heat exchanger is of the plate type.

[0025] In one embodiment, the fan and the manifold are arranged to:

axially draw ambient air through a portion of the heat exchanger,
pump air radially and direct it back into the heat exchanger at a location laterally spaced-apart from the inlet, and
provide sufficient air pressure to cause it to spread through the heat exchanger before exiting at an upper heat exchanger outlet.

[0026] In one embodiment, the fan is arranged to be driven by the drum drive mechanism. In one embodiment, the fan is on an outlet shaft of a motor of said drum drive mechanism.

[0027] In one embodiment, the dryer further comprises a valve for blocking flow of hot water to the heat exchanger for part of a drying cycle. Preferably, the controller is arranged to control operation of said valve, for a phase of operation such as a cooling down period.

[0028] In one embodiment, the fan and the heat exchanger are arranged for contra-flow to prevent dust or other contaminant build-up on heat exchange elements.

DETAILED DESCRIPTION OF THE INVENTION

Brief Description of the Drawings

[0029] The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:-

Fig. 1 is a rear perspective view of a dryer of the invention;

Fig. 2 is a perspective cut-away view showing the major internal parts for inlet air flow;

Figs. 3 and 4 are further perspective cut-away views showing some of the parts more clearly;

Fig. 5 is an exploded perspective view of the major air-handling parts of the dryer;

Fig. 6 is a perspective view of an alternative dryer;

Fig. 7 is a cut-away perspective of the dryer of Fig. 6;

Fig. 8 is another cut-away perspective view, with the heat exchanger removed;

Fig. 9 is an exploded view of this dryer;

Figs. 10 and 11 are plan and exploded perspective views showing the air flows of the dryer of Figs. 6 to 9 in more detail;

Fig. 12 is an exploded perspective view of an alternative heat exchange assembly for a dryer of the invention, and

Fig. 13 is an exploded perspective view of the major air-handling parts of a further dryer of the invention, in this case a condenser dryer.

Description of the Embodiments

[0030] Referring to the drawings a domestic tumble dryer 1 of the invention comprises a rectangular box housing 2. It is similar in overall configuration to a conventional, under-counter, tumble dryer. At its back it has a panel 3 with an air inlet 4, an outlet 5, and a vent 6.

[0031] Internally, the dryer 2 has a drum 10 of the con-

ventional type, driven in a conventional manner by a motor 11 via a belt 12.

[0032] In addition, however, there is a heat exchange assembly comprising a tube and fin heat exchanger 20 with a hot water inlet 20(a) and a cool water outlet 20(b) for linking with a building's heating system. The heat exchanger comprises vertically arranged fins 20(c) through which horizontal tubes run in a zig-zag pattern from the inlet 20(a) to the outlet 20(b).

[0033] There is a heat exchanger manifold 21 on the internal side of the heat exchanger 20, and on the top side of the heat exchanger there is a hot air outlet 22 to a drum air inlet manifold 23. The drum air inlet manifold 23 is shallow, and round in shape when viewed from the rear, being similar in overall configuration to the inlet manifold of a conventional dryer which uses an electric element for heating the air as it passes through the manifold. The drum air inlet manifold manifold 23 includes an electrical coil element 24 in a flow path axially into the drum 10 via apertures in the back plate of the drum 10. The drum aperture arrangement to take in hot air is conventional.

[0034] The heat exchanger manifold 21 includes a centrifugal fan 25 around a manifold inlet 26 which is in-line with the overall machine's inlet 4. The manifold 21 also has an exhaust outlet 27 parallel to the inlet 26 and laterally spaced apart from it. The outlet 27 is arranged to blow air back into the heat exchanger 20 at a location offset from the manifold inlet 26. In this case the inlet 26 has a cross-sectional area of about 120 cm^2, and the outlet 27 has a cross-sectional area of about 60 cm^2. It is preferable that the area of the manifold outlet be greater than that of the manifold inlet, as this causes a faster flow velocity for the same overall flow rate, thereby assisting distribution of second pass air into and across the heat exchanger as described in more detail below. In general the outlet has a cross-sectional area which is preferably in the range of 25% to 90% that of the inlet.

[0035] The fan 25 in the manifold 21 is driven by the motor 11 and so does not require a drive additional to that which is provided in a typical tumble dryer.

[0036] The controller is preferably of a conventional type in hardware terms, being programmed to operate the components according to user instructions especially in terms of temperatures and times. The instructions will have a bearing on the fan speeds, and possible control of a solenoid valve for heat exchanger supply.

[0037] In use, the control panel (not shown) is operated to select heat energy from the heating system instead of the element 24 if such hot water is available. The fan 25 draws air from outside through the inlet 4 and the heat exchanger 20 in a first pass. This air is heated as it passes through the heat exchanger 20. The air is then blown laterally in the manifold 21 by the fan 25. The fan 25 is of the centrifugal type, configured to efficiently draw air in axially and to pump it radially out. The pumped air is driven out through the manifold outlet 27 back into the heat exchanger 20 in a second pass. As the heat exchanger has a back plate opposed to the manifold outlet 27, the pumped air is forced to spread laterally across the rear of the heat exchanger 20. The path for this in a narrow space between the plate 30 and the fins, but in other embodiments it may be may be through apertures in the (vertically-arranged) fins.

[0038] The flow caused by the fan 25 and the configuration of the heat exchanger 20 and the plate 30 causes mixing of the air from the manifold 21 with fresh inlet air drawn through the machine inlet 4. This enhances the pre-heating effect. Hence the air entering the manifold 21 is already at an elevated temperature. This is best illustrated by the arrows in Fig. 4.

[0039] The air which is not re-circulated (approximately over 80% of it) is routed through the heat exchanger 20, picking up heat in the process, and exits the heat exchanger via the outlet 22 and progresses up into the drum manifold 23. This is a disc-shaped space from which the heated air enters the drum 10 via the drum's rear inlet apertures.

[0040] If there is no hot water available the dryer 1 can operate using the conventional form of electric air heating using the coil 24 in the drum manifold 23. The machine's controller may also be configured to use this element at a lower setting if some heat is available from the heating system.

[0041] Advantageously, the overall air flow path is the same whether heat is drawn from the heat exchanger 20 or from the electric element. This achieves simplicity of dryer construction, reliability, and compactness.

[0042] It will be appreciated that the invention achieves much more economical clothes drying, by making use of heat which is available in a building's heating system. It may be easily coupled to the heating system in a manner akin to connecting a conventional radiator.

[0043] Also, the dryer has the major benefit of the heat exchanger and several of the components being self-cleaning because of the contra flow of air through the heat exchanger. This reduces or eliminates need for cleaning, and moreover reduces the fire hazard which might arise with build-up of fluff on hot parts. Indeed, in general there is reduced risk of fire because the components of the machine are at a lower temperature than with conventional machines using a heated electrical element as the only heat source. Moreover, even if the machine is used in the electrical element mode for a significant period of time there is still a reduced risk of fire by fluff depositing on the electrical element. This is because the air is pumped from a location just below the element and so there is a higher air pressure than is conventional with air being drawn by a fan downstream of the drum.

[0044] Also, the machine does not take up any more space than a conventional machine, and it allows drying even when heat is not available from the heating system.

[0045] Further, there may be a valve at the heat exchanger inlet to temporarily block flow of hot water for certain phases of use of the machine 1. For example, the

hot water flow may be blocked during a final phase of say 10 minutes to allow the clothes to cool down and prevent creasing.

[0046] Also, the dryer may be of the condenser type, using the existing technology for condensing.

[0047] Also, where there is a gap between the plate 30 and the heat exchange 20, the depth of this gap may be chosen to set a desired level of air turbulence and re-circulation. In another embodiment the gap may be adjustable after manufacture to achieve the desired effect. There may be different arrangements of heat exchangers and/or valves for diversion of air to control the extent of re-circulation.

[0048] Referring to Figs. 6 to 11 an alternative dryer, 100, is illustrated and parts similar to those of the dryer 1 are given the same reference numerals. The dryer 100 has an outer casing 102 with a back panel 104 having a grille. In this case there is a drum manifold 110, which is dish-shaped as is conventional. However it has a cut-out in the lower side to receive an electrical heater 111. A plate 115 is fitted against the fan / manifold assembly 25/21, having apertures 116 and 117 aligned with the manifold 26 and the manifold outlet 27. When a rectangular heat exchanger 120 is placed against the plate 115 it is in line with the electrical heater 111 and the interior of the drum manifold 110. The heat exchanger 120 has water inlet and outlet couplers 121 and 122 respectively. A drive shaft (not shown) from the motor 11 drives the belt 12 and the fan 25, as in the above embodiment.

[0049] The heat exchanger 120 has copper tubes and aluminium fins. The copper pipes are mechanically crimped in the fins, and these are provided with small collars which increase the surface of exchange between each other. The fins have an aluminium surface slightly waved to improve the quality of the thermic exchange by effect of turbulence. This characteristic does not modify significantly the pressure drop created on the air. The standard space between the fins is of 2.1 mm. In another embodiment, the heat exchanger may have an "AIRA" air curtain design fitted in order to provide additional regulation to air flow.

[0050] The tubes are made of copper reels of 10mm tubes directly formed to dimension. After the expansion process in the fin the internal surface is smooth to reduce water pressure drop. The frames are of galvanised steel, to ensure rigidity of the set and protect the copper and the aluminium from contact with sharp elements. It allows the mounting of the exchanger on gliders. The collectors are made of copper, arranged to collect the parallel circuits of the heat exchanger and gather them into one single main circuit. The distributor/capillaries are welded to allow a well balanced distribution of the liquid in the parallel circuits of the tube/coils.

Heat Exchanger

Finned Height	302mm
Fin Spacing,	2.1mm
Tubes	CU.30
Fins	AL.10
Weight	4.10kg
Primary Surface	0.20m^2
Secondary Surface	3.20m^2
Volume of tubes	0.68dm^3

[0051] In use, inlet air 140 flows into the heat exchanger 120, through the gaps between the heat exchanger fins 124 (through which tubes 123 extend). The fins 124 are vertically aligned and so flow 140 can continue through the heat exchanger 120 and into the fan/manifold assembly 25/21 as a first pass flow 141. The fan 25 has blades 150 curved with a convex surface facing in the (clockwise, as viewed from the heat exchanger) direction of travel. The fan 25 delivers air in a lateral flow 142 across the manifold 21 and from there it flows in a second pass 143 back into the heat exchanger 120. Due to a gap 130 between the panel 104 and the fins 124 some air flows (144) laterally across the back of the heat exchanger. It is drawn back in by the first pass or inlet flow 140/141, to mix with the first pass air, so that some of the flow into the fan 25 is heated twice. The flow along the fins 124 is shown by the arrows 145. The final heated air exits the heat exchanger on the top right as viewed from the rear, in a flow 146.

[0052] In one example of use, water flows into the heat exchanger at an average rate of 68 1/hr, and there is a pressure drop of 0.12 kPa across the heat exchanger.

[0053] The following is a set of test data for performance of the dryer 100.

1) At 75°C hot water supply:

7kg wet clothes, 80 minutes drying time
3kg wet clothes, 60 minutes drying time

2) At 60°C hot water supply:
7kg wet clothes 110 to 120 minutes drying time
3) At 56°C hot water supply
6kg wet clothes, 160 minutes drying time.

[0054] In one test the air flow rate was up to 16m^3/h.

[0055] A 55 minute wash with a 1400rpm spin cycle was utilised to wash clothes to ensure clothes were prepared for each drying test cycle and presented in similar conditions and identical weights.

[0056] The air speed into the heat exchanger at the inlet 116 for the above was 12 m/s, and the speed out of the manifold outlet 117 was 18 m/s.

[0057] Referring to Fig. 12 an alternative heat exchange assembly for a dryer of the invention has parts similar to the above embodiments indicated by the same reference numerals. In this case there is a plate 160 behind and in contact with the rear of the heat exchanger

120. This completely seals off the rear of the heat exchanger in the sense of preventing lateral flow across. However, there is space above the heat exchanger fins on the left side as viewed in Fig. 12. Hence, there is a flow 165/166 downwardly and into the fins, forwardly 167 under action of the fan 25, out (168) of the manifold, up (169) through the fins, and finally out (170) into the drum manifold. There is also mixing in this embodiment because there is an enclosed space above the fins on the right (as viewed from the rear). Second pass air can travel across ((171) to be drawn into the first pass air 165/166.

[0058] In this embodiment there is even higher efficiency because the air 165 will be pre-heated to some extent before it reaches the heat exchanger, by contact with the drum.

[0059] Referring to Fig. 13 a condenser dryer embodiment has a heat exchange assembly 200, and again like parts are given the same reference numerals. There is a condenser tubular section 203 and a fan 205 for drawing in cool air to cause condensation into a water trap 206. Hence the provision of a heat exchanger does not reduce flexibility in dryer configuration, both air exhaust and condenser types can be readily provided.

[0060] The dryer of the various embodiments has the major benefit of achieving exceptional energy efficiency by using heat which is available anyway in most buildings, but at the same time requiring little configuration and size difference from the known electric-only dryers. Because the fan (25) is arranged to pull air through the heat exchanger it is particularly efficient to direct it in a manner to optimise heat transfer with the multiple passes, possible involving mixing. Use of a centrifugal fan having curved blades with convex surfaces facing in a direction or rotation allows particularly effective drawing of air from space around the heat exchanger in the first pass and then to change direction for the second pass, of in embodiments with only one pass, for onward flow to the drum. If there is only one pass, it is preferable that the heat exchanger be more aligned in the flow direction.

[0061] The fan being arranged to direct air through the heat exchanger in a first pass and back into the heat exchanger in at least one further pass, provides particularly efficient heat transfer and compactness of the heat transfer assembly. The manifold mounted adjacent the heat exchanger also contributes significantly to compactness. It is a very advantageous way to draw ambient air through a portion of the heat exchanger and to blow the air back into a different portion of the heat exchanger. Because these portions are spaced apart in the lateral dimension (horizontal in use), the heat exchanger may be configured to be shallow but wide (approximately planar configuration), allowing it to fit in the housing in a compact manner. In embodiments where the manifold inlet has a larger cross-sectional area than the manifold outlet, there is a higher flow rate in the second pass, helping spread of the air across the heat exchanger and also upwardly to the drum. It has been found that it is advantageous if the manifold outlet has a cross-sectional area in the range of 30% to 80% of that of the inlet. Where the fan and the heat exchanger are arranged to allow some first pass air to mix with second pass air, a higher temperature can be achieved without unduly sacrificing fan efficiency. A diverter such as a plate is a particularly effective and compact way of causing second pass air to spread across the heat exchanger and into the path of first pass air.

[0062] By having elongate parallel elements, the air can flow alongside and perpendicular to said elongate elements until it is drawn into volumes between said elongate elements by first pass air, and moreover it is directed towards the drum. The fins therefore influence both heat transfer and direction of air travel while guiding air towards the drum. Where the heater includes an electrical element the controller is configured to engage or energise the electrical element when no alternative heat source is available; this dual facility ultimately increases the versatility for the end user.

[0063] Where the electrical heating element is forward of the manifold or the heat exchanger or both, recycled air flow acts as an effective cleanser of all components from flint/fluff due to the multidirectional travel of air-flow during all operations of this system. There is advantageously very effective blowing of fluff off the electrical element.

[0064] This is in contrast to many known dryers, in which the fan is directly downstream of the drum, and so is acing to pull air across the element via the drum and the clothes within. On the other hand, by having the fan blow air across the element there is much less risk of fluff depositing on the element and the attendant fire risk.

[0065] Where fan is arranged to be driven by the drum drive mechanism, the dryer can be particularly compact and have few parts.

[0066] The invention is not limited to the embodiments described but may be varied in construction and detail. For example the dryer may be of a capacity suitable for commercial use. It is preferable, but not essential, that air is drawn in through the heat exchanger for the electrical mode of operation. In an alternative embodiment the air flow components draw air and pump it in an inline axial manner through a heat exchanger without mixing. Such a heat exchanger may be in the form of baffles in an air flow duct. Also, the heat exchanger may comprise an assembly of more than one physical unit mounted together.

Claims

1. A clothes dryer comprising:

a controller,
a housing (2),
a drum (10),
a drum drive mechanism (11, 12),
a drum hot air inlet (23),

a heater (20, 24), and
an air fan (25) for pumping air through the heater *en route* to the drum hot air inlet, wherein the heater includes a heat exchanger (20, 120) having a coupling (20(a), 20(b)) for connection to a supply of hot water or other liquid,
characterized in that,
the air fan is arranged to direct air through the heat exchanger in a first pass (141, 142) and back into the heat exchanger (20, 120) in at least one further pass (143).

2. A clothes dryer as claimed in claim 1, wherein the air fan (25) is arranged to pull air through the heat exchanger (20, 120), and optionally the air fan (25) is a centrifugal fan having curved blades with convex surfaces facing in a direction of rotation.

3. A clothes dryer as claimed in claim 2, wherein the air fan (25) is arranged to axially pull air through the heat exchanger (20) and into an internal volume of said air fan (25).

4. A clothes dryer as claimed in any preceding claim, wherein the air fan (25) is in a manifold (21) mounted adjacent the heat exchanger (20, 120) and is arranged (21) to pull air through the heat exchanger and into the manifold through a manifold inlet (26) in said first pass, and to blow heated air through a manifold outlet (27) and into the heat exchanger in said further pass.

5. A clothes dryer as claimed in claim 4, wherein the air fan (25) and the manifold (21) are arranged to:

draw (14) ambient air through a portion of the heat exchanger (120) and into the manifold (21), and
blow said air (143) back into a different portion of the heat exchanger (20, 120).

6. A clothes dryer as claimed in claim 5, wherein said portions of the heat exchanger (20, 120) are spaced apart in a lateral dimension across the dryer, and wherein the air fan and the heat exchanger are arranged to provide sufficient air pressure to cause air (144, 145) in said further pass to spread through at least part of the heat exchanger (20, 120) before exiting (146) at an upper heat exchanger outlet.

7. A clothes dryer as claimed in any of claims 4 to 6, wherein the air fan is a centrifugal fan (25) mounted to draw said first pass air axially into a volume of the fan, and to blow it laterally within the manifold (21) with sufficient pressure to exhaust the manifold and enter the heat exchanger in said further pass.

8. A clothes dryer as claimed in any of claims 4 to 7, wherein said manifold inlet (26) has a larger cross-sectional area than said manifold outlet (27), and wherein the manifold outlet has a cross-sectional area in the range of 25% to 90% of the cross-sectional area of the manifold inlet.

9. A clothes dryer as claimed in any preceding claim, wherein the air fan and the heat exchanger (20, 120) are arranged to allow some first pass air to mix with further pass air.

10. A clothes dryer as claimed in claim 9, wherein the dryer comprises a diverter (30, 104) for diverting further pass air across the heat exchanger and into a path of said first pass air, and optionally the diverter comprises a plate (30, 104) bordering or spaced apart from the heat exchanger (20, 120), and optionally wherein the plate is normal to a direction of said further pass air flow through the heat exchanger.

11. A clothes dryer as claimed in claim 10, wherein the heat exchanger comprises elongate parallel elements (124), and the diverter (104) is spaced apart from said elongate parallel elements to define a volume (130) within which said second pass air (144) can flow alongside and perpendicular to said elongate parallel elements until it is drawn into volumes between said elongate parallel elements by said first pass air, and optionally the diverter (104) is located on a side of the heat exchanger opposed to the fan (25), and optionally the diverter includes an aperture for flow of first pass air into the heat exchanger.

12. A clothes dryer as claimed in any preceding claim, wherein the heater includes an electrical element (24), and the controller is configured to operate the electrical element (24) if heat is not available to the heat exchanger, and the electrical element (24) is in a drum air inlet manifold (23) of said drum hot air inlet, and optionally the heat exchanger (20, 120) is below and operatively connected to the drum inlet manifold (23).

13. A clothes dryer as claimed in any preceding claim, wherein the heat exchanger (20, 120) comprises heat exchange tubes extending through fins, and the fins (124) are arranged in a direction aligned with the drum hot air inlet (23, 110).

14. A clothes dryer as claimed in any preceding claim, wherein the air fan (25) is arranged to be driven by the drum drive mechanism (11), and optionally the air fan is on an outlet shaft of a motor of said drum drive mechanism (11).

15. A clothes dryer as claimed in any preceding claim, further comprising a valve for blocking flow of hot water to the heat exchanger for part of a drying cycle,

and the controller is arranged to control operation of said valve, for a phase of operation such as a cooling down period.

Patentansprüche

1. Wäschetrockner, umfassend:

eine Steuereinheit,
ein Gehäuse (2),
eine Trommel (10),
einen Trommelantriebsmechanismus (11, 12),
einen Trommelheißlufteinlass (23),
ein Heizelement (20, 24) und
einen Ventilator (25) zum Pumpen von Luft durch das Heizelement auf dem Weg hin zum Trommelheißlufteinlass,
wobei das Heizelement einen Wärmeaustauscher (20, 120) mit einer Kopplung (20(a), 20(b)) zur Verbindung mit einer Versorgung mit Heißwasser oder einer anderen Flüssigkeit enthält,
dadurch gekennzeichnet, dass
der Ventilator so angeordnet ist, dass er Luft bei einem ersten Durchlauf (141, 142) durch den Wärmeaustauscher und bei mindestens einem weiteren Durchlauf (143) zurück in den Wärmeaustauscher (20, 120) leitet.

2. Wäschetrockner nach Anspruch 1, wobei der Ventilator (25) so angeordnet ist, dass er Luft durch den Wärmeaustauscher (20, 120) zieht und optional der Ventilator (25) ein Radialventilator mit gekrümmten Schaufeln mit konvexen Flächen, die in eine Drehrichtung gerichtet sind, ist.

3. Wäschetrockner nach Anspruch 2, wobei der Ventilator (25) so angeordnet ist, dass er Luft axial durch den Wärmeaustauscher (20) in einen Innenraum des Ventilators (25) zieht.

4. Wäschetrockner nach einem vorhergehenden Anspruch, wobei der Ventilator (25) in einem benachbart zum Wärmeaustauscher (20, 120) montierten Verteiler (21) ist und so angeordnet (21) ist, dass er bei dem ersten Durchlauf Luft durch den Wärmeaustauscher in den Verteiler durch einen Verteilereinlass (26) zieht und bei dem weiteren Durchlauf erwärmte Luft durch einen Verteilerauslass (27) in den Wärmeaustauscher bläst.

5. Wäschetrockner nach Anspruch 4, wobei der Ventilator (25) und der Verteiler (21) so angeordnet sind, dass sie:

Außenluft durch einen Abschnitt des Wärmeaustauschers (120) in den Verteiler (21) ziehen (14) und
die Luft (143) zurück in einen anderen Abschnitt des Wärmeaustauschers (20, 120) blasen.

6. Wäschetrockner nach Anspruch 5, wobei die Abschnitte des Wärmeaustauschers (20, 120) in einer Querdimension des Trockners beabstandet sind, und wobei der Ventilator und der Wärmeaustauscher so angeordnet sind, dass sie einen Luftdruck bereitstellen, der ausreichend ist, um zu bewirken, dass sich Luft (144, 145) bei dem weiteren Durchlauf mindestens in einem Teil des Wärmeaustauschers (20, 120) verteilt, bevor sie an einem oberen Wärmeaustauscherauslass austritt (146).

7. Wäschetrockner nach einem der Ansprüche 4 bis 6, wobei der Ventilator ein Radialventilator (25) ist, der so montiert ist, dass er die Luft des ersten Durchlaufs axial in einen Raum des Ventilators zieht und sie innerhalb des Verteilers (21) bei einem Druck, der ausreichend ist, damit sie bei dem weiteren Durchlauf aus dem Verteiler abgesaugt wird und in den Wärmeaustauscher eintritt, quer bläst.

8. Wäschetrockner nach einem der Ansprüche 4 bis 7, wobei der Verteilereinlass (26) einen größeren Querschnitt als der Verteilerauslass (27) aufweist, und wobei der Verteilerauslass einen Querschnitt im Bereich von 25 % bis 90 % des Querschnitts des Verteilereinlasses aufweist.

9. Wäschetrockner nach einem vorhergehenden Anspruch, wobei der Ventilator und der Wärmeaustauscher (20, 120) so angeordnet sind, dass sie zulassen, dass etwas Luft des ersten Durchlaufs sich mit Luft des weiteren Durchlaufs vermischt.

10. Wäschetrockner nach Anspruch 9, wobei der Trockner ein Umlenkelement (30, 104) zum Umlenken von Luft des weiteren Durchlaufs durch den Wärmeaustauscher auf einen Weg der Luft des ersten Durchlaufs umfasst und optional das Umlenkelement eine an den Wärmeaustauscher (20, 120) angrenzende oder vom Wärmeaustauscher beabstandete Platte (30, 104) umfasst und optional wobei die Platte normal zu einer Richtung der Strömung der Luft des weiteren Durchlaufs durch den Wärmeaustauscher ist.

11. Wäschetrockner nach Anspruch 10, wobei der Wärmeaustauscher längliche, parallele Elemente (124) umfasst und das Umlenkelement (104) von den länglichen, parallelen Elementen beabstandet ist, um einen Raum (130) abzugrenzen, innerhalb dessen die Luft (144) des zweiten Durchlaufs entlang und senkrecht zu den länglichen, parallelen Elementen strömen kann, bis sie durch die Luft des ersten Durchlaufs in Räume zwischen den länglichen, parallelen

Elementen gezogen wird, und sich optional das Umlenkelement (104) auf einer Seite des Wärmeaustauschers gegenüber dem Ventilator (25) befindet und optional das Umlenkelement eine Öffnung, durch die Luft des ersten Durchlaufs in den Wärmeaustauscher strömen kann, enthält.

12. Wäschetrockner nach einem vorhergehenden Anspruch, wobei das Heizelement ein elektrisches Element (24) enthält und die Steuereinheit konfiguriert ist, um das elektrische Element (24) zu betreiben, wenn für den Wärmeaustauscher keine Wärme zur Verfügung steht, und das elektrische Element (24) in einem Trommellufteinlassverteiler (23) des Trommelheißlufteinlasses ist und optional der Wärmeaustauscher (20, 120) unter und wirkverbunden mit dem Trommeleinlassverteiler (23) ist.

13. Wäschetrockner nach einem vorhergehenden Anspruch, wobei der Wärmeaustauscher (20, 120) durch Lamellen verlaufende Wärmeaustauschrohre umfasst und die Lamellen (124) in einer am Trommelheißlufteinlass (23, 110) ausgerichteten Richtung angeordnet sind.

14. Wäschetrockner nach einem vorhergehenden Anspruch, wobei der Ventilator (25) so angeordnet ist, dass er durch den Trommelantriebsmechanismus (11) angetrieben wird, und optional der Ventilator auf einer Abtriebswelle eines Motors des Trommelantriebsmechanismus (11) ist.

15. Wäschetrockner nach einem vorhergehenden Anspruch, weiter umfassend ein Ventil zum Blockieren der Strömung von Heißwasser hin zum Wärmeaustauscher für einen Teil eines Trockengangs, und die Steuereinheit ist so angeordnet, dass sie den Betrieb des Ventils für eine Betriebsphase wie eine Abkühlzeit steuert.

Revendications

1. Sèche-linge comportant :

un dispositif de commande,
une carrosserie (2),
un tambour (10),
un mécanisme d'entraînement de tambour (11, 12),
une entrée d'air chaud de tambour (23),
un corps de chauffe (20, 24), et
un ventilateur (25) servant à pomper de l'air au travers du corps de chauffe en route vers l'entrée d'air chaud de tambour,
dans lequel le corps de chauffe comprend un échangeur de chaleur (20, 120) ayant un raccord (20(a), 20(b)) à des fins de raccordement à une alimentation en eau chaude ou autre liquide,
caractérisé en ce que,
le ventilateur est agencé pour diriger de l'air au travers de l'échangeur de chaleur au cours d'un premier passage (141, 142) et de retour dans l'échangeur de chaleur (20, 120) au cours d'au moins un autre passage (143).

2. Sèche-linge selon la revendication 1, dans lequel le ventilateur (25) est agencé pour aspirer de l'air au travers de l'échangeur de chaleur (20, 120) et éventuellement le ventilateur (25) est un ventilateur centrifuge ayant des pales courbes aux surfaces convexes orientées dans une direction allant dans le sens de la rotation.

3. Sèche-linge selon la revendication 2, dans lequel le ventilateur (25) est agencé pour aspirer de l'air dans le sens axial au travers de l'échangeur de chaleur (20) et jusque dans le volume interne dudit ventilateur (25).

4. Sèche-linge selon l'une quelconque des revendications précédentes, dans lequel le ventilateur (25) est dans un collecteur (21) monté de manière adjacente par rapport à l'échangeur de chaleur (20, 120) et est agencé (21) pour aspirer de l'air au travers de l'échangeur de chaleur et jusque dans le collecteur au travers d'une entrée de collecteur (26) au cours dudit premier passage, et pour souffler de l'air chaud au travers d'une sortie de collecteur (27) et jusque dans l'échangeur de chaleur au cours dudit autre passage.

5. Sèche-linge selon la revendication 4, dans lequel le ventilateur (25) et le collecteur (21) sont agencés pour :

attirer (14) de l'air ambiant au travers d'une partie de l'échangeur de chaleur (120) et jusque dans le collecteur (21), et
souffler ledit air (143) de retour dans une partie différente de l'échangeur de chaleur (20, 120).

6. Sèche-linge selon la revendication 5, dans lequel lesdites parties de l'échangeur de chaleur (20, 120) sont espacées les unes par rapport aux autres dans une dimension latérale en travers du sèche-linge, et dans lequel le ventilateur et l'échangeur de chaleur sont agencés pour fournir une pression d'air suffisante pour amener l'air (144, 145) au cours dudit autre passage à se répartir au travers d'au moins une partie de l'échangeur de chaleur (20, 120) avant de sortir (146) au niveau d'une sortie supérieure de l'échangeur de chaleur.

7. Sèche-linge selon l'une quelconque des revendica-

tions 4 à 6, dans lequel le ventilateur est un ventilateur centrifuge (25) monté pour attirer ledit air de premier passage dans le sens axial jusque dans un volume du ventilateur, et pour le souffler dans le sens latéral à l'intérieur du collecteur (21) avec suffisamment de pression pour le faire sortir du collecteur et le faire entrer dans l'échangeur de chaleur au cours dudit autre passage.

8. Sèche-linge selon l'une quelconque des revendications 4 à 7, dans lequel ladite entrée de collecteur (26) a une section transversale supérieure à ladite sortie de collecteur (27), et dans lequel la sortie de collecteur a une section transversale se trouvant dans la plage allant de 25 % à 90 % de la section transversale de l'entrée de collecteur.

9. Sèche-linge selon l'une quelconque des revendications précédentes, dans lequel le ventilateur et l'échangeur de chaleur (20, 120) sont agencés pour permettre à une partie de l'air de premier passage de se mélanger à l'air de l'autre passage.

10. Sèche-linge selon la revendication 9, dans lequel le sèche-linge comporte un déflecteur (30, 104) servant à dévier l'air de l'autre passage en travers de l'échangeur de chaleur et jusque dans un chemin dudit air de premier passage, et éventuellement le déflecteur comporte une plaque (30, 104) à côté ou à distance de l'échangeur de chaleur (20, 120), et éventuellement dans lequel la plaque est perpendiculaire par rapport à une direction de l'écoulement dudit air de l'autre passage au travers de l'échangeur de chaleur.

11. Sèche-linge selon la revendication 10, dans lequel l'échangeur de chaleur comporte des éléments parallèles allongés (124), et le déflecteur (104) est espacé par rapport auxdits éléments parallèles allongés pour définir un volume (130) à l'intérieur duquel ledit air de deuxième passage (144) peut s'écouler le long desdits éléments parallèles allongés, et de manière perpendiculaire par rapport à ceux-ci, jusqu'à ce qu'il soit attiré dans des volumes entre lesdits éléments parallèles allongés par ledit air de premier passage, et éventuellement le déflecteur (104) est situé sur un côté de l'échangeur de chaleur à l'opposé du ventilateur (25), et éventuellement le déflecteur comprend une ouverture à des fins d'écoulement de l'air de premier passage jusque dans l'échangeur de chaleur.

12. Sèche-linge selon l'une quelconque des revendications précédentes, dans lequel le corps de chauffe comprend un élément électrique (24), et le dispositif de commande est configuré pour faire fonctionner l'élément électrique (24) si de la chaleur n'est pas disponible au niveau de l'échangeur de chaleur, et l'élément électrique (24) est dans un collecteur d'entrée d'air de tambour (23) de ladite entrée d'air chaud de tambour, et éventuellement l'échangeur de chaleur (20, 120) est sous le collecteur d'entrée de tambour (23) et est raccordé de manière fonctionnelle à celui-ci.

13. Sèche-linge selon l'une quelconque des revendications précédentes, dans lequel l'échangeur de chaleur (20, 120) comporte des tubes d'échangeur de chaleur s'étendant au travers d'ailettes, et les ailettes (124) sont agencées dans une direction alignée sur l'entrée d'air chaud de tambour (23, 110).

14. Sèche-linge selon l'une quelconque des revendications précédentes, dans lequel le ventilateur (25) est agencé pour être entraîné par le mécanisme d'entraînement de tambour (11), et éventuellement le ventilateur est sur un arbre de sortie d'un moteur dudit mécanisme d'entraînement de tambour (11).

15. Sèche-linge selon l'une quelconque des revendications précédentes, comportant par ailleurs une vanne servant à bloquer l'écoulement d'eau chaude vers l'échangeur de chaleur au cours d'une partie d'un cycle de séchage, et le dispositif de commande est agencé pour commander le fonctionnement de ladite vanne, au cours d'une phase de fonctionnement telle une période de refroidissement.

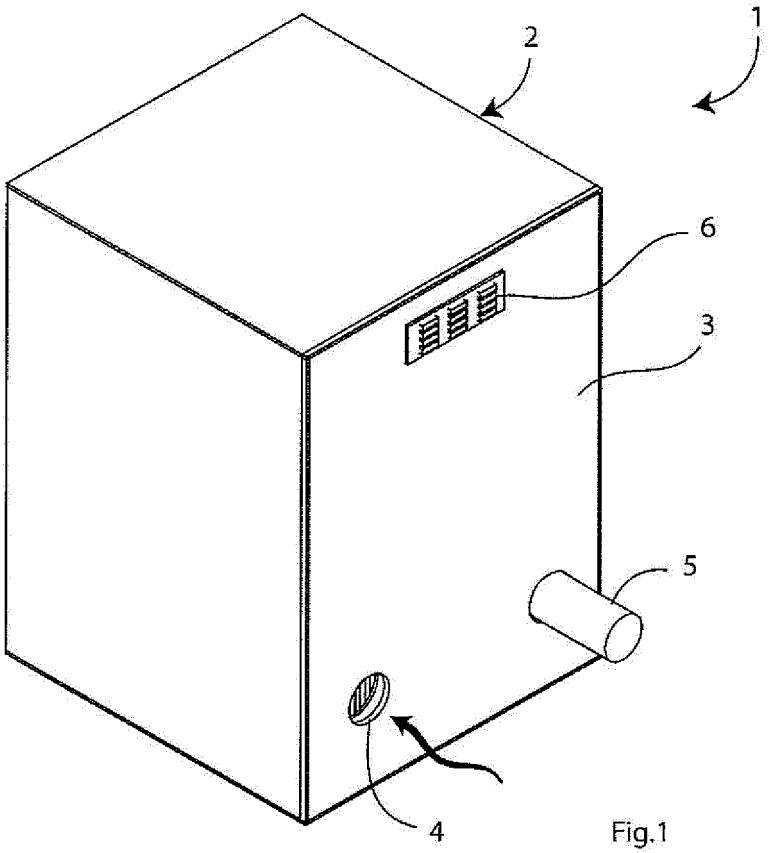


Fig.1

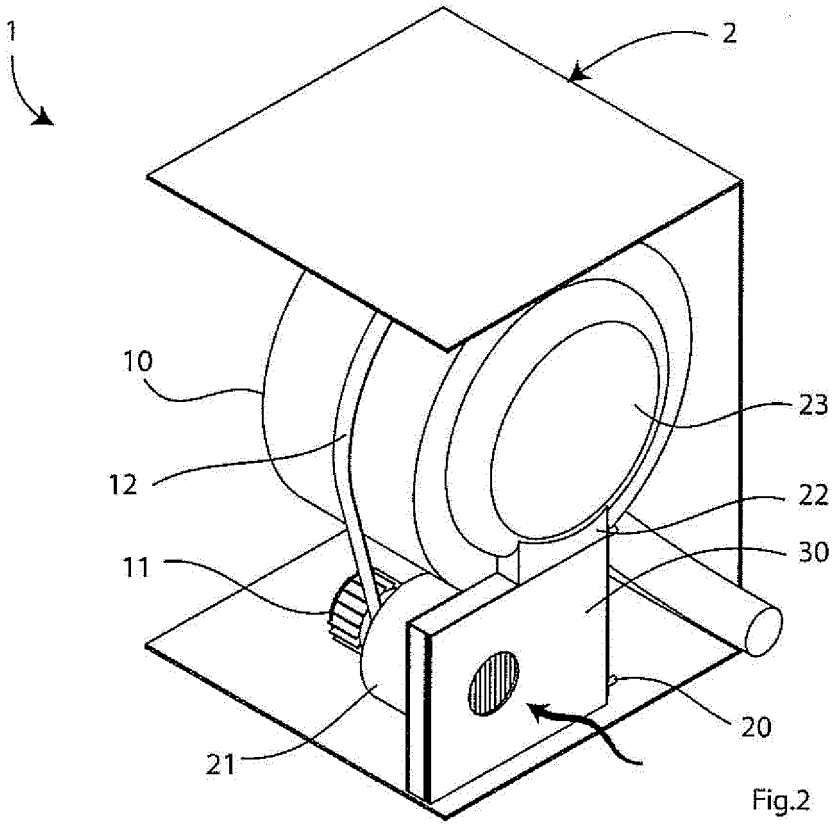


Fig.2

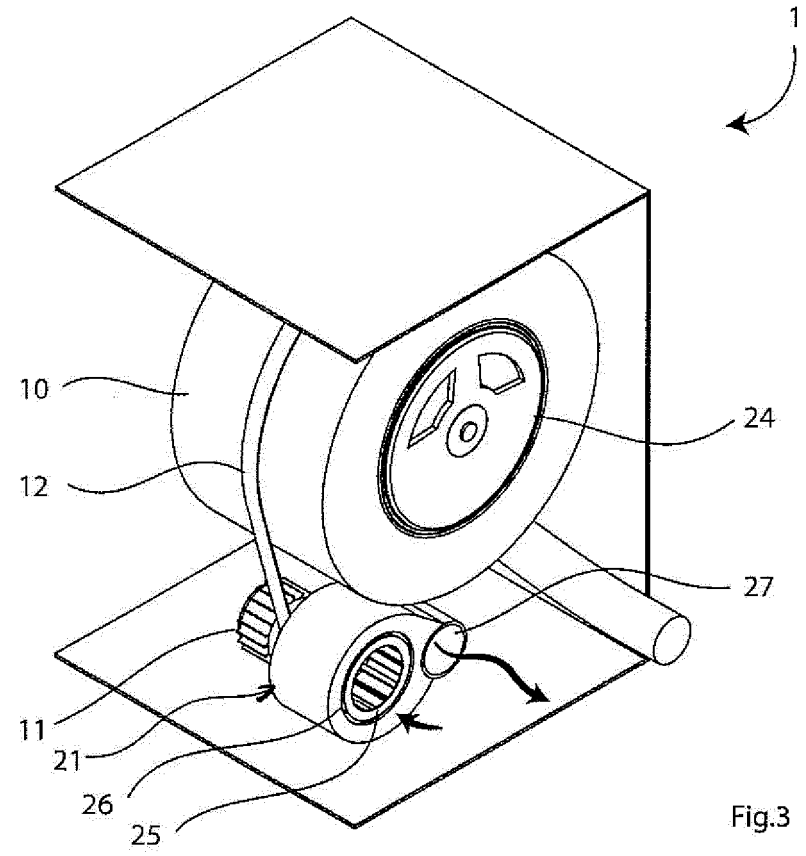


Fig.3

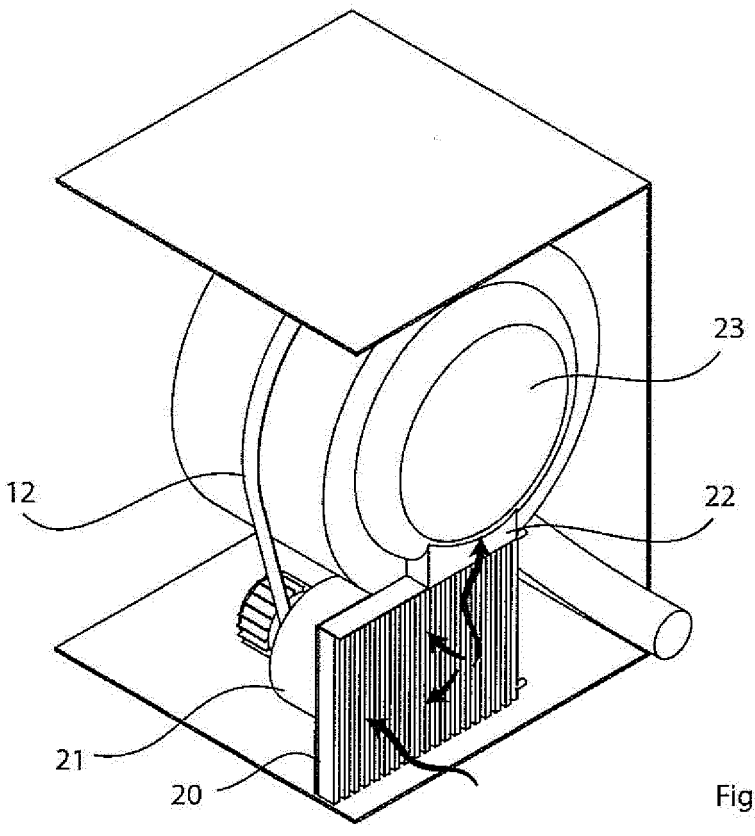


Fig.4

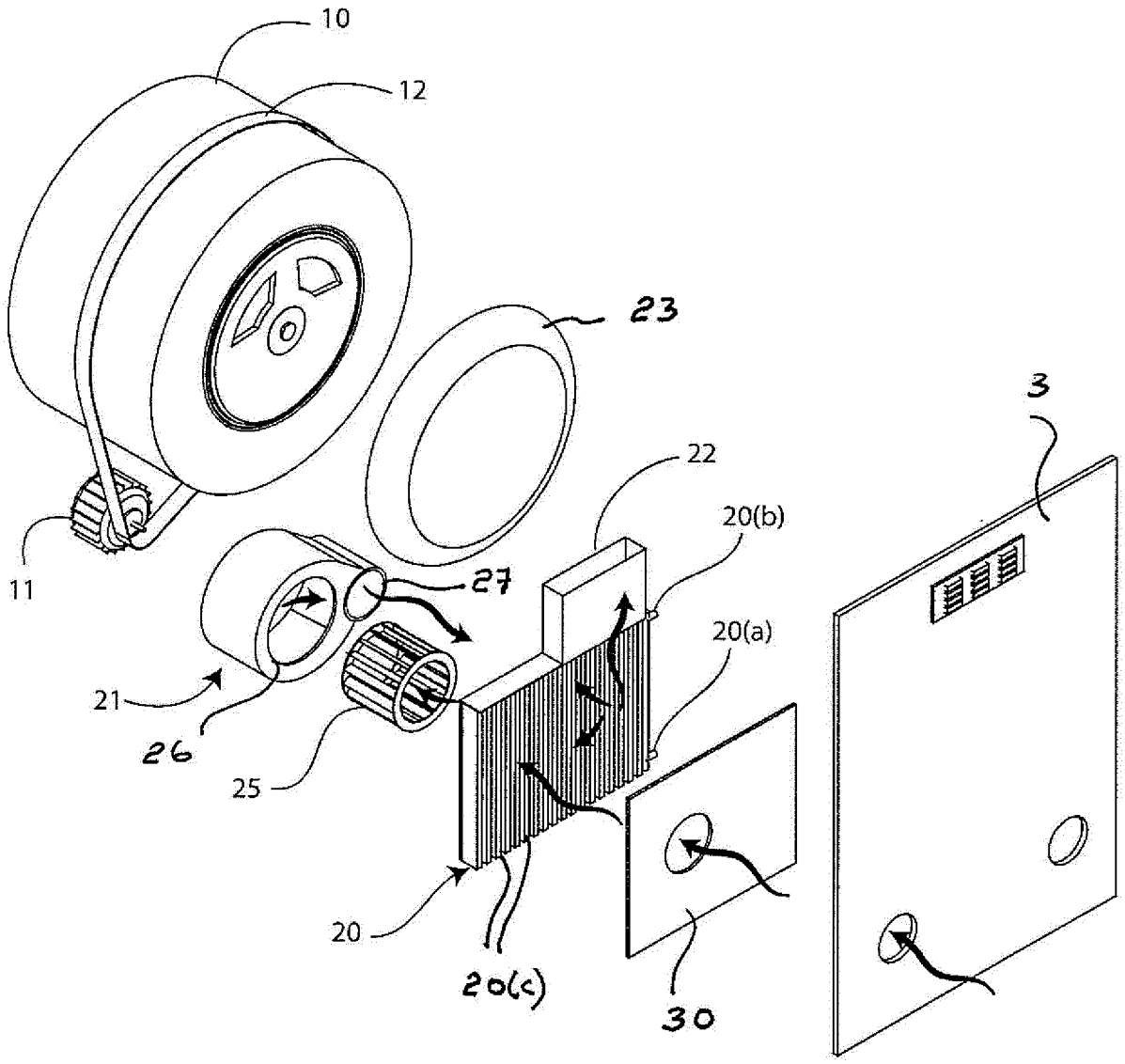


Fig.5

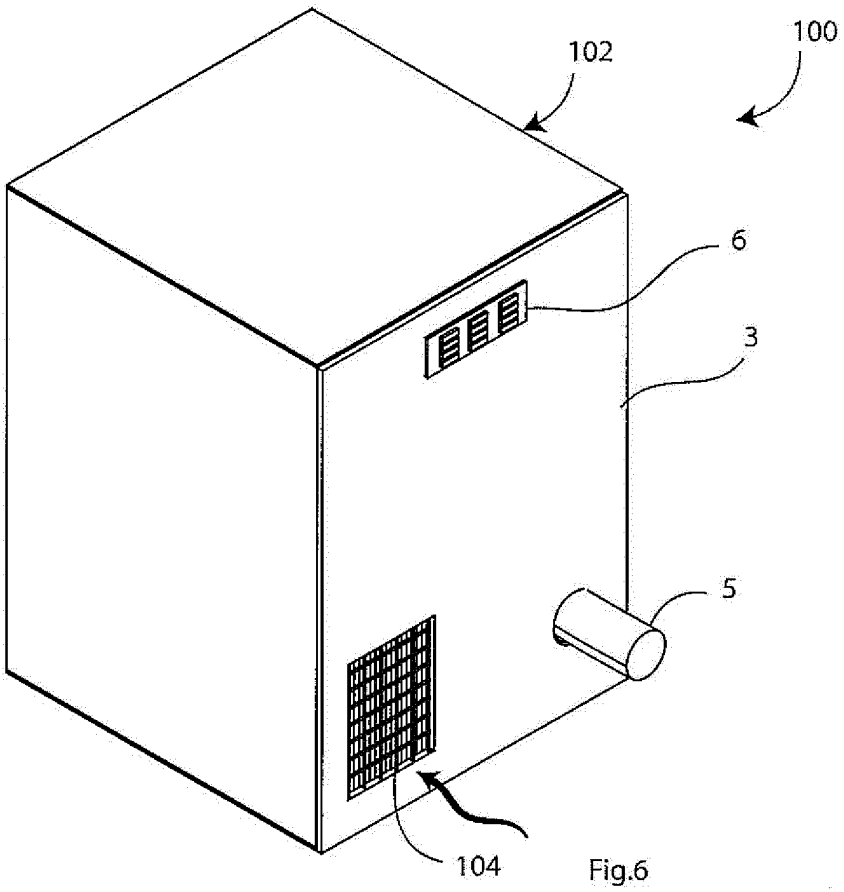


Fig.6

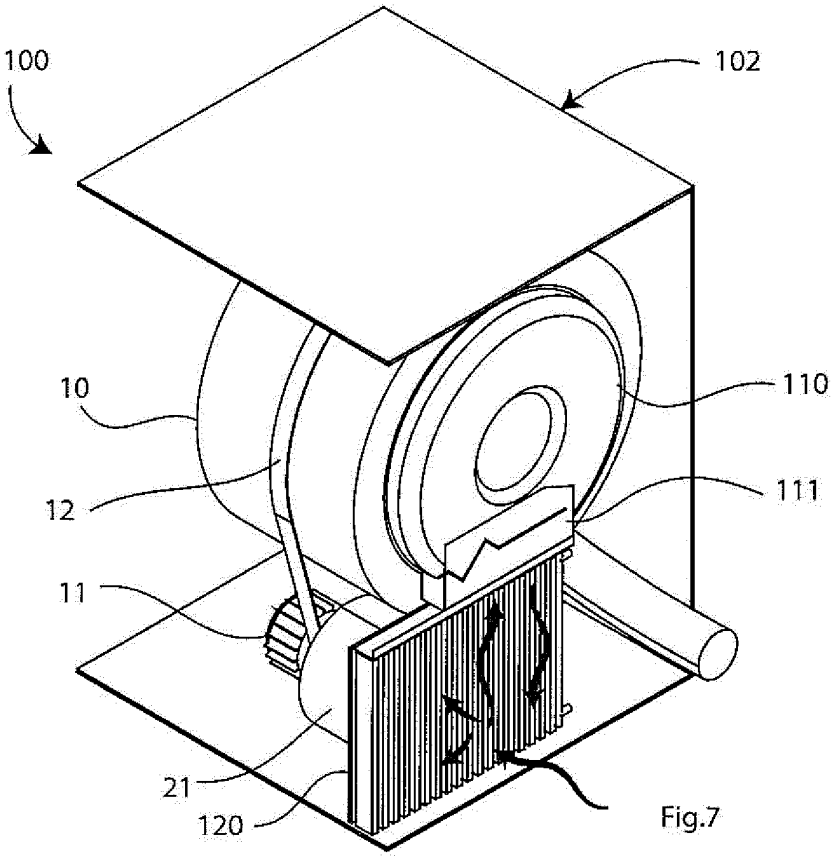
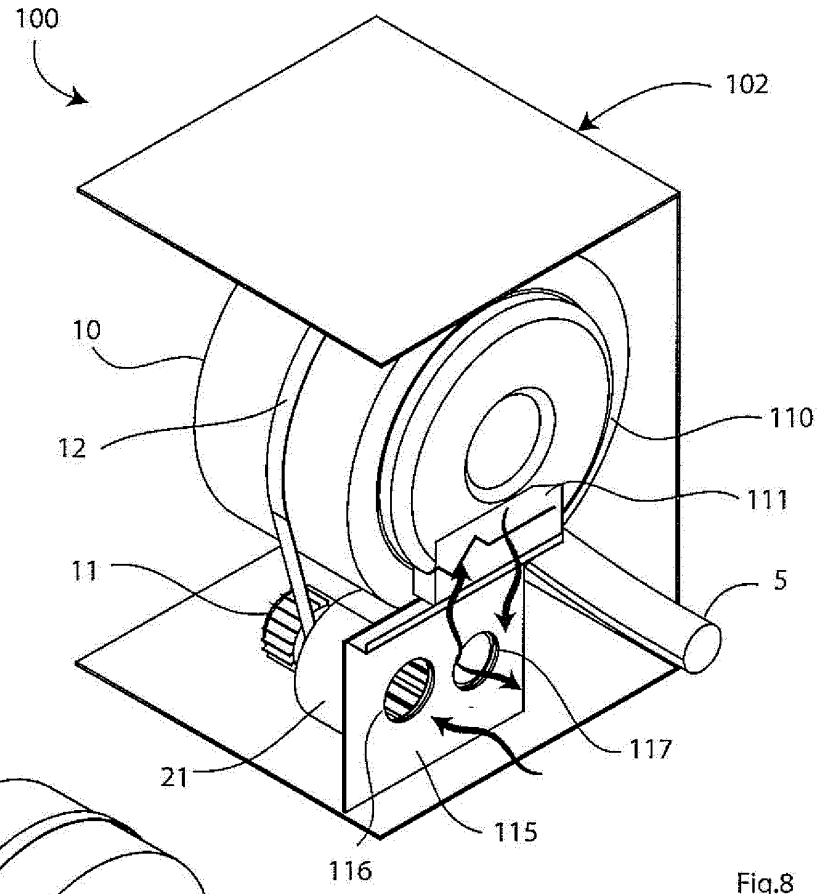


Fig.7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12
110
111
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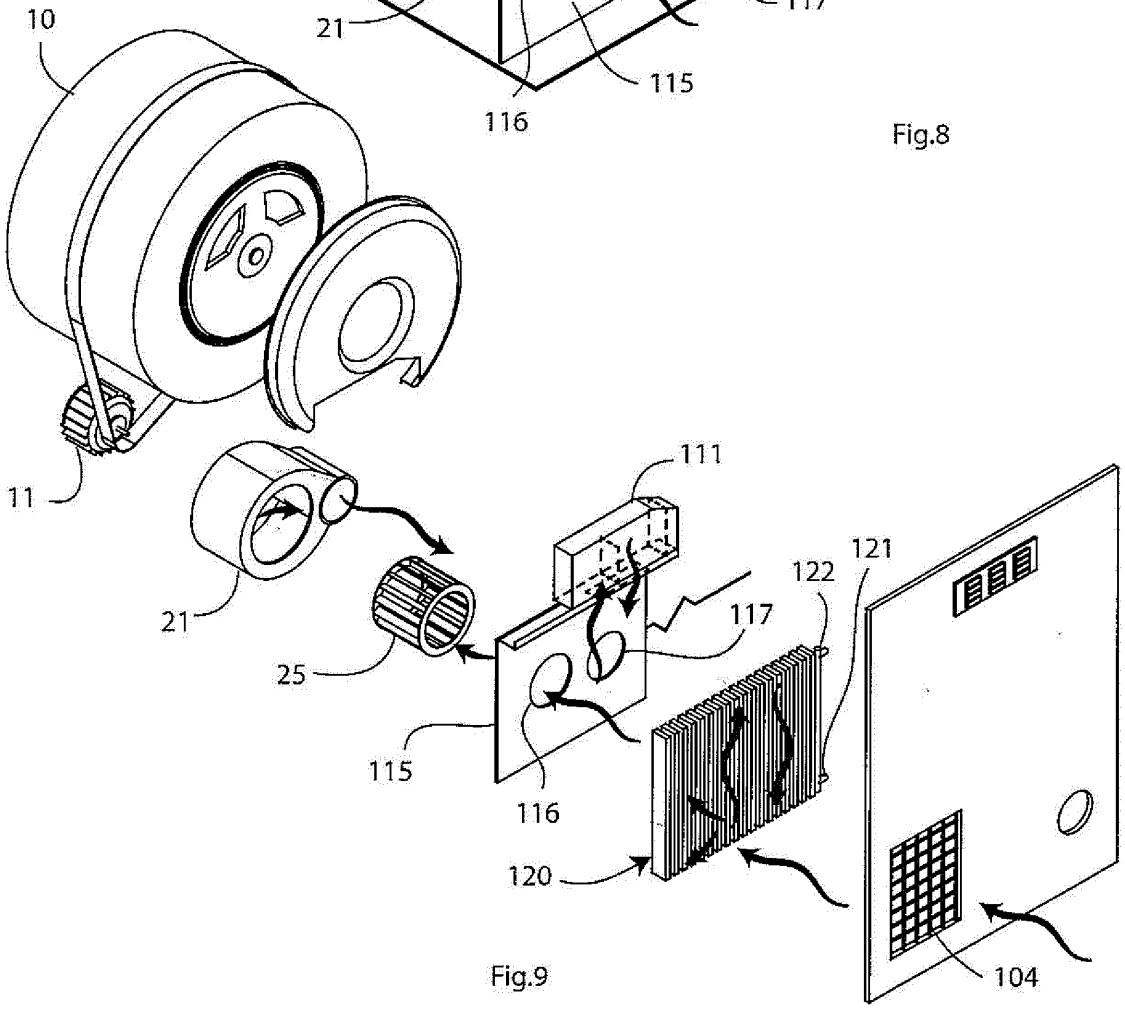
5
117
21
115
116

Fig.8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11
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104

Fig.9

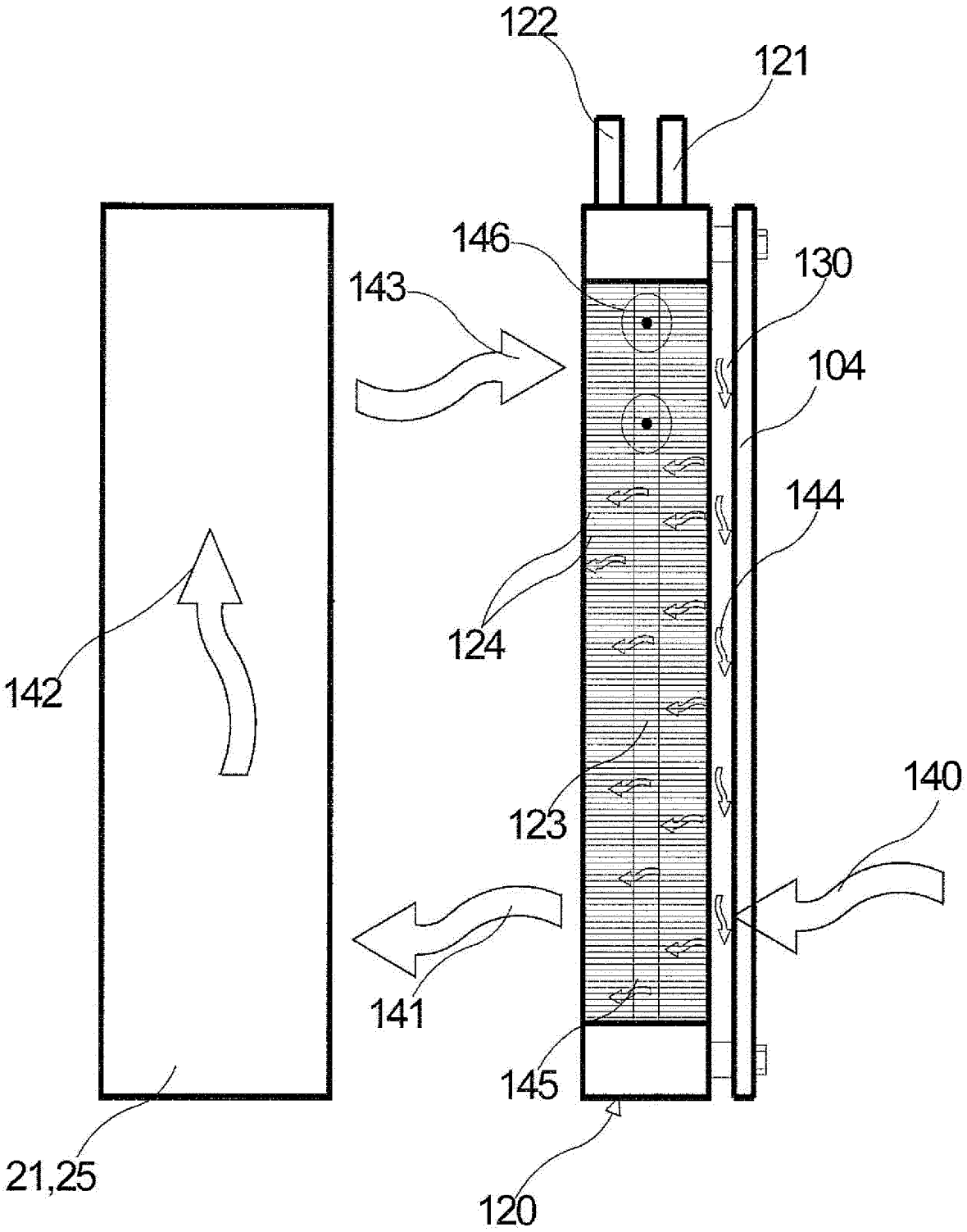

Fig: 10

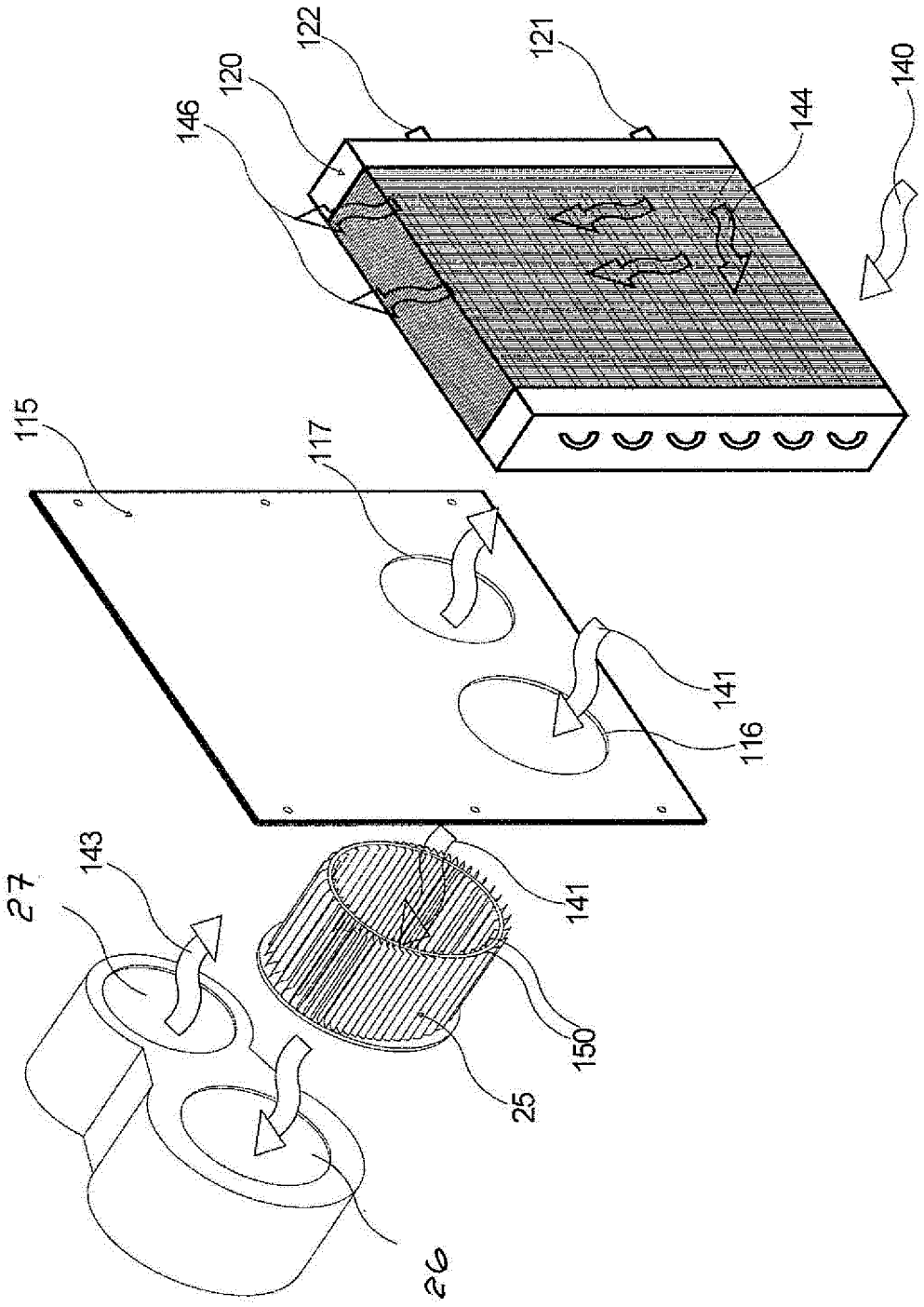

Fig: 11

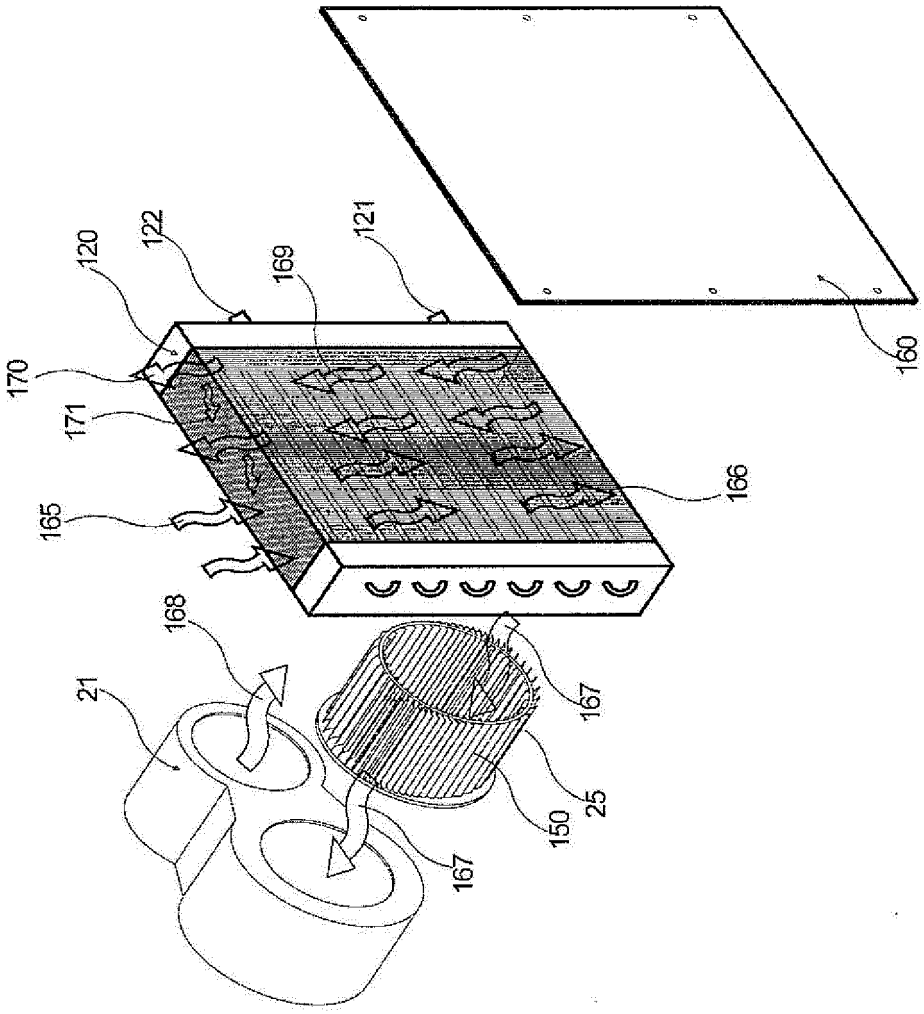

Fig: 12

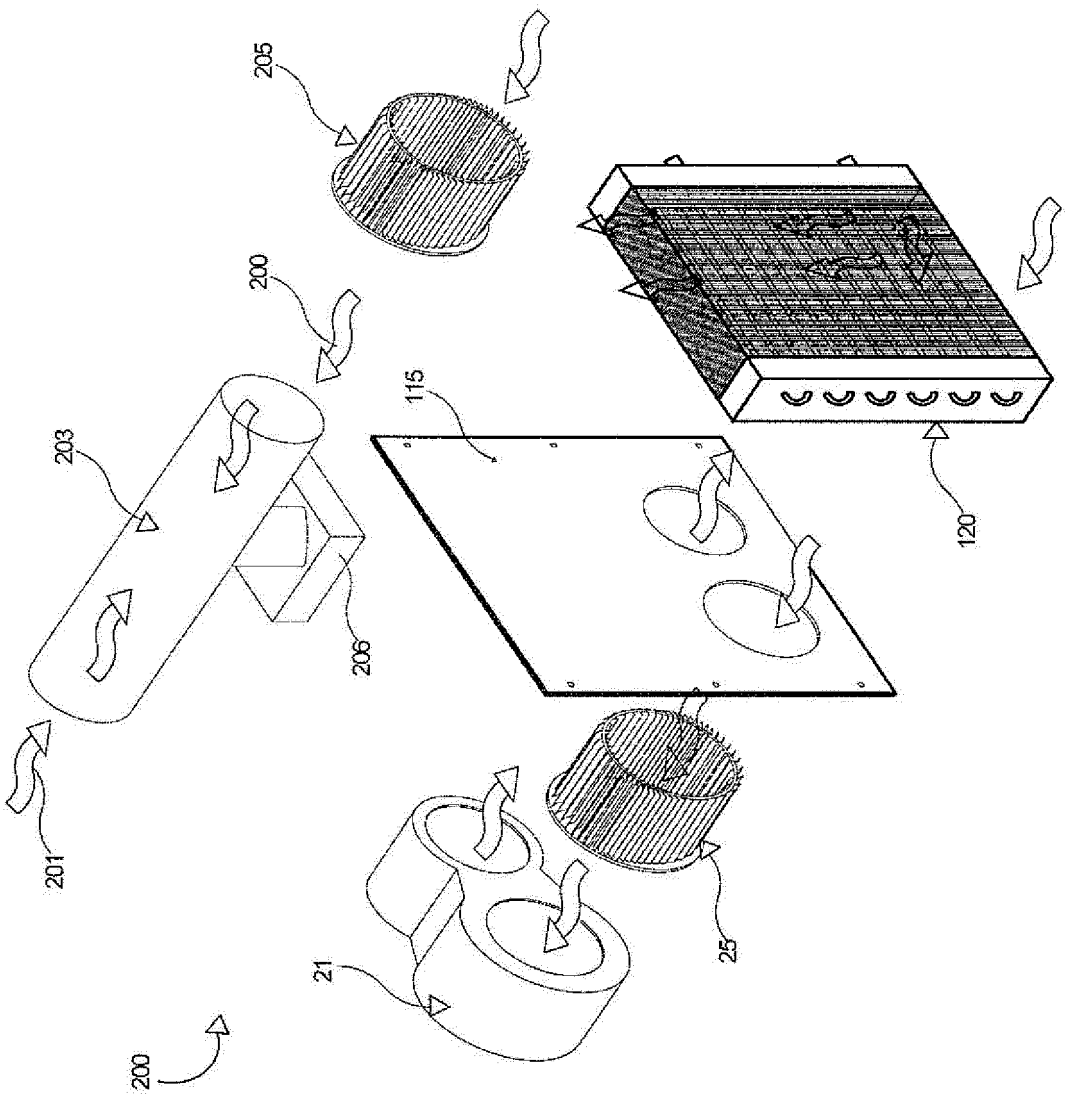

Fig: 13

REFERENCES CITED IN THE DESCRIPTION

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