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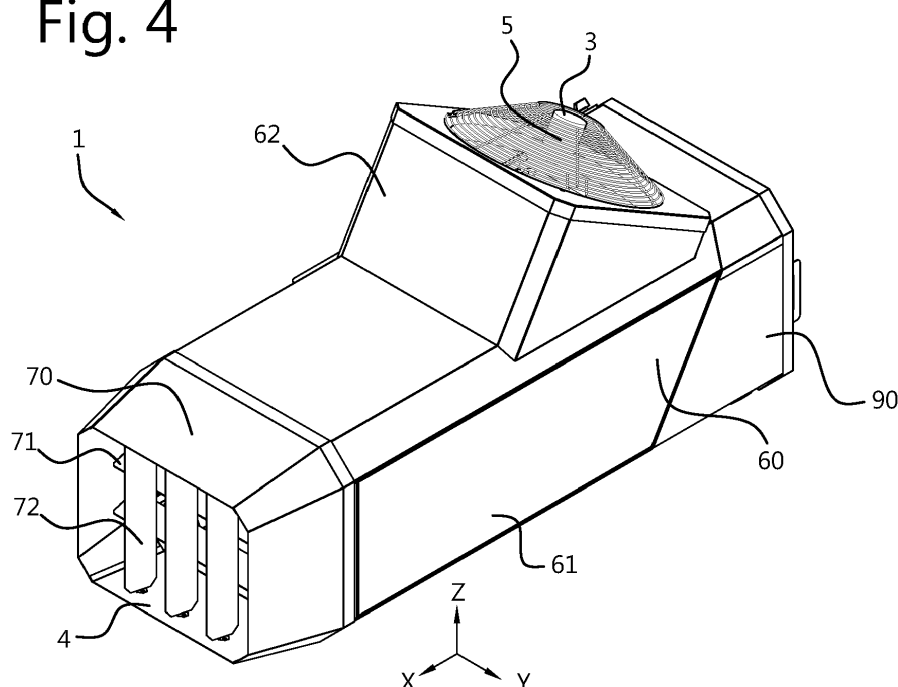
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(54) **AIR HEATER**

(57) The invention discloses an air heater comprising a conduit having an inlet at one end and an outlet at another end, a heating element positioned in the conduit between the inlet and the outlet for heating an air flow from the inlet to the outlet, the heating element consisting of two or more planar structures substantially parallel to each other and substantially perpendicular to the air flow, each of the two or more planar structures comprising a

heating pipe, wherein the heating pipe in each of the two or more planar structures is shifted relative to the heating pipes of the other of the two or more planar structures so that when viewed in projection along the direction of the air flow the overlap between the heating pipes is minimal, preferably does not exceed 10% of the surface area of a planar structure.

Fig. 4



Description

Technical field

[0001] The invention relates to an air heater. The invention further relates to a method for manufacturing such an air heater.

Background

[0002] Utility model CN210004590U describes an air duct heater including a casing and a fan. The left end of the casing is provided with an air outlet, and the right end of the casing is provided with an air inlet for an air flow generated by the fan. The casing is provided with a plurality of heating tubes to heat the air, each heating tube firmly fixed to the casing. A lower end of the heating pipe is inserted into a groove.

[0003] A rate of heat transfer by the heater of the art is drastically low as an air flow of higher velocity at the fan comes into contact with elements of the casing. The prior art heater is actually mainly designed for heating air in ducts, which means solely for relatively small volumes of air and to be supported by a duct.

[0004] As a consequence the air heater of the art would render the heating of large residential or commercial spaces particularly slow and laborious. Furthermore the device would require a support to hold the fan.

[0005] It is an object of the invention to provide an air heater which is suited for room or space heating, with high heating rate, and simple structure which provides for a self-standing device. It is a further object of the invention to provide a method for manufacturing such an air heater.

Summary of the invention

[0006] According to a first aspect, the invention discloses an air heater comprising a conduit having an inlet at one end and an outlet at another end, a heating element positioned in the conduit between the inlet and the outlet for heating an air flow from the inlet to the outlet, the heating element consisting of two or more planar structures substantially parallel to each other and substantially perpendicular to the air flow, each of the two or more planar structures comprising a heating pipe wherein the heating pipe of each of the two or more planar structures is shifted relative to the pipes of the other of the two or more planar structures so that when viewed in projection along a direction of the air flow, the overlap between the heating pipes in the two or more planar structures is minimal, i.e., preferably not exceeding 10%, more preferably 5%, most preferably 1% of the surface area of the planar structure. The air heater of the invention provides with its conduit an enclosed space for heating of air from a large space or room which may enter the heater via the inlet. Due to the heating element comprising several planar structures of heating pipes which

merely overlap when seen in projection, a contact surface of air flow and heating pipes is increased over the length of the conduit. This way, more air may be heated at different positions when flowing through the conduit, while additional turbulence of the air flow may be created. As a result, an average velocity of the air flow is increased and heat transfer from the heating pipes to the air may be maximised.

[0007] In a further embodiment the air heater comprises a flow-enhancing element, such as a fan, an air blower or an air compressor positioned in the conduit at or near the inlet for generating the air flow between the inlet and the outlet. Adding a flow-enhancing element at or in a vicinity of the inlet provides for a higher and more controlled air flow at the inlet and directed onto the heating element. By using the flow-enhancing element relatively close to the heating element, air comes into contact with the heating element in a turbulent mode. Consequently heat transfer rate is increased. Independently on the nature of the selected flow-enhancing element, the heating pipes with mutually small overlap along the flow direction are arranged so that the probability of contact between the air and the heating element is maximized along a length of the conduit. Both the heating element and the flow-enhancing element are mounted in the conduit, therefore there is no increase as to the size of the heater and the heater is self-standing: both the heating element and the flow-enhancing element can be carried by the conduit itself.

[0008] In a further embodiment a distance between the flow-enhancing element, and the heating element does not exceed 20%, preferably 10%, more preferably 5% of a length of the conduit. A short distance between the flow-enhancing element (any of a fan, air blower or air compressor), and the heating element allows to make use of the turbulent air coming into contact with the heating element. As a result, the heat transfer from the heating element to the air passing the heating element is enhanced. The minimum distance between fan and the heating elements can not be too close as this is determined by the maximum operating temperature of the fan during exposure to the heating elements. As will be appreciated, the limit depends on the actual dimensions of the heater and on the actual power of the heating elements.

[0009] In a further embodiment each heating pipe comprises a rounded zigzag portion formed by an even number of segments, the segments substantially parallel to each other and extending in the associated planar structure along a height of the conduit between a first end and a second end, each two nearest segments connected at their first ends or at their second ends by an outwardly extending U-shaped pipe leg in the planar structure, so as to form a continuous pipe. The zigzagging shape of the heating pipe in the planar structure allows to cover a larger surface area of the planar structure with less piping. As a result, an average local density of air to be heated is increased. Furthermore a weight of the heat-

er may be lowered, due to a reduction of the length of the heating pipe in the planar structure. The heating pipe, comprising an even number of interconnected parallel segments, does only require power inlet and outlet on one side of the heating element. As a result the number of contact points between the heating pipe and the surrounding conduit is minimized. In a further embodiment each heating pipe comprises two of the rounded zigzag portions and a transverse portion separating the two rounded zigzag portions, the transverse portion being one transverse pipe leg connecting two segments, the two segments substantially parallel in the associated planar structure and extending along a height of the conduit between the first end and the second end, the transverse portion forming a junction with an outer segment of the first rounded zigzag portion at one side and an outer segment of the second rounded zigzag portion at another side, via an outwardly extending U-shaped pipe leg, over a transverse distance which equals at least 50% of the width of a rounded zigzag portion.

[0010] The heating pipe comprising a transverse portion provides for a minimized piping density in areas of the planar structure where air heating would not be efficient, for instance in areas where an air flow with a lower velocity comes into contact with the pipe. Also, a weight of the piping may be better controlled.

[0011] In a further embodiment an axial fan for generating an air flow in an axial direction is positioned at the inlet and an area of each planar structure which in projection overlaps with the shaft is comprises the transverse portion while an area of each planar structure which in projection overlap with the blades comprises the rounded zigzag portion. According to the invention, the heating element is shaped in correspondence with the exhaust pattern of the actual fan. Where the fan can not provide for high air velocity, i.e., the volume that is a projection of a shaft of the fan along the length of the conduit, the piping density is set to low. That allows to reduce the weight of the heat pipe by placing heating pipes only where a higher heating rate is achievable (i.e., facing the blades of the fan in this case).

[0012] In a further embodiment the inlet and at least a part of the heating element are in a first portion of the conduit that is at an angle α relative to a second portion of the conduit including the outlet. The portion at an angle allows for an increase of the velocity of the air flow that has flown past at least part of the heating element and is redirected to the outlet in the second portion with extra turbulence due to the change of the flow direction. Furthermore, due to the increased velocity a dust accumulation in the conduit is drastically reduced. Instead, dust brought into the conduit from the outside by the air inflow is drawn to the outside of the conduit via the outlet with the outflow.

[0013] In a further embodiment, the heating pipes are each connected to power means located at a distance from the heating pipe. The power means allow to energize one of more of the heating pipes of the heating el-

ement, so that current passes through electric wiring in the heating pipe and may heat the air flowing into the conduit. Maintaining the power means at a distance from the heating elements allows to isolate the electronics from any heat generated during use of the air heater. The power means may be arranged in a separate compartment of the air heater, or outside.

[0014] In a further embodiment, the heating pipes are each connected to a controller for selective heating of one or more of the two or more planar structures of heating pipes. The use of a controller allows to choose whether to make use of the entire series of heating pipes, by energizing all of them, or select one or more of the heating pipes only for current to pass through, or adapting power levels to individual heating pipes. The fact that each heating pipe may be controlled separately allows safety and control to the user, that the heater may proceed even when one of the heating pipes is damaged and needs to be replaced.

[0015] In a further embodiment the controller is further connected to at least one of a temperature sensor for measuring an air temperature outside the conduit near the inlet and a flow sensor for measuring an air flow inside the conduit. The air heater of the invention provides for enhanced temperature and/or flow control which insures better user control of the input and output to the air heater.

[0016] In a further embodiment, the outlet is arranged at the end of a funnel shaped section of the conduit to guide the air flow to the outlet. The use of a funnel-shaped end of the conduit near the outlet allows for a higher speed outflow of warm air to be distributed into the room or space to be heated.

[0017] In a further embodiment gurney flaps and/or air deflectors are placed at or near the outlet. Such elements at/or near the outlet allow to control the air flow trajectory. For instance air deflectors when placed inside the conduit may allow a deviation of the trajectory for instance towards a centre of the outlet, while gurney flaps at the outlet may provide for a long throw of warm air distributed to the room or space to be heated.

[0018] In a further embodiment the inlet is positioned relatively above the outlet when installed. A higher height of the inlet this allows to collect air from higher temperatures of a room: The air intake is directed upwards, what results in that the heater takes warmer air from the top of the heated space. This air is sucked downwards into the heater. Having the outlet of the heater being lower than the intake results in a better air mixing in the heated space. It helps temperature building up at the ceiling, and thus more provides efficient heating.

[0019] In a further embodiment a distance between the heating element and the outlet does not exceed 50% of a length of the conduit X_1 . As the air does not have to travel a large distance between the last heating planar structure of the heating element and the outlet, warmer air may be distributed into the space or room to be heated.

[0020] According to a second aspect, the invention discloses a method for manufacturing an air heater com-

prising the steps of: arranging a conduit having an inlet at one end and an outlet at another end defining an air flow direction from the inlet to the outlet, arranging in the conduit a heating element consisting of two or more planar structures substantially parallel to each other and substantially perpendicular to the air flow direction, each of the two or more planar structures comprising a heating pipe, such that the heating pipe in each of the two or more planar structures is shifted relative to the heating pipes of the other of the two or more planar structures so that when viewed in projection along the direction of the air flow the overlap between the heating pipes is minimal, i.e., does not exceed 10% or less of the surface area of a planar structure. The method of the invention provides for an air flow trajectory through a heater, the air trajectory being curved in a second direction so that an air velocity is increased. The increased air velocity allows for increased turbulence leading to a rapid heating of a room or space.

[0021] In a further embodiment the step of arranging the conduit further comprises arranging a first portion of the conduit extending in a first direction and a second portion of the conduit that is at an angle relative to the first portion, the heating element being arranged at least in part in the first portion.

[0022] The method of the invention provides for an air heater with sufficient air turbulence which reduces possible dust accumulation at the angled portion while an air exits the heater with high velocity.

Brief summary of figures

[0023]

Figure 1 shows a longitudinal section of an air heater according to the invention,

Figure 2 shows a perspective view of an heating element of the air heater according to the invention,

Figure 3 shows a longitudinal section of an air heater according to an embodiment of the invention,

Figure 4 shows a perspective view of the air heater according to the embodiment of Figure 3.

Detailed description

[0024] Figure 1 shows a longitudinal section of an air heater 1 in the plane XY according to the invention. The plane XY is a plane of the cartesian coordinate system XYZ. The air heater 1 comprises a conduit 2 and a heating element 10 for heating air inside the conduit. The conduit 2 is made of a wall extending lengthwise along axis X in length, Z in depth and Y in height. The conduit has a length X_1 . The conduit 2 preferably has substantially constant dimensions along the length of the conduit including a substantially constant height Y_1 . The wall of the conduit

2 can be made of one of steel or stainless steel with a relatively low thermal conductivity to withstand high operating temperatures of heated air inside the conduit 2. The shown conduit 2 has a rectangular cross-section extending between an inlet 3 at one end, and an outlet 4 at another end. The conduit may also be of another shape such as for instance a substantially circular shape with constant dimensions that allow to host the heating element 10. The inlet 3 consists in an opening between the exterior and the inside of the conduit 2. The inlet opening has a width which does not exceed the height H of the conduit, preferably has dimensions under 40% of the height Y_1 . The air entering the conduit via the inlet 3 is driven to the other end of conduit 2, i.e., driven towards the outlet 4, defining an air flow direction. An enhanced airflow in the conduit may be provided by a flow-enhancing element 5 shown as an axial fan and placed at a vicinity of the inlet 3. The flow-enhancing element 5 is preferably positioned adjacent to the inlet 3. Alternative embodiments of the air heater may include a blower, an air compressor, a radial fan or a mixed flow fan (not shown) instead for a more focused air flow. The axial fan comprises a series of blades 36 rotatably arranged around a shaft 37, pulls air from the inlet 2 and forces it out in a direction parallel to the shaft 37 through rotation of the blades 36 on the shaft 37. As a result, a velocity of the airflow is maximum in the vicinity of the blades and minimum near the shaft 37. The outlet 4 is designed for air to exit the conduit 2. The outlet consists in an opening between the exterior and the interior of the conduit 2 for air to flow out from the conduit. The heating element 10 is placed in the conduit between the inlet 3 and the outlet 4 to heat the air flowing from the inlet 3 to the outlet 4. The heating element is preferably positioned at a distance from the flow-enhancing element, with a pre-determined distance so as to have turbulent air entering the heating element, for example the distance does not exceed 20%, preferably 10%, most preferably 5% of a length X_1 of the conduit 2. As mentioned above the minimum distance is determined by limitations of the thermal exposure of the fan to the heating elements to avoid damage to the fan.

[0025] The shown heating element comprises a series of five planar structures 11, 12, 13, 14, 15 which are all arranged substantially parallel to each other and substantially perpendicular to the air flow direction in the conduit. This distance between subsequent planar structures may vary but preferably the planar structures are all separated by an equal distance. It is noted that other embodiments falling within the scope of the invention may comprise any number of planar structures above two and different from five. Each planar structure 11, 12, 13, 14, 15 of the heating element 10 comprises one or a series of interconnected heating pipes forming a continuous heating pipe 20, 21, 22, 23, 24 in the respective planar structure. A heating pipe comprises electric wiring. By passing an electrical current through the wiring, heat is produced by the heating pipe in the planar structure,

and thus by the heating element in the conduit. For that the heating element 10 is electrically connected to power means 80 which allow to energize at least one or more of the heating planar structures 11, 12, 13, 14, 15 through the current input and the current output of each pipe. A view of an exemplary distribution of the heating pipes in the planar structures 11, 12, 13, 14, 15 and along a length of the conduit according to the invention will be shown in Fig. 2. In short the heating pipes 20, 21, 22, 23, 24 are arranged in respective planar structures 11, 12, 13, 14, 15 so that when viewed in projection along the axis Y an overlap of the heating pipes is minimal, i.e., preferably does not exceed 10% of the surface area of the planar structure, more preferably 5%, most preferably 1%. This allows to maximize the generated power density. The heating elements of the air heater 1 when in use may have an operating temperature up to maximal about 450 degrees Celsius. The large operating range allows use in a variety of large residential and commercial spaces with required climate control to be heated, such as poultry houses, storage rooms for drying products and greenhouses. The power means 80 are positioned at a distance from the heating planar structures in a separate compartment 90 of the air heater 1. The separate compartment may be made from the same material as the conduit wall and allows to hold the power means at a distance from the heating element and allows shielding from generated heat while permitting a protection from the outside environment. In an alternate embodiment, power means which power the heating element may also be outside of the heater 1. When powered, the heating element heats the air flow travelling from the inlet 3 to the outlet 4 via one or more of the heating pipes. When present the compartment 90 may further be arranged to comprise further electronics, such as a control unit. The control unit may be connected to a temperature sensor (not shown) for measuring a temperature of the room near the heater. A control unit may also assist the power means to selectively power one or more of the planar structures, optionally at different ratings. Based on the selection, one or more planar structures may be powered to heat up the room.

[0026] Figure 2 shows a view of the heating element 10 in the plane YZ of the cartesian system of Fig. 1, according to the invention. As described about Fig. 1, the heating element 10 in the conduit 2 comprises one or more planar structures 11, 12, 13, 14, 15 which are substantially parallel to each other. Each of the one or more planar structures 11, 12, 13, 14, 15 has a surface area corresponding to a cross-sectional surface area of the conduit 2. Preferably a direction of each planar structure does not deviate by more than 10 degrees from the axis Z, to minimize irregularities in the air flow. Each planar structure comprises a heating pipe 20, 21, 22, 23, 24, as described earlier. Each pipe 20, 21, 22, 23, 24 of the shown heating element 10 is continuous in its respective planar structure and comprises two junctions of a rounded zigzag portion A1, A2 of a pipe and a transverse por-

tion B1 of a pipe. The transverse portion B1 of the pipe separates and joins the two rounded zigzag portions A1, A2. Each rounded zigzag portion A1 and A2 comprises an even number of segments 40, 41, 42, 43 and 45, 46, 47, 48 the segments substantially parallel to each other and extending in the planar structure along a height Z of the conduit between a first end and a second end. Each two sets of nearest segments are connected at their first ends or at their second ends by an outwardly extending U-shaped pipe leg 50, 51, 52 and 54, 55, 56 in the planar structure, so as to form the continuous rounded zigzag portion A1, A2 of the pipe. The transverse portion B is formed by a transverse pipe leg 59, and two substantially parallel segments 44, 49 extending along a height Z of the conduit. The transverse pipe leg 59 transversely connects the two segments 44, 49 at one of their first end or second end. The transverse portion B1 joins an outer segment 43 of the first rounded zigzag portion A1 with an outer segment 48 of the second rounded zigzag portion via an outwardly extending U-shaped pipe 53, 56. This U-shaped pipe 53, 56 extends over a transverse distance Y_T of at least half a transverse distance of one of a rounded zigzag portion A1, A2. In alternative embodiments the heating pipe solely comprises one rounded zigzag portion A and no transverse leg (not shown). Other arrangements of heating pipes in the planar structures may be as well considered provided that the heating pipes are arranged so that a heating pipe is shifted transversely to the length X of the conduit on a planar structure relative to any of the other pipes on the other planar structures to achieve an overlap along a length of the conduit X under 10% of the plane surface area, as described earlier. In other words, there is a higher coverage of the conduit volume at the heating element by the heating pipes and more air can be heated. The transverse portion B as shown faces a center of the flow-enhancing element, the axial fan 5 near the inlet. Near the center of the fan at the shaft, the air has a lower velocity and thus the piping density on the planar structure may be reduced without reducing the maximum reachable watt density. In other embodiments with a blower, air compressor or a different fan type other regions of the planar structure may as well be chosen to have a portion with a transverse leg B where the air flow is incident with a lower velocity than in other regions of the planar structure. The pipes are supported by their current inlets 30, 32, 34 (others not shown) and current outlets 31, 33, 35 which are in direct connection with a segment of the pipe and protrude from a bottom wall of the conduit and connect to the power means 80. There is no other contact point between the pipe in the planar structure and the conduit.

[0027] Figure 3 shows a longitudinal section of an air heater 1 according to another embodiment of the invention in the plane XY of a coordinate system XYZ. The elements are similar to the air heater of Fig. 1. Only in this embodiment the conduit is different from the conduit of Fig. 1. The conduit comprises a first portion 60 including the inlet 3 and the heating element 10. In other em-

bodiments the first portion 60 may comprise only a portion of the heating element 10, i.e. only one or a few planar structures of the heating element are located in the first portion 60. The first portion 60 may also comprise a flow-enhancing element 5. The first portion 61 is placed at an angle α to the rest of the conduit forming second portion 61, including the outlet 4, and extending along axis X. The angle α exceeds 0 degrees and is lower than 90 degrees relative to the horizontal. Therefore at least some planar structures of the heating element 10 are also oriented at an angle α to the horizontal. Due to the first portion at an angle, an upper portion of the conduit 2 near the inlet 3 is placed at a height above the second portion 61 of the conduit. The heating element 10 is the same as the heating element shown in Fig. 1-2 and is also substantially parallel to an airflow from the inlet 3 of the air heater. Only due to the angle, it is located in a plane Y1Z1 of a sub-cartesian coordinate system X1Y1Z1 of the first inclined portion 60. The heating element may present variations explained in the description of Fig. 2 comprising at least a rounded zigzag portion, and optionally a transverse portion. each planar structure. Alternative embodiments (not shown) may comprise a portion 60 at the angle α to the rest of the conduit 61 and extending underneath it in the coordinate system XYZ. The outlet 4 is arranged to end a funnel-shaped section 70 extending along X and in fluid connection with a second portion 61 of the conduit 2. In other embodiments the funnel section 70 is omitted and the outlet may as well be part of the second portion 61.

[0028] Figure 4 shows a perspective view of the air heater in the system XYZ according to the embodiment of the invention shown in Fig. 3 showing the upper portion 62 of the conduit 2 at an angle α to the rest of the conduit. The outlet 4 is shown to comprise a funnel-shaped section 70 as well and comprises a series of orthogonally arranged flow conductor elements 71, 72 to further increase a velocity of the exiting air flow. Such flow conductor may include gurney flaps or air deflectors or other known options to the person skilled in the art. A variety of supporting and holding elements (not shown), such as handles, may be placed on the outer surface of the conduit. Furthermore one or more perforations (not shown) in the conduit wall may allow for cleaning and/or evacuation of cleaning fluids and/or condensation. In addition in the wall of the conduit one or more doors may be provided for accessing the internals of the air heater for maintenance and/or cleaning.

Claims

1. An air heater (1) comprising

a conduit (2) having an inlet (3) at one end and an outlet (4) at another end, a heating element (10) positioned in the conduit (2) between the inlet (3) and the outlet (4) for heating an air flow

from the inlet (3) to the outlet (4);

the heating element (10) consisting of two or more planar structures (11, 12, 13, 14, 15) substantially parallel to each other and substantially perpendicular to the air flow; each of the two or more planar structures comprising a heating pipe (20, 21, 22, 23, 24), wherein the heating pipe (20, 21, 22, 23, 24) in each of the two or more planar structures (11, 12, 13, 14, 15) is shifted relative to the heating pipes of the other of the two or more planar structures so that when viewed in projection along the direction of the air flow the overlap between the heating pipes (20, 21, 22, 23, 24) is minimal, preferably does not exceed 10% of the surface area of a planar structure.

2. The air heater according any of the preceding claims wherein a flow-enhancing element (5), such as a fan, an air blower or an air compressor is positioned in the conduit (2) at or near the inlet (3) for generating the air flow between the inlet and the outlet.

3. The air heater according to claim 2 wherein a distance between the flow-enhancing element (5), and the heating element (10) does not exceed 20%, preferably does not exceed 10%, more preferably does not exceed 5%, of a length L of the conduit (2).

4. The air heater according to any of the preceding claims, wherein each heating pipe (20, 21, 22, 23, 24) comprises a rounded zigzag portion (A1, A2) formed by an even number of segments (40, 45) the segments substantially parallel to each other and extending in the associated planar structure along a height Z of the conduit (2) between a first end and a second end, each two nearest segments connected at their first ends or at their second ends by an outwardly extending U-shaped pipe leg (50, 51, 52, 54, 55, 56) in the planar structure, so as to form a continuous heating pipe.

5. The air heater according to any of claims 1-3, wherein each heating pipe (20, 21, 22, 23, 24) comprises two rounded zigzag portions (A1, A2) according to claim 4 and a transverse portion (B) separating the two rounded zigzag portions, the transverse portion (B) having one transverse pipe leg (59) connecting two segments (44, 49), the two segments substantially parallel in the associated planar structure and extending along a height of the conduit between a first end and a second end, the transverse portion forming a junction with an outer segment (43) of the first portion of the first rounded zigzag portion at one side and an outer segment (48) of the second rounded zigzag portion at another side (43, 48), via an outwardly extending U-shaped pipe leg (53, 56), over a distance which equals at least 50% of the width of

one of the rounded zigzag portions.

6. The air heater according to claim 5, wherein an axial fan for generating an air flow in an axial direction is positioned at the inlet (3) and an area of each planar structure (11, 12, 13, 14, 15) which in projection overlaps with the shaft is comprises the transverse portion while an area of each planar structure which in projection overlap with the blades comprises the rounded zigzag portion. 5 10
7. The air heater according to any of the preceding claims wherein the inlet (3) and at least a part of the heating element (10) are in a first portion (60) of the conduit (2) that is at an angle α relative to a second portion (61, 70) of the circuit including the outlet (4). 15
8. The air heater according to any of the preceding claims wherein the heating pipes (20, 21, 22, 23, 24) in each of the two or more planar structures (11, 12, 13, 14, 15) are each connected to power means (80) located at a distance from the heating pipes (20, 21, 22, 23, 24). 20
9. The air heater according to any of the preceding claims wherein the heating pipes (20, 21, 22, 23, 24) in each of the two or more planar structures (11, 12, 13, 14, 15) are each connected to a controller (31) for selective heating of one or more of the two or more planar structures of heating pipes. 25 30
10. The air heater according to claim 9 wherein the controller is further connected to at least one of a temperature sensor for measuring an air temperature outside the conduit (2) near the inlet (3) and a flow sensor for measuring an air flow inside the conduit (2). 35
11. The air heater according to any of the preceding claims, wherein the outlet (4) is arranged at the end of a funnel shaped section (70) in fluid connection with the conduit (2) to guide the air flow to the outlet (4), and/or one or more gurney flaps and/or air deflectors are placed at or near the outlet (4). 40 45
12. The air heater according to any one of the preceding claims 7-11, wherein the inlet (3) is positioned relatively above the outlet (4) when installed.
13. The air heater according to any of the preceding claims, wherein a distance between the heating element (10) and the outlet (4) does not exceed 50% of a length of the conduit L. 50
14. A method for manufacturing an air heater comprising the steps of: 55

arranging a conduit having an inlet at one end

and an outlet at another end defining an air flow direction from the inlet to the outlet;
 arranging in the conduit a heating element consisting of two or more planar structures substantially parallel to each other and substantially perpendicular to the airflow direction, each of the two or more planar structures comprising a heating pipe, such that the heating pipe in each of the two or more planar structures is shifted relative to the heating pipes of the other of the two or more planar structures so that when viewed in projection along the direction of the air flow the overlap between the heating pipes is minimal, preferably does not exceed 10% of the surface area of a planar structure.

15. The method according to claim 14, wherein the step of arranging the conduit further comprises arranging a first portion of the conduit extending in a first direction and a second portion of the conduit that is at an angle relative to the first portion, the heating element being arranged at least in part in the first portion.

Fig. 1

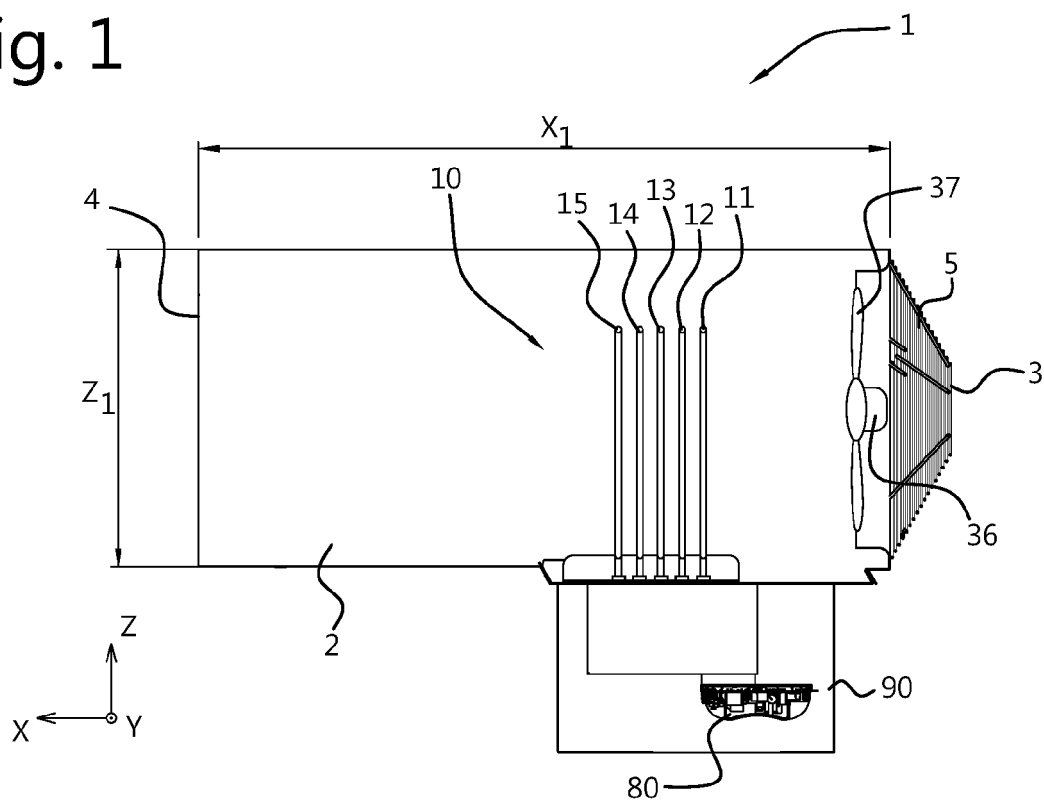


Fig. 2

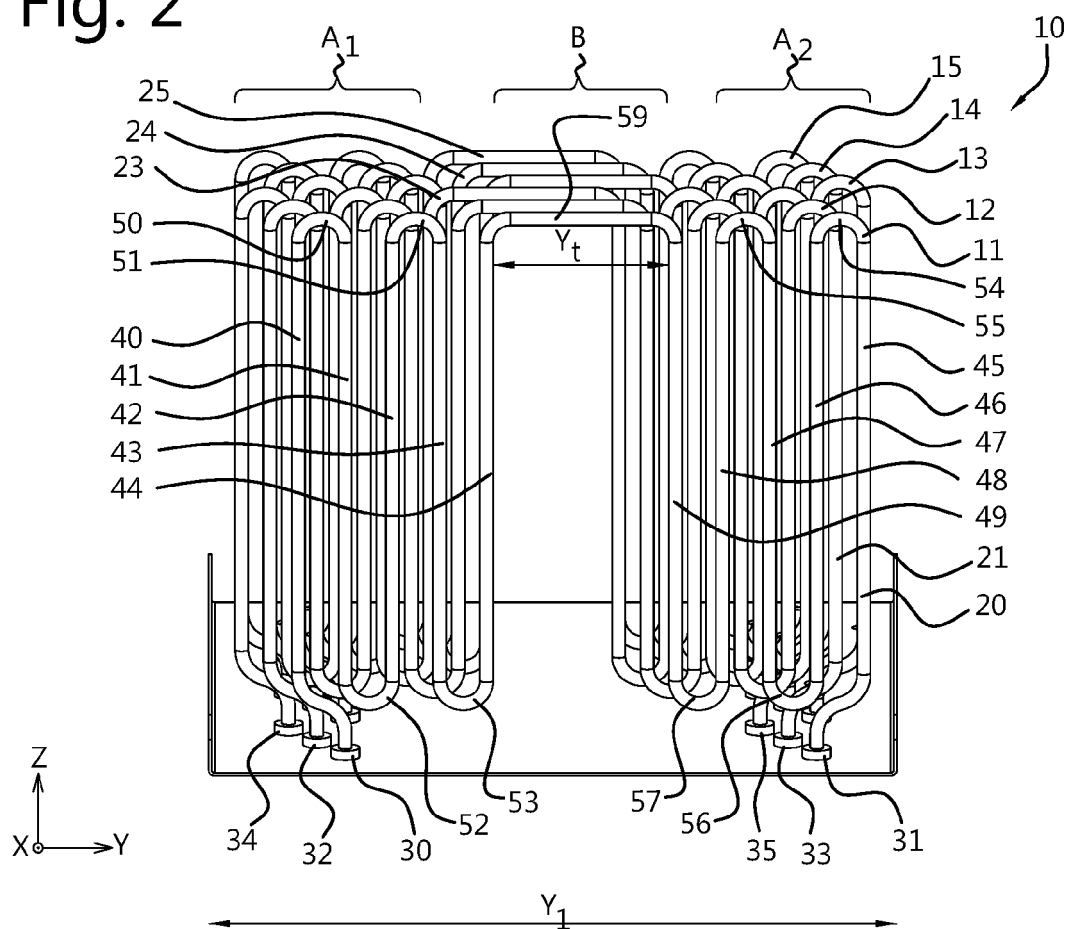


Fig. 3

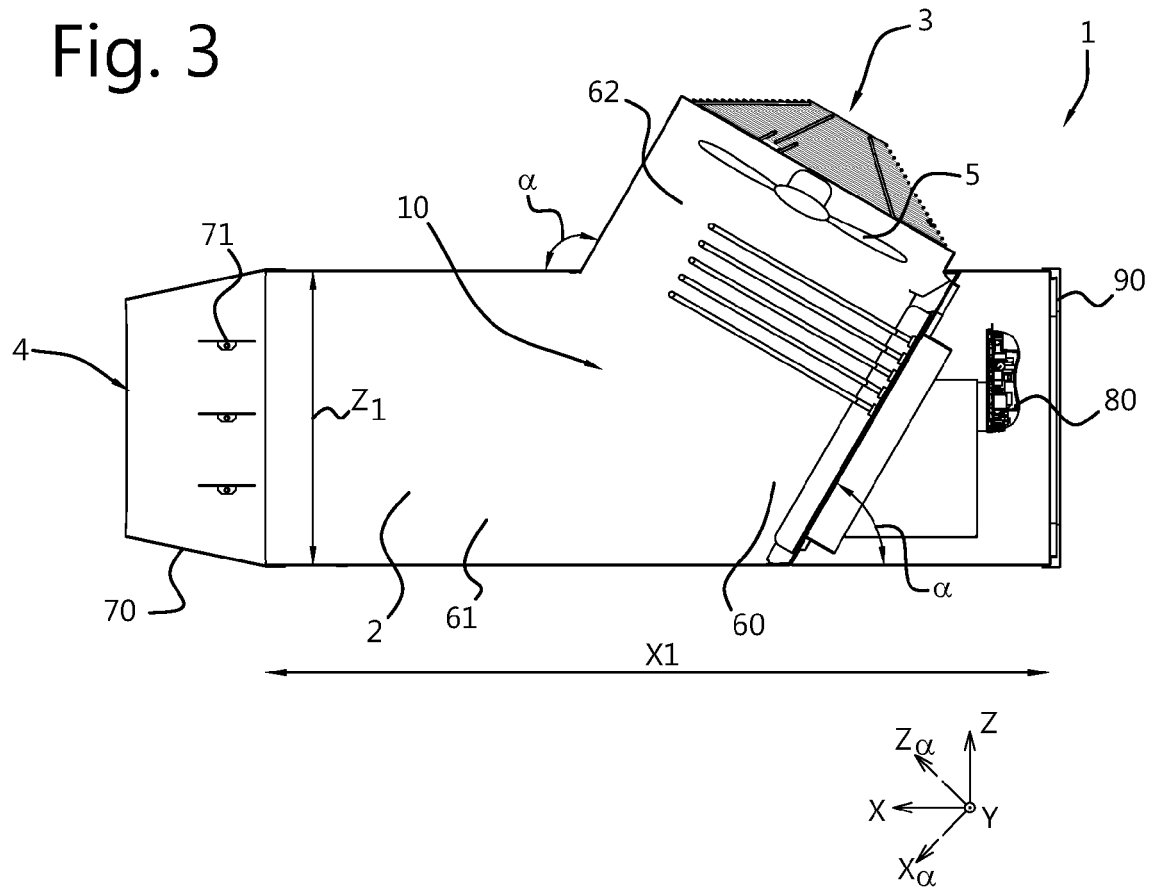
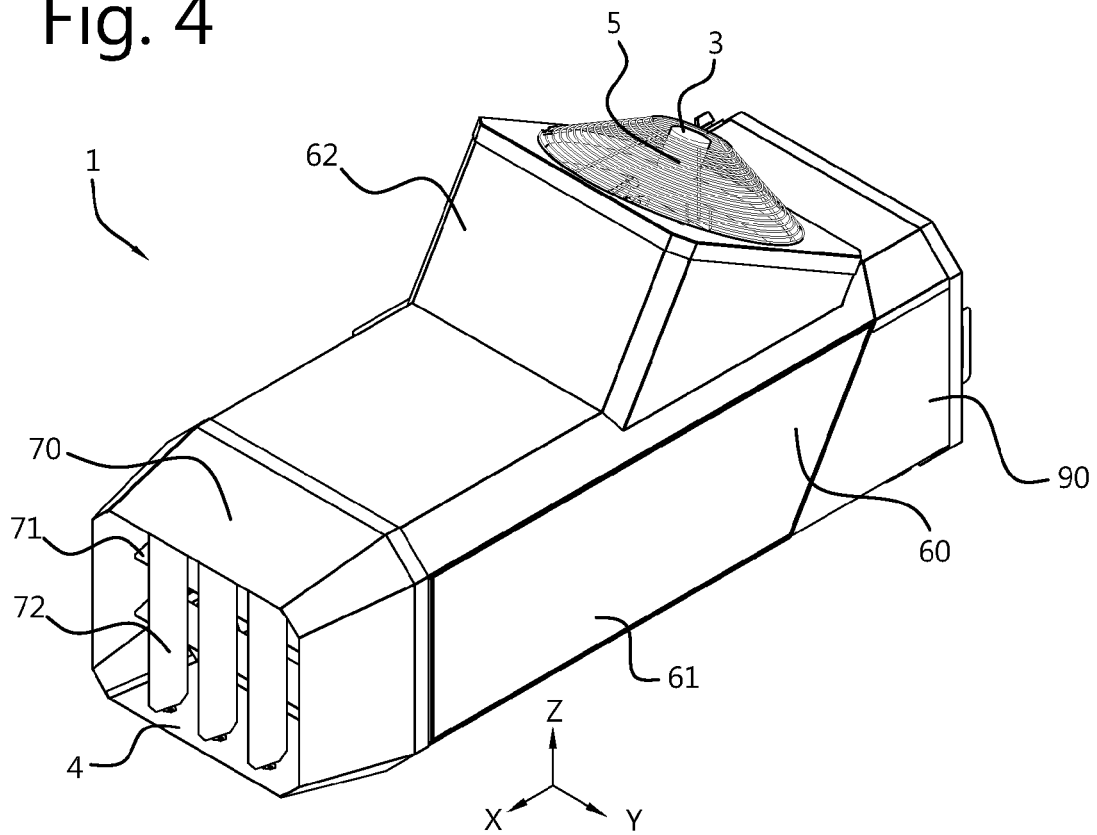


Fig. 4





EUROPEAN SEARCH REPORT

Application Number

EP 22 17 6567

5

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 593 176 A (SEEFELDT WILLIAM J [US]) 3 June 1986 (1986-06-03)	1-3, 8-10, 13, 14	INV. F24H3/08 F24H9/1863
Y	* column 3 - column 7; figures 2, 6, 7 *	6, 7, 15	
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Place of search

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Examiner

Riesen, Jörg

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