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(54) DEVICE FOR EXCHANGING THERMAL ENERGY WITH AMBIENT AIR

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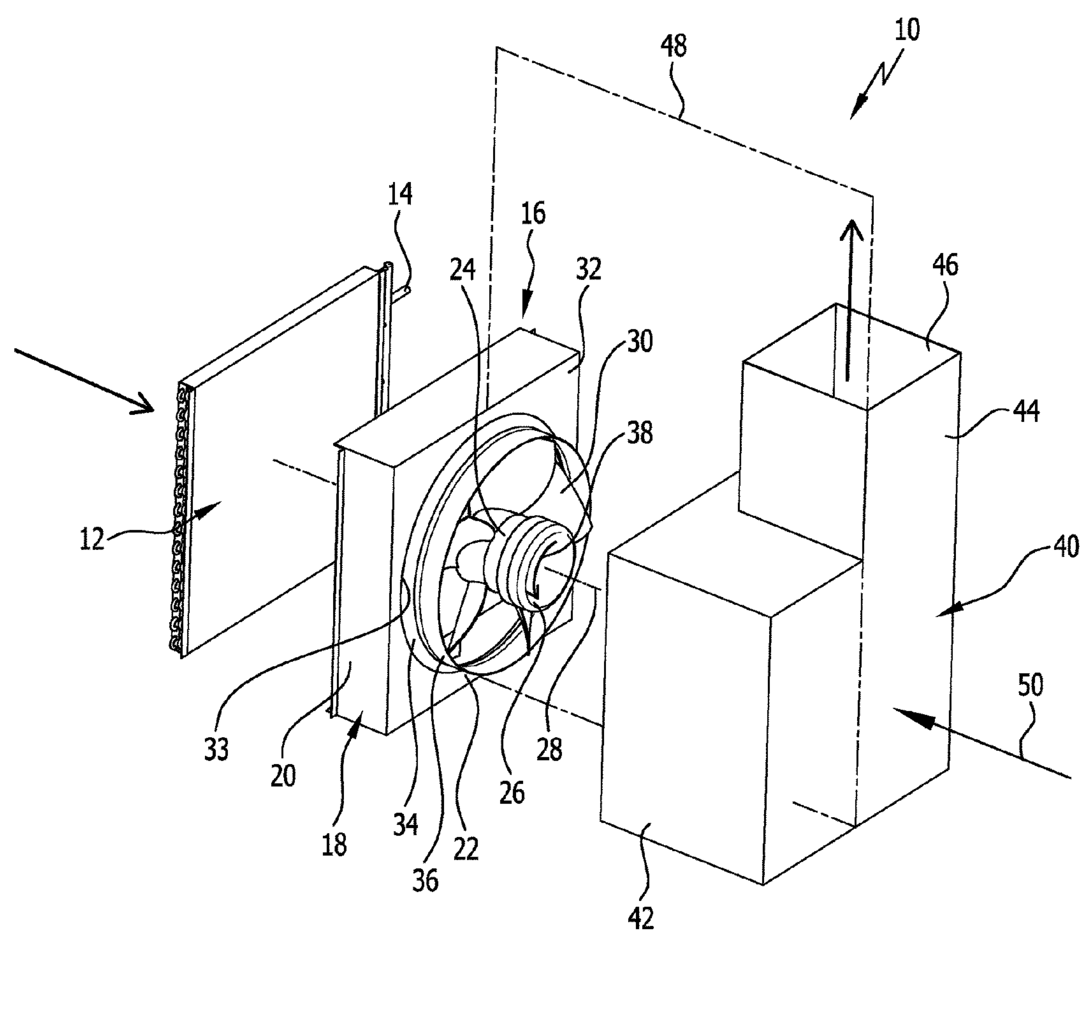
(57) **ABSTRACT**

The invention relates to a device for exchanging thermal energy with ambient air, comprising at least one heat exchanger (**12**; **162**, **164**; **202**) through which an air flow can flow and which is assigned an axial fan (**16**; **166**, **168**; **208**) for conveying the air flow through the heat exchanger and an outflow housing (**40**; **170**, **172**; **210**) receiving the air flow, wherein the outflow housing has an air outlet opening (**46**) for discharging the air flow into the environment. In order to develop the device in such a way that the outflow of the axial fan (**16**; **166**; **168**; **208**) can be deflected transverse to the outlet direction of the axial fan with minimal flow losses, according to the invention, the outflow housing (**40**; **170**; **172**; **210**) forms an air-receiving space (**41**) axially offset to an impeller wheel (**24**) and a motor (**26**) of the axial fan (**16**; **166**, **168**; **208**), which receives the conveyed air flow over the entire cross-section of the impeller wheel (**24**) and the motor (**26**) and is penetrated by the fan rotational axis (**28**), and wherein the outflow housing covers the impeller wheel (**24**) and the motor (**26**) when viewed from the rear and is designed and configured to supply the conveyed air flow to the air outlet opening (**46**) with a directional component tangential to a swirling movement imposed on the air flow by the axial fan.



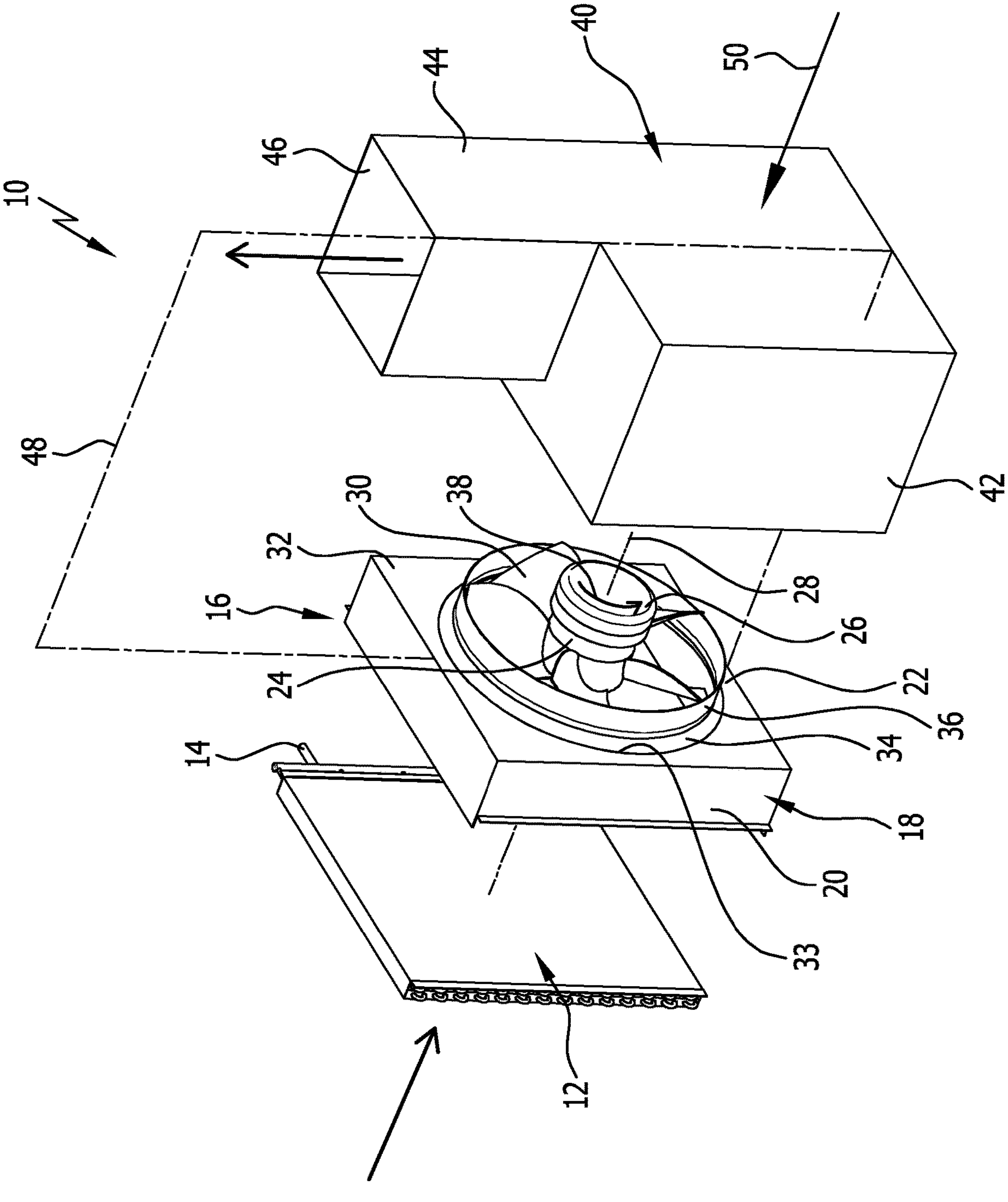


FIG.1

FIG.2

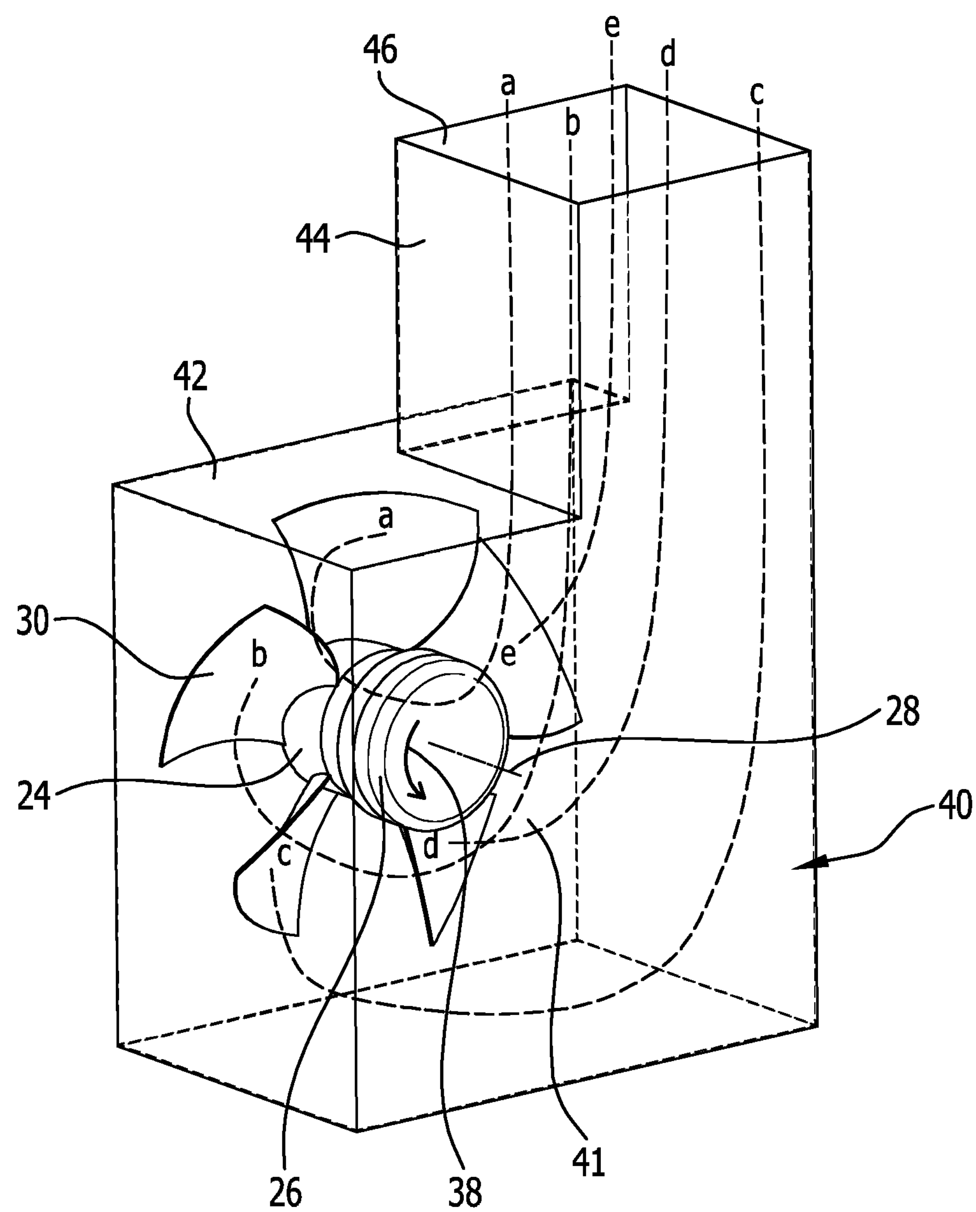


FIG.3

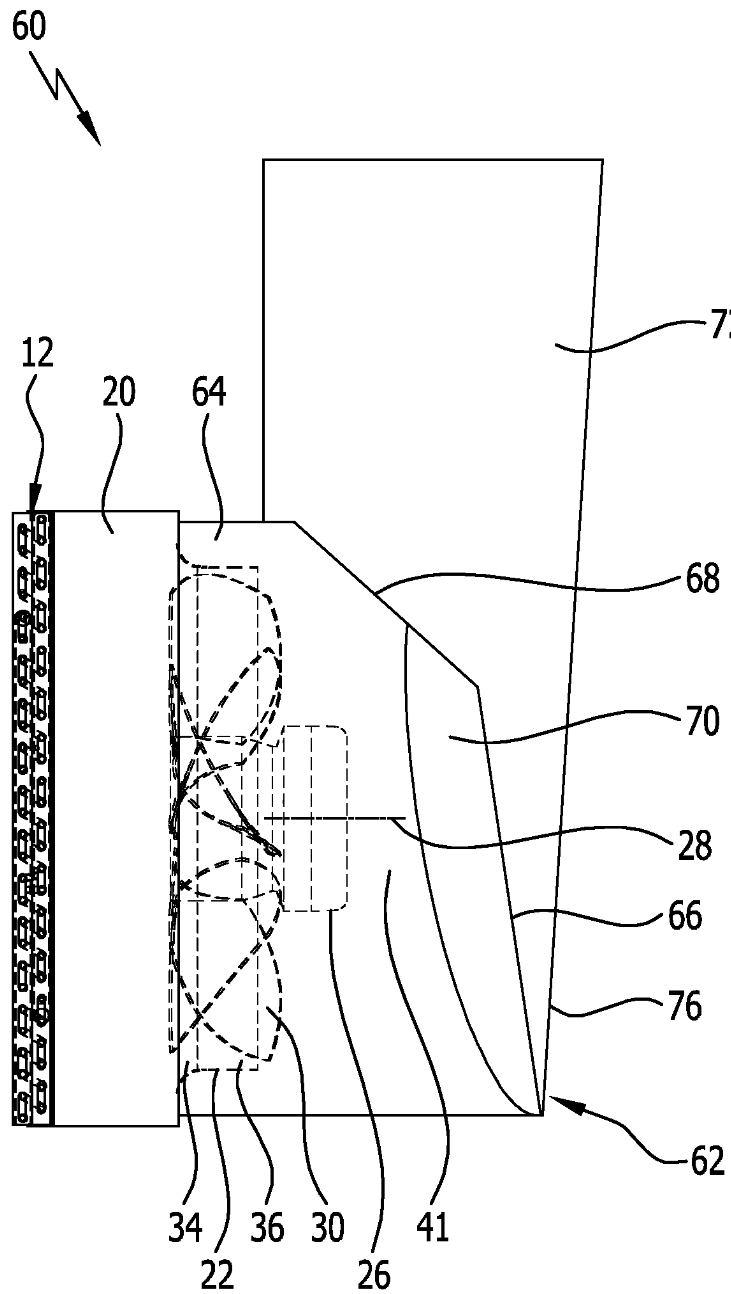


FIG.4

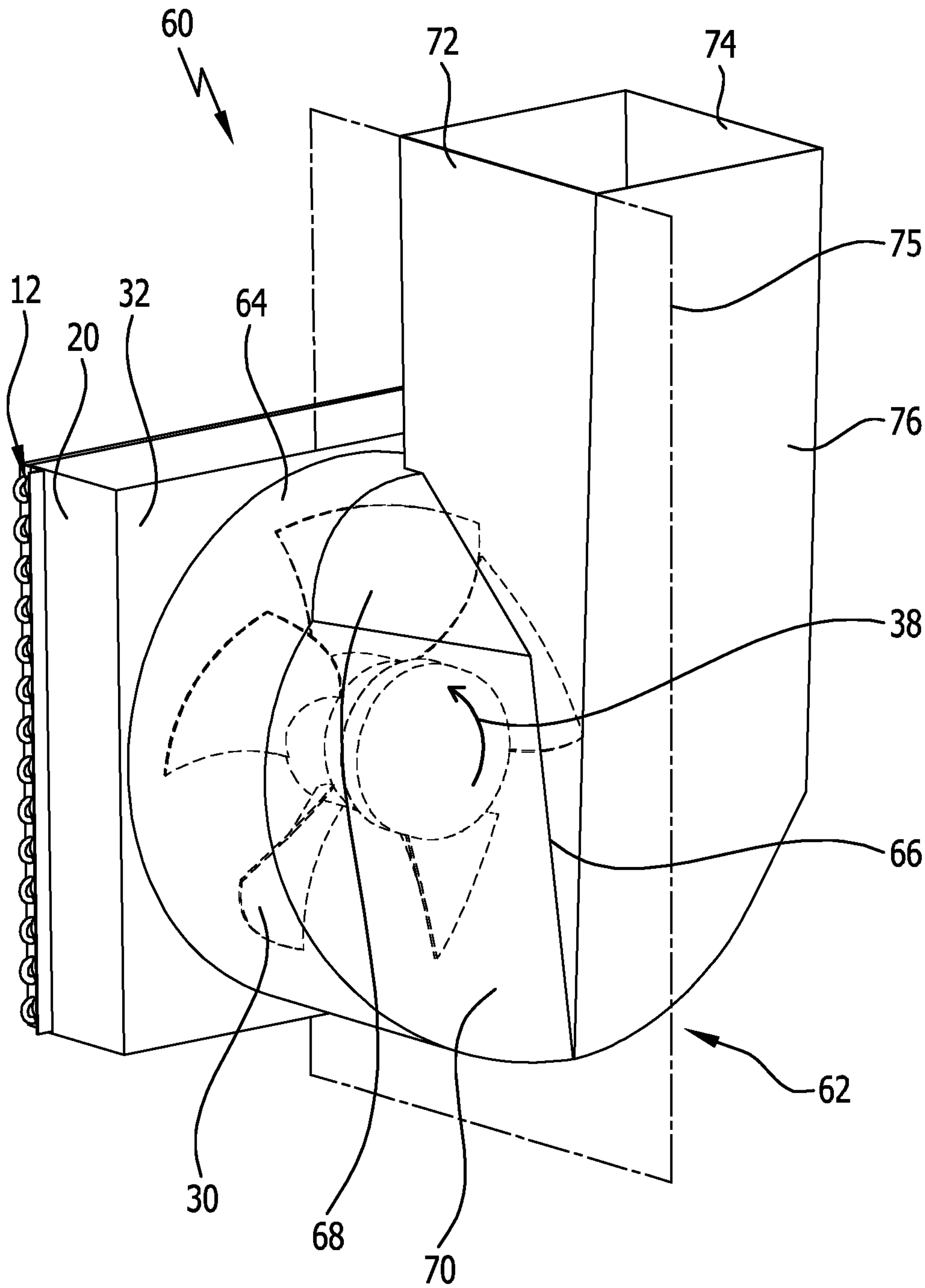


FIG.5

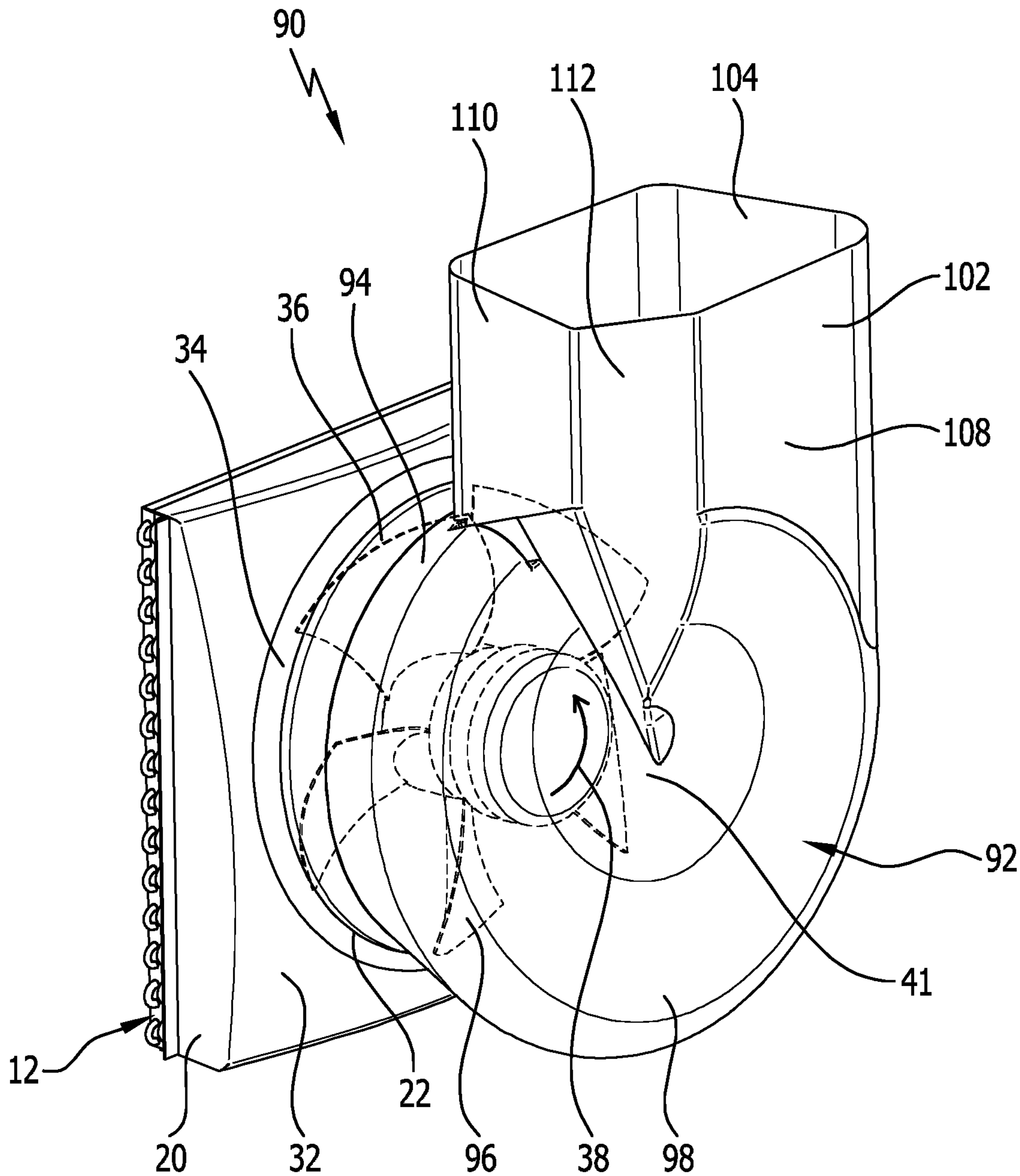


FIG.6

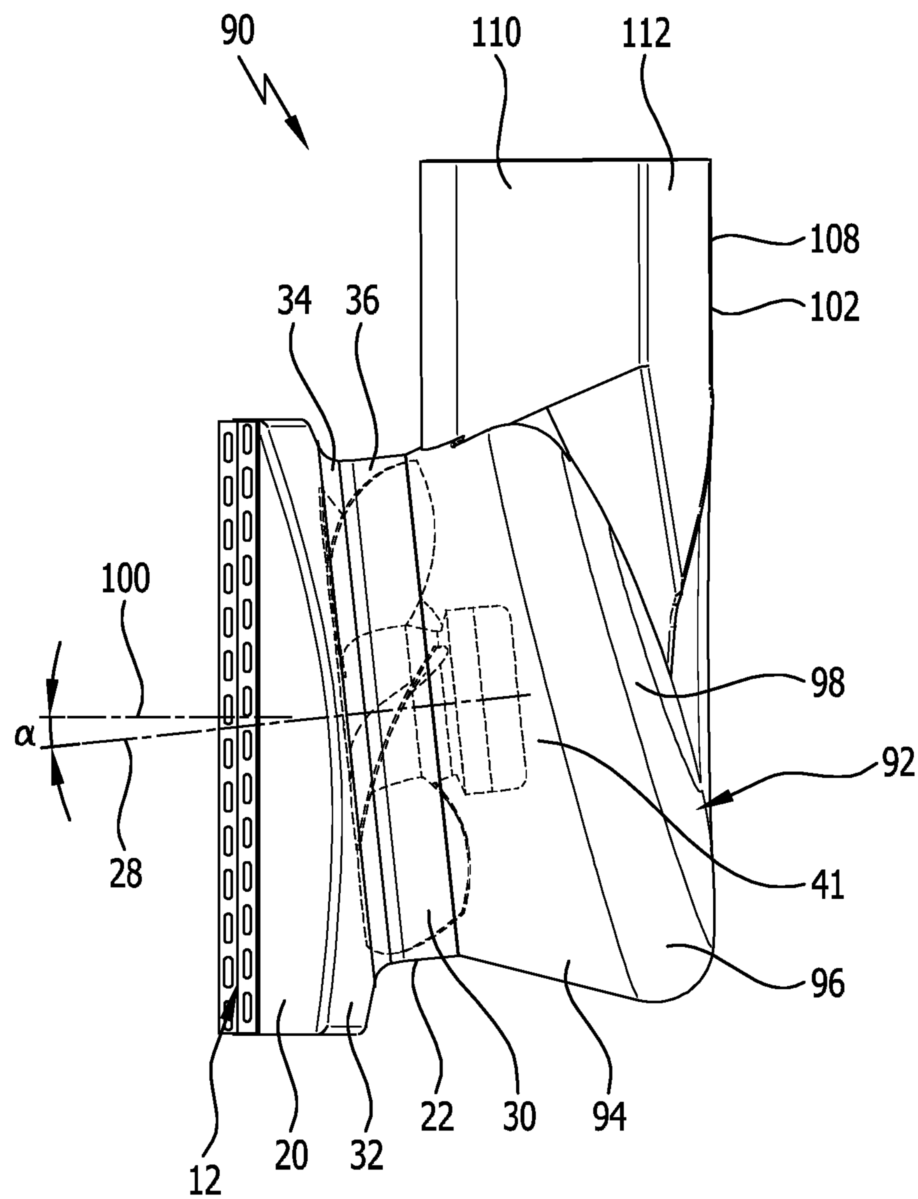


FIG.7

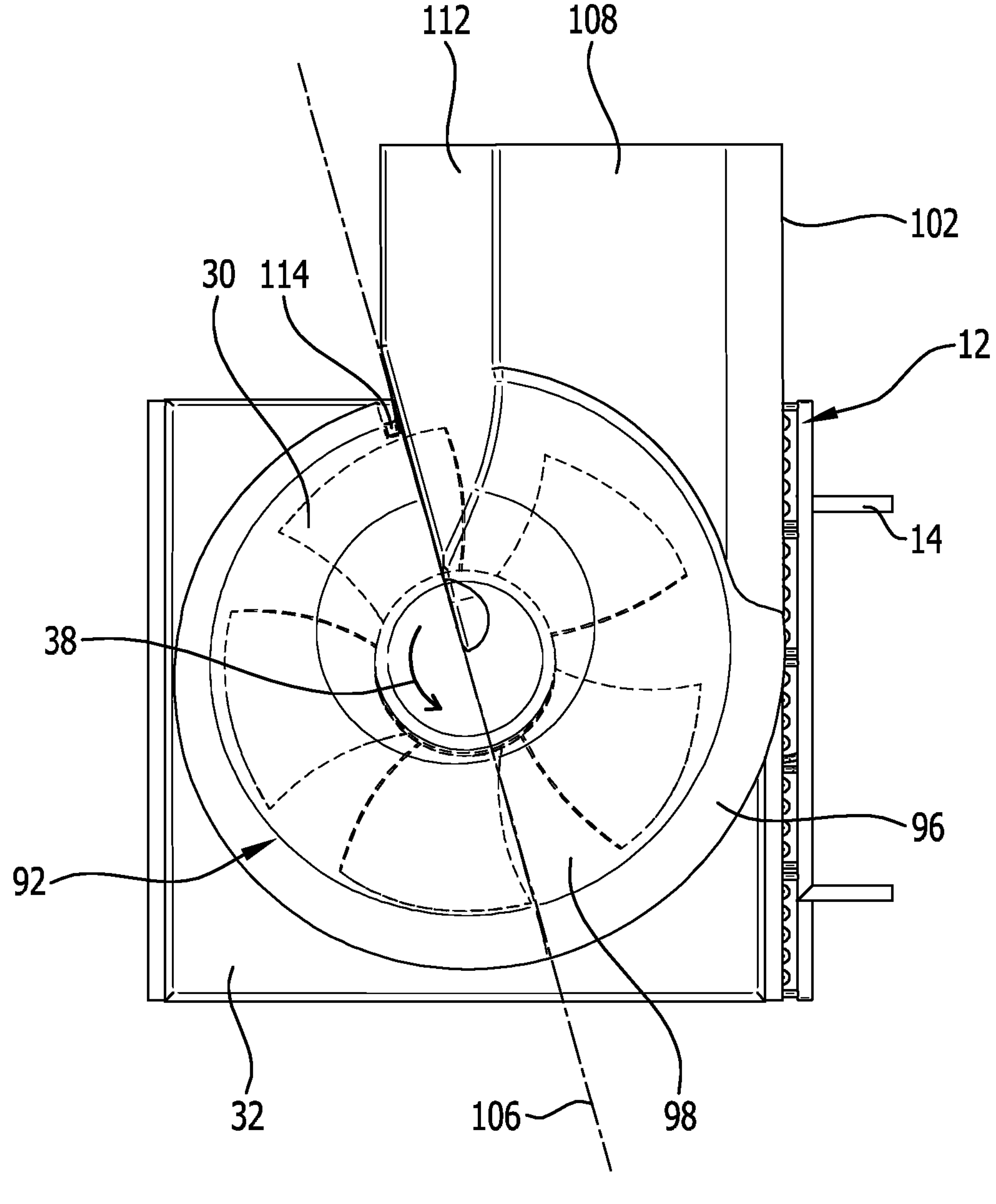


FIG.9

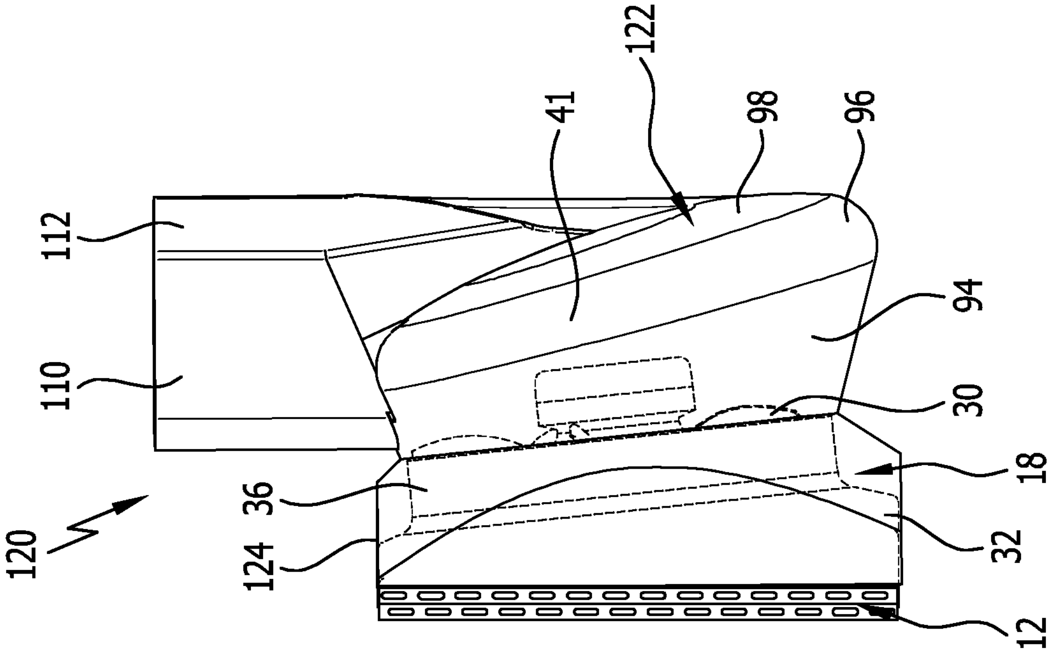

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FIG.8

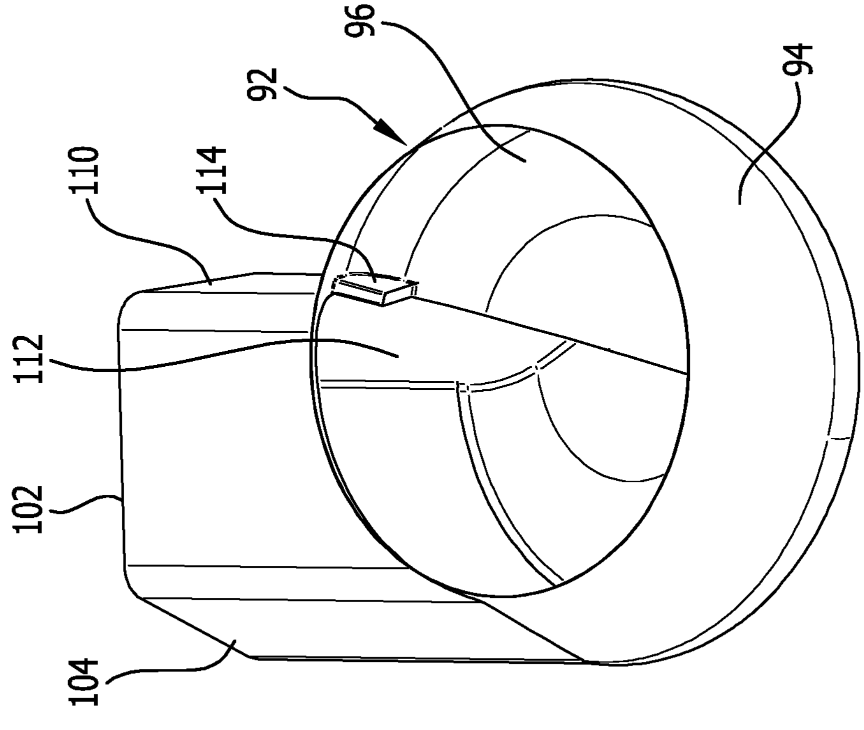
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FIG.11

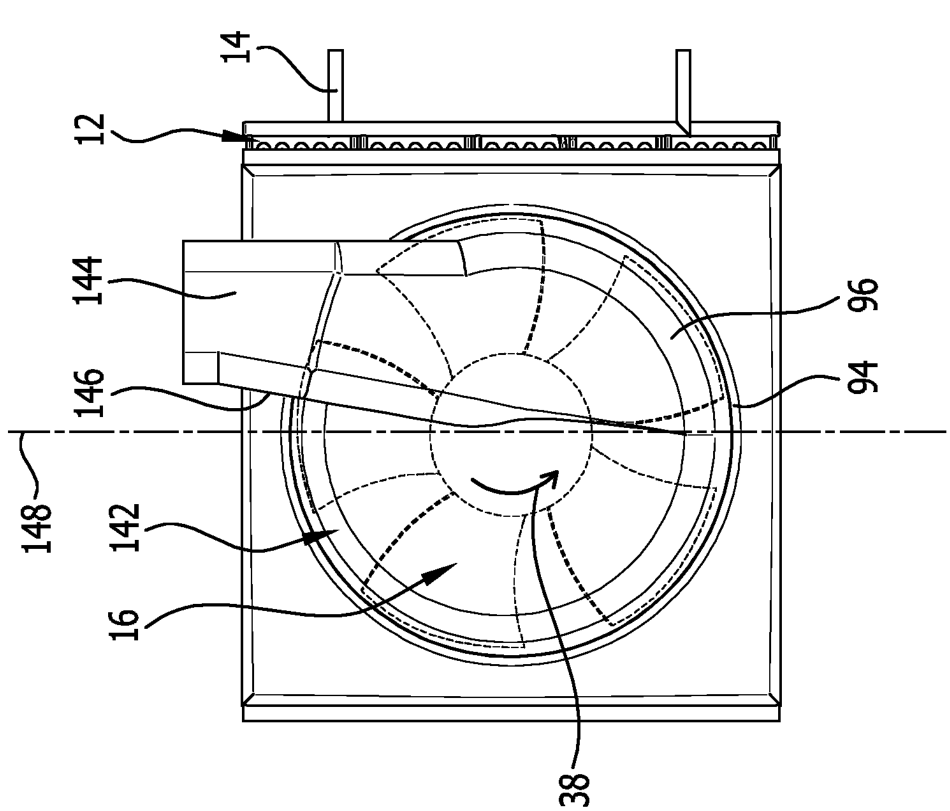
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FIG.10

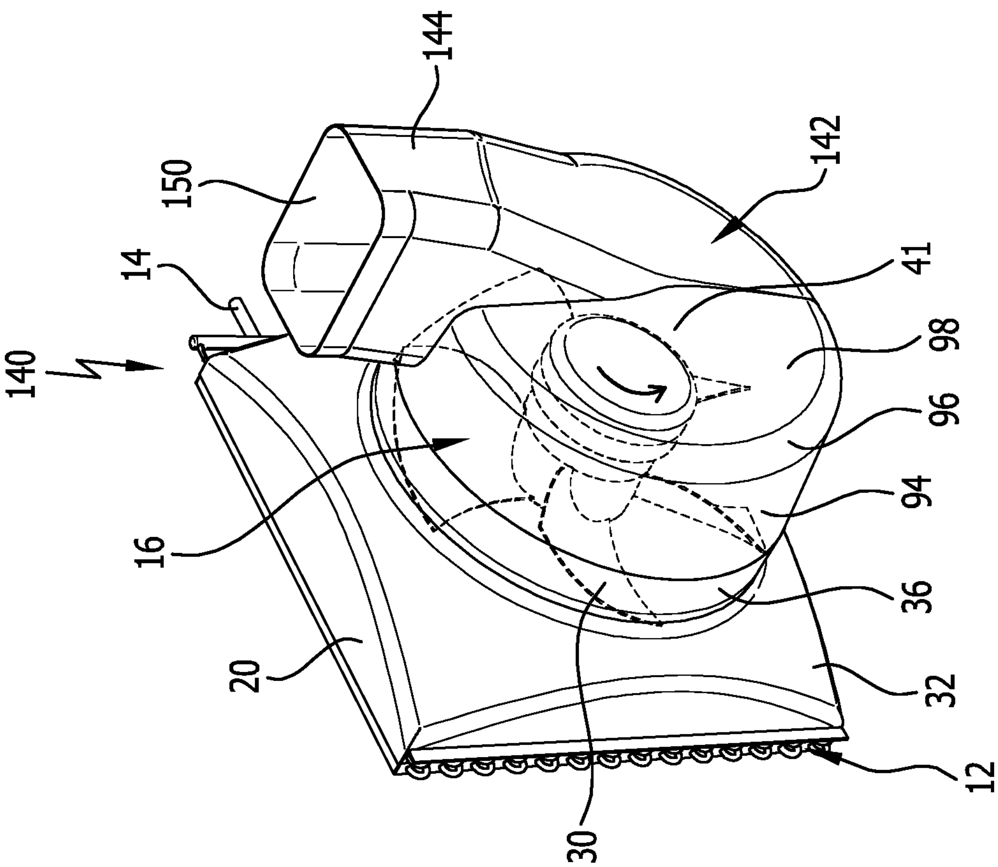
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FIG.12

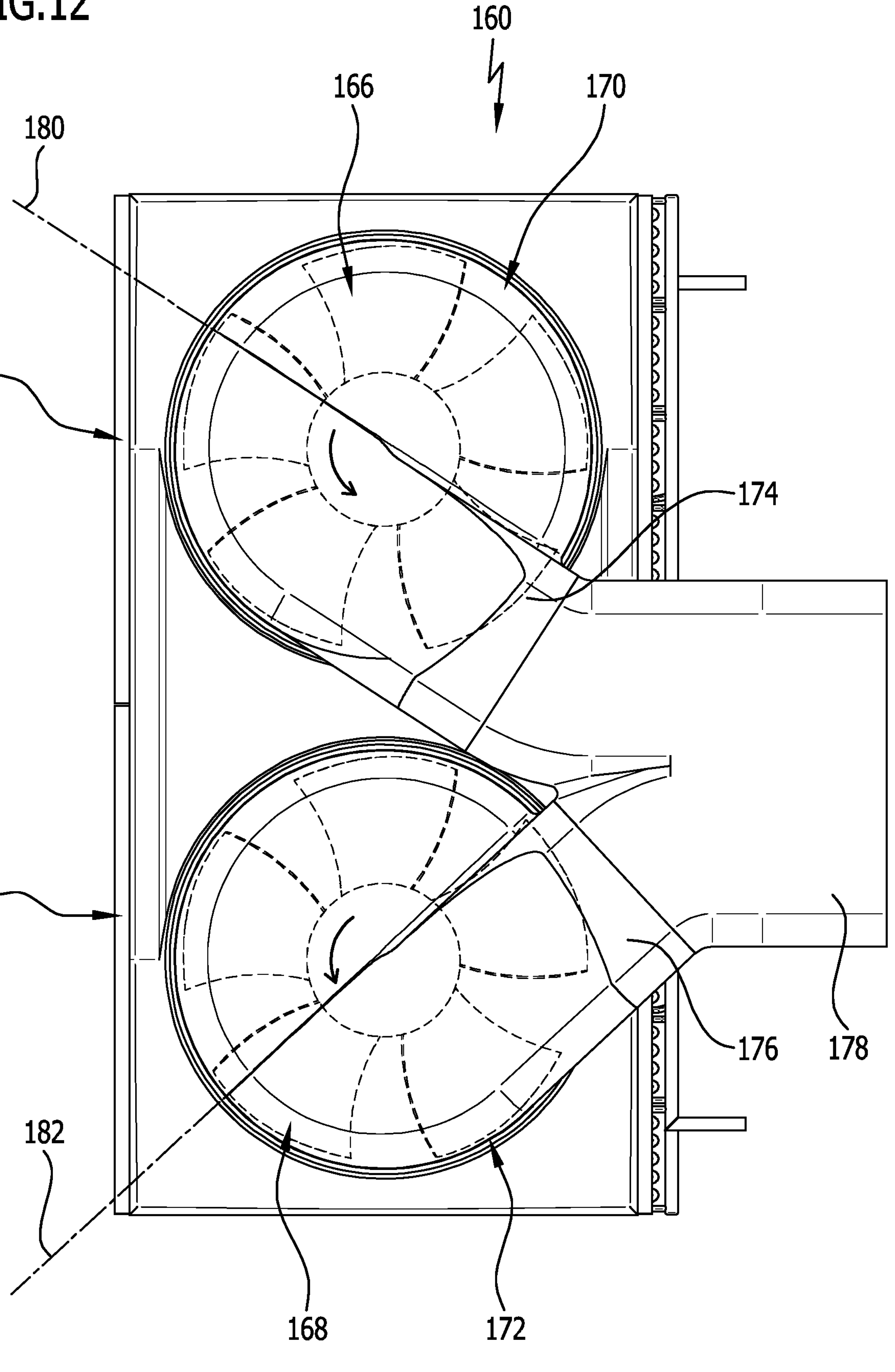
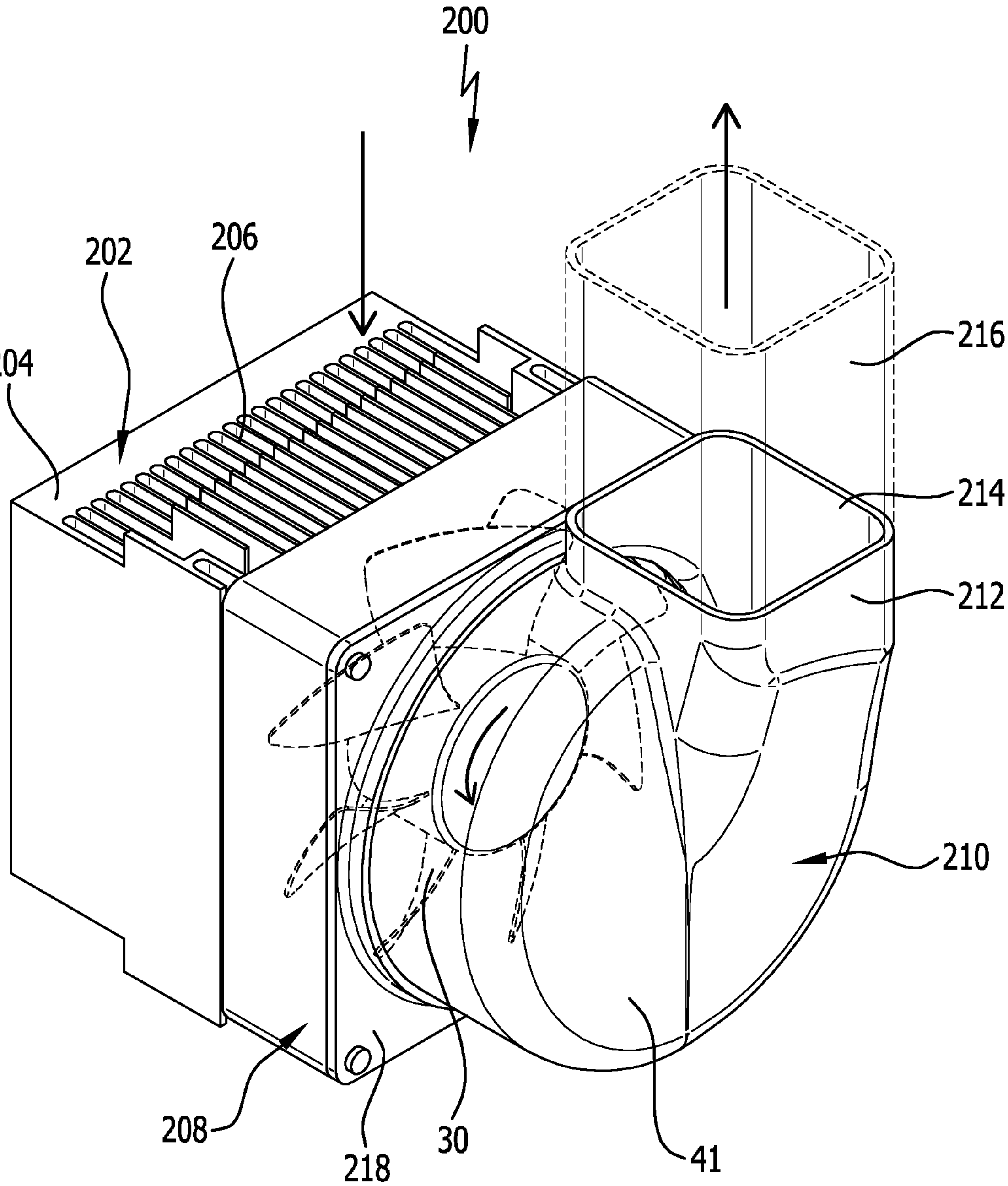


FIG.13



DEVICE FOR EXCHANGING THERMAL ENERGY WITH AMBIENT AIR

[0001] The invention relates to a device for exchanging thermal energy with ambient air, comprising at least one heat exchanger through which an air flow can flow and which is assigned an axial fan for conveying the air flow through the heat exchanger, and an outflow housing receiving the air flow conveyed by the axial fan on the downstream side, wherein the axial fan has a motor and an impeller wheel, with blading, that can be driven by the motor to rotate about an axis of rotation, and wherein the outflow housing has an air outlet opening for discharging the air flow to the environment.

[0002] Devices with a heat exchanger through which an air flow can flow, an axial fan for conveying the air flow through the heat exchanger and with an outflow housing receiving the air flow conveyed by the axial fan on the downstream side that has an air outlet opening for discharging the air flow to the environment, are used, for example, in heat pumps and air conditioning systems in which the heat exchanger, in heating mode, assumes the function of an evaporator of a coolant flowing through the heat exchanger and, in cooling mode, the function of a condenser.

[0003] Such devices are also used in the electronics sector for cooling electronic components, wherein the heat exchanger is designed in the form of a heat sink through which the air flow can flow and on which the electronic components are arranged. In order to apply the air flow conveyed by the axial fan to the heat sink, the axial fan is usually chosen to be large enough that it almost completely covers the surface of the heat sink.

[0004] Compared to radial fans, axial fans have the advantage of a large intake area, and thereby enable a uniform flow through the heat exchanger. However, axial fans have the disadvantage that the delivered volume flow decreases even with a moderate increase in back pressure. For this reason, axial fans often have a free outflow, without obstructions. In many cases, however, it is necessary to deflect by 90° the air flow to be discharged into the environment downstream of the axial fan. In order to minimize pressure losses in so doing, the outflow housing often has a box-like shaft whose width corresponds at least to the diameter of the axial fan. This results in a considerable increase in the size of the device, wherein pressure losses often cannot be avoided despite the considerable size.

[0005] With heat pumps for heating buildings or swimming pools, it is often preferred to bury them in the ground rather than install them in the basement or outdoors, due to the space required. In such cases of an outflow housing, the return of the air flow to the environment requires minimal flow resistance, despite strong air deflection, in order to avoid a noticeable reduction in the conveyed volume flow.

[0006] In the electronics sector, too, to increase the cooling performance, in particular of high-performance processors, it is advantageous to direct the outflow of the axial fan to an air outlet opening via an outflow housing with a small installation space and minimal pressure loss, and thereby prevent internal backflow—a so-called thermal short circuit.

[0007] The object of the present invention is therefore to develop a device of the type mentioned at the outset in such a way that the outflow of the axial fan can be diverted transversely to the outlet direction of the axial fan with the lowest possible flow losses.

[0008] This object is achieved according to the invention in a device of the generic type in that the outflow housing forms an air intake chamber, axially offset from the impeller wheel and from a motor of the axial fan, which receives the conveyed air flow over the entire cross-section of the impeller wheel and the motor and is penetrated by the axis of rotation of the axial fan, wherein the outflow housing covers the impeller wheel and the motor like a hood in a rear view, and wherein the outflow housing is designed and configured to supply the conveyed air flow to the air outlet opening with a directional component tangential to a swirling movement imposed on the air flow by the axial fan.

[0009] The device according to the invention has an outflow housing which receives the air flow conveyed by the axial fan on the outflow side and supplies it to an air outlet opening through which the air flow can be released into the environment. The outflow housing forms an air intake chamber, axially offset from the impeller wheel and from the motor of the axial fan, which receives the air flow conveyed by the axial fan over the entire cross-section of the impeller wheel and the motor, and is penetrated by the axis of rotation of the axial fan. In a rear view looking along the axis of rotation, the outflow housing covers the impeller wheel and the motor like a hood. The air flow conveyed by the axial fan can therefore be received by the outflow housing over a large area and consequently with low losses across the entire cross-section of the impeller and the motor.

[0010] Under the action of the axial fan, the conveyed air flow is subjected to a swirling movement around the axis of rotation of the axial fan. According to the invention, the air flow is supplied to the air outlet opening with a directional component tangential to the swirling movement. The swirling movement of the air flow is used to deflect the air flow by 90°. Due to the imposed swirl, the air flow, which is supplied to the outflow housing over a large area across the entire cross-section of the impeller wheel and the motor, performs a loop-shaped movement within the hood-like outflow housing and is supplied to the air outlet opening substantially in a tangential direction. This creates a parallel flow in the region of the air outlet opening, which evenly fills the entire cross-section of the air outlet opening, with the air flow showing hardly any residual swirl. The deflection of the air flow therefore occurs with very low flow losses.

[0011] Compared with a conventional 90° pipe bend with an outlet diameter that corresponds to the diameter of the impeller wheel of the axial fan, the size of the outflow housing can be kept significantly smaller; in particular, the extension of the outflow housing in the axial direction relative to the axis of rotation can be significantly reduced, such that the device according to the invention has a very compact design. In addition, a much more uniform velocity distribution of the air flow can be created in the region of the air outlet opening, which can further reduce pressure losses.

[0012] The axial extension of the discharge housing can, for optimum flow, be adapted to the existing ratio of swirl to axial velocity of the air flow, which depends upon the utilized impeller wheel blading and the selected operating point of the axial fan. The size of the air outlet opening influences the exit speed of the air flow. An increase in size causes a diffuser effect, i.e., a slowing down of the air flow. A reduction in size creates a jet effect and therefore an acceleration of the air flow. For example, the exit speed can be chosen to be just large enough to safely avoid backflow to the inlet of the heat exchanger and therefore a thermal short circuit. This enables very high energy efficiency of the device according to the invention.

[0013] Preferably, the air outlet opening is arranged downstream of the axial fan in a region, laterally offset from a center plane of the axial fan, of the outflow housing, wherein the center plane is aligned coaxially with the axis of rotation of the axial fan, and wherein the blading of the impeller rotates in this laterally offset region in a rear view of the outflow housing towards the air outlet opening. In a rear view of the outflow housing looking along the axis of rotation, the center plane of the axial fan divides the impeller into two halves. The air outlet opening is arranged downstream of the axial fan on that side of the center plane on which the blading of the impeller rotates when rotating about the axis of rotation in the rear view of the outflow housing towards the air outlet opening. As a result, the air flowing on this side of the center plane moves basically in a tangential direction to the air outlet opening, and the air flowing on the opposite side of the center plane moves within the hood-like outflow housing in a looping motion towards the air outlet opening.

[0014] This creates a parallel flow in the air outlet opening, which evenly fills practically the entire cross-section of the air outlet opening and has practically no residual swirl.

[0015] In a preferred embodiment of the invention, the extent of the air outlet opening transverse to the axis of rotation is a maximum of 1.9 times the outer radius of the impeller wheel. This helps to feed the air flow substantially in a tangential direction to the air outlet opening.

[0016] It is advantageous if the extension of the air outlet opening transverse to the axis of rotation is at least 0.5 times the outer radius of the impeller wheel. In such an embodiment of the invention, the air flow is accelerated in the region of the air outlet opening and released into the environment at a higher speed. This makes it particularly reliable for counteracting backflow to the inlet of the heat exchanger and therefore a thermal short circuit.

[0017] It is advantageous if the outflow housing has an air outlet nozzle that defines the air outlet opening. The air outlet opening can be aligned in a tangential direction with respect to the swirling movement of the air flow, in order to generate a particularly uniform parallel flow and to keep flow losses particularly low.

[0018] It can be provided that the air outlet nozzle widen or taper in the direction of flow. A widening leads to a diffuser effect, i.e., a slowing down of the flow, and a tapering leads to a nozzle effect and therefore to an acceleration of the flow. The choice of a widening or tapering of the air outlet nozzle therefore makes it possible to specify the speed at which the air flow is released into the environment.

[0019] In a preferred embodiment of the invention, the outflow housing has a rear wall opposite the axial fan, which has at least one rear wall section inclined to the axis of rotation of the axial fan, over which the distance of the rear wall to the axial fan increases. In this case, it is advantageous if the at least one rear wall section, which is inclined to the axis of rotation, is arranged on the side of a central plane, aligned coaxially with the axis of rotation, on which the flowing air rotates in a loop-shaped movement. In the direction of rotation, there is an increase in the mass flow due to the continuous supply of air from the axial fan. In order to counteract a resulting increase in the flow velocity, an increase in the flow cross-section of the air flow can, with the aid of at least one rear wall section over which the distance of the rear wall to the axial fan increases, be achieved, in order to thereby counteract an increase in the flow velocity. This can reduce flow losses.

[0020] It is advantageous if the outflow housing has a side wall running in the circumferential direction. This allows an additional reduction in flow losses and avoids dirt deposits within the outflow housing.

[0021] It is particularly advantageous if the side wall of the outflow housing widens with increasing distance to the axial fan. The side wall thereby forms a kind of cone that opens in the direction facing away from the axial fan.

[0022] It is advantageous if the side wall continuously transitions into a rear wall of the outflow housing via a rounding. The rounding can vary in its radius, i.e., it can narrow or widen. The rounding supports the low-loss deflection of the air flow towards the air outlet opening.

[0023] It is particularly advantageous if the rear wall widens in a spiral shape in the circumferential direction. The spiral-shaped widening enables a particularly low-loss supply of the air flow to the air outlet opening by deflecting the air flow by 90°, wherein an increase in the speed of the air flow can be counteracted, despite the volume flow from the impeller wheel increasing linearly in the circumferential direction.

[0024] In an advantageous embodiment of the invention, the axial fan has a housing which defines an inflow channel and an outflow channel, wherein the inflow channel is arranged upstream of the impeller wheel, and the outflow channel surrounds the impeller wheel in the circumferential direction. The air flow can be supplied to the impeller wheel via the inflow channel. The inflow channel can be connected directly to the heat exchanger. The outflow channel surrounds the impeller wheel and, in combination with the blading of the impeller wheel, defines the air flow on the downstream side of the axial fan.

[0025] It is advantageous if the inflow channel extends to a bulkhead that has an opening to which the outflow channel is connected. The bulkhead makes it possible to separate the inflow side of the axial fan from its outflow side in order to thereby avoid an internal backflow and therefore a thermal short circuit.

[0026] In an advantageous embodiment of the invention, the outflow channel forms a constriction, adjacent to the opening in the bulkhead, to which an annular wall is connected. The constriction results in a reduction in the flow cross-section of the air flow and therefore an increase in its speed, i.e., the constriction forms an inlet nozzle. The annular wall in combination with the blading of the impeller wheel defines the axial movement of the air flow. The annular wall is preferably cylindrical or conical.

[0027] It can be provided that the outflow housing be connected to the bulkhead of the fan housing and surround the outflow channel of the fan housing in the circumferential direction. In such a design, the fan housing dips into the outflow housing.

[0028] It is advantageous if the heat exchanger is designed to be flat, and the axis of rotation of the axial fan is aligned obliquely to the heat exchanger. The oblique alignment of the axis of rotation supports the low-loss deflection of the air flow towards the air outlet opening.

[0029] In a preferred embodiment of the invention, the axis of rotation of the axial fan is aligned at a maximum angle of 30°, in particular 5° to 10°, to the surface normal of the heat exchanger.

[0030] In an advantageous embodiment of the invention, the outflow housing has a flow guide element which is directed radially inwards with respect to the axis of rotation of the axial fan and which is arranged in the transition region between an air outlet nozzle and a side wall of the outflow housing. The flow guide element allows the volume flow to be discharged to be separated from the loop-shaped circulating volume flow in a structurally simple manner. This improves the parallel flow in the region of the air outlet opening.

[0031] The flow guide element can, for example, be designed like a tongue.

[0032] It can be provided that the device according to the invention have a single heat exchanger to which an axial fan and an outflow housing are assigned, wherein, by means of the axial fan, an air flow can be generated which flows through the heat exchanger and which can be discharged to the environment via the air outlet opening of the outflow housing.

[0033] Alternatively, it can be provided that the device according to the invention have a plurality of heat exchangers, in particular two heat exchangers, each of which is assigned an axial fan and an outflow housing, wherein the air flows conveyed by the axial fans can be fed via the air outlet openings of the outflow housings to a common air outlet channel, via which the air flows can be discharged to the environment, wherein the air outlet openings are aligned obliquely to one another. For example, it can be provided that the device have two heat exchangers arranged one above the other or next to the other, through each of which can flow an air flow generated by an axial fan assigned to the respective heat exchanger, wherein the air flow can be fed to an outflow housing from which the air flow can be fed to the common air channel via the respective air outlet opening.

[0034] The air outlet openings of the outflow housings can each be defined by an air outlet nozzle, wherein the air outlet nozzles of the two outflow housings are aligned at an angle to each other.

[0035] It is particularly advantageous if the two outflow housings are designed identically and are aligned in different ways with respect to the common air outlet channel. When the device is mounted, the two outflow housings can be rotated into a specific rotational position relative to the respective fan axis of rotation, so that their air outlet nozzles open into the common air outlet channel.

[0036] It is advantageous if the outflow housing is mounted on a base plate of the axial fan so as to rotate about its axis of rotation.

[0037] The invention also relates to the use of the device explained above in a heat pump or air conditioning system or for cooling electronic components.

[0038] The following description of preferred embodiments of the invention serves to explain in more detail, in conjunction with the drawing. In the figures:

[0039] FIG. **1** shows an exploded view of a first embodiment of a device for exchanging thermal energy with the ambient air;

[0040] FIG. **2** shows a perspectival view of an outflow housing of the device from FIG. **1** with exemplary flowlines of an air flow;

[0041] FIG. **3** shows a side view of a second embodiment of a device for exchanging thermal energy with the ambient air;

[0042] FIG. **4** shows a perspectival view of the device from FIG. **3**;

[0043] FIG. **5** shows a perspectival view of a third embodiment of a device for exchanging thermal energy with the ambient air;

[0044] FIG. **6** shows a side view of the device from FIG. **5**;

[0045] FIG. **7** shows a rear view of the device from FIG. **5**;

[0046] FIG. **8** shows a perspectival view of an outflow housing of the device from FIG. **5** with a view of a flow inlet obliquely from below;

[0047] FIG. **9** shows a side view of a fourth embodiment of a device for exchanging thermal energy with the ambient air;

[0048] FIG. **10** shows a perspectival view of a fifth embodiment of a device for exchanging thermal energy with the ambient air;

[0049] FIG. **11** shows a rear view of the device of FIG. **10**;

[0050] FIG. **12** shows a rear view of a sixth embodiment of a device for exchanging thermal energy with the ambient air;

[0051] FIG. **13** shows a perspectival view of a seventh embodiment of a device for exchanging thermal energy with the ambient air.

[0052] In FIG. **1**, a first advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air is shown schematically in an exploded view and is designated overall by reference sign **10**. The device **10** has a conventional flat heat exchanger **12** with a fluid line **14** through which a fluid can flow in order to heat or cool the fluid, wherein an exchange of thermal energy with the ambient air takes place. For this purpose, an air flow generated by an axial fan **16** can pass through the heat exchanger **12**. The axial fan **16** is connected to the heat exchanger **12** in the flow direction of the air flow and has a fan housing **18** which forms an inflow channel **20** rectangular in cross-section and an outflow channel **22** circular in cross-section. In addition, the axial fan **16** has an impeller wheel **24** which can be made to rotate by a motor **26** about an axis of rotation **28**. The impeller wheel **24** has a blading **30** formed from a plurality of blades for conveying the air flow. The impeller wheel **24** is rotatably mounted in the outflow channel **22**, and the inflow channel **20** is arranged upstream of the impeller wheel **24**.

[0053] Starting from the heat exchanger **12**, the inflow channel **20** extends to a bulkhead **32** which has an opening **33** to which a constriction **34** of the outflow channel **32** is connected. The constriction **34** forms an inlet nozzle. The constriction **34** is followed by an annular wall **36** of the outflow channel **32**, which surrounds the impeller wheel **24** in the circumferential direction. Looking at the motor **26**, the impeller wheel **24** rotates counterclockwise. The direction of rotation of the impeller wheel **24** is illustrated in FIG. **1** by the arrow **38**.

[0054] The device **10** also has an outflow housing **40** which is connected to the axial fan **16** in the flow direction of the conveyed air flow and receives on the outflow side the air flow conveyed by the axial fan **16**.

[0055] The outflow housing **40** is designed in the manner of a hood, which forms an air intake chamber **41** axially offset from the impeller **24** and the motor **26** and through which the rotation axis **28** passes. In a rear view looking along the axis of rotation **28**, the outflow housing **40** covers the impeller wheel **24** and the motor **26**, the motor axis (not shown in the drawing) of which is aligned coaxially with the axis of rotation **28**. The outflow housing receives the air flow conveyed by the axial fan **16** over a large area across the entire cross-section of the impeller wheel **24** and the motor **26**.

[0056] The outflow housing **40** is shown enlarged in FIG. **2** together with the impeller wheel **24** and the motor **26**. The outflow housing **40** has a cuboid-shaped housing body **42** which rests against the bulkhead **32** and surrounds the outflow channel **22** as well as the impeller wheel **24** and the motor **26**.

[0057] An air outlet nozzle **44** is connected to the top of the housing body **42** and defines an air outlet opening **46** of the outflow housing **40**. The air flow conveyed by the axial fan **16** can be discharged into the environment via the air outlet opening **46**.

[0058] The air outlet nozzle **44** and the air outlet opening **46** are arranged in a region laterally offset from a center plane **48**, shown in dash-dotted lines, of the outflow housing **40**, wherein the center plane is coaxial with the axis of rotation **28** and is aligned vertically in the illustrated position of use of the device **10**, and wherein the blading **30** of the impeller wheel **24** rotates in this laterally offset region in a rear view of the outflow housing **40** towards the air outlet opening **46**. The viewing direction in the rear view is illustrated in FIG. **1** by the arrow **50**.

[0059] Under the action of the axial fan **16**, the conveyed air flow is subjected to a swirling movement around the axis of rotation **28**. The arrangement of the air outlet nozzle **44** and the air outlet opening **46**, laterally offset from the center plane **48**, and the blading **30**, rotating in this laterally offset region in a rear view of the outflow housing **40** relative to the air outlet opening **46**, of the impeller wheel **24** results in the air flow, conveyed by the axial fan **16**, in this laterally offset region being fed to the air outlet opening **46** substantially in a tangential direction with respect to the swirling movement. On the side, facing away from the air outlet nozzle **44** and the air outlet opening **46**, of the center plane **48**, the air flow executes a loop-shaped movement and then flows in a substantially tangential direction towards the air outlet opening **46**. This creates a parallel flow in the air outlet nozzle **44**, which evenly fills the entire cross-section of the air outlet nozzle **44** and hardly has any residual swirl. To illustrate the air flow in the region of the outflow housing **40**, some flowlines a, b, c, d, and e are shown in dashed lines in FIG. **2** as examples.

[0060] The device **10** therefore makes it possible to guide an air flow through the heat exchanger **12** in an axial direction relative to the axis of rotation **28** and to divert the air flow in the outflow housing **40** by 90° using the swirling movement caused by the axial fan **16**, wherein the diversion is associated with very low flow losses, and the air flow in the region of the air outlet opening **46** substantially forms a parallel flow. The low-loss deflection of the air flow within the outflow housing **40** is achieved even though the extension of the outflow housing **40** in the axial direction, i.e., its installation depth, is smaller than the extension of the outflow housing **40** transverse to the axis of rotation **28**. The device **10** therefore enables a low-loss deflection of the air flow by 90°, wherein the device **10** has a compact design. The installation depth of the outflow housing **40** can, for a particularly low-loss deflection of the air flow, be adapted to the existing ratio of swirl to axial velocity of the air flow, which depends upon the blading **30** used for the impeller wheel **24** and the selected operating point of the axial fan **16**.

[0061] FIGS. **3** and **4** schematically show a second advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air, wherein the device as a whole is designated by reference sign **60**. For identical components, the same reference signs are used in FIGS. **3** and **4**, as well as in FIGS. **5** to **13** explained in more detail below, as in FIGS. **1** and **2**. To avoid repetition, reference is made to the previous explanations regarding these components.

[0062] The device **60** shown in FIGS. **3** and **4** differs from the device **10** shown in FIGS. **1** and **2** by a hood-like outflow housing **62** which has a cylindrical side wall **64** which surrounds the outflow channel **22** as well as the impeller wheel **24** and the motor **26** of the axial fan **16** in the circumferential direction and extends in the axial direction from the bulkhead **32** of the axial fan **16** to a rear wall **66**, opposite the axial fan **16**, which has a first flat rear wall section **68** inclined to the axis of rotation **28** and a second flat rear wall section **70** inclined to the axis of rotation **28**, over which the distance of the rear wall **66** to the axial fan **16** increases in each case. The two rear wall sections **68**, **70** are connected to an air outlet nozzle **72** of the outflow housing **62**.

[0063] The air outlet nozzle **72** defines an air outlet opening **74** and, in a manner corresponding to the air outlet nozzle **44**, explained above with reference to FIGS. **1** and **2**, is arranged laterally offset from a center plane **75** aligned coaxially with the axis of rotation **28**. The center plane **75** is shown in FIG. **4** in dash-dotted lines. The first rear wall section **68** and the second rear wall section **70** are positioned on the side, opposite the air outlet nozzle **72**, of the center plane **75**. The air outlet nozzle **72** extends with a nozzle rear wall **76** to the lower end of the outflow housing **62**, wherein the nozzle rear wall **76** is inclined backwards in the side facing away from the axial fan **16** so that the flow cross-section of the air outlet nozzle **72** continuously expands in the flow direction.

[0064] Via the obliquely aligned rear wall sections **68**, **70**, the internal volume of the outflow housing **62** expands on the side of the central plane **75**, on which the flowing air executes a loop-shaped movement, wherein, in this region, the volume flow continuously increases in the circumferential direction due to the air continuously conveyed by the impeller wheel **24**. In order to achieve a substantially constant flow velocity despite the increase in the volume flow, the obliquely aligned rear wall sections **68**, **70** are used, which cause an expansion of the internal volume of the outflow housing **62** in this region. On the side, opposite the rear wall sections **68**, **70**, of the center plane **75**, the blading **30** of the impeller wheel **24** rotates in a rear view of the outflow housing **62** towards the air outlet opening **74**, so that the air flow is supplied to the air outlet opening **74** substantially in a tangential direction with respect to the swirling movement of the air flow, as has already been explained above with reference to FIGS. **1** and **2**. The flow cross-section of the air outlet nozzle **72** continuously increasing in the flow direction acts as a diffuser which slows down the flow.

[0065] The device **60** therefore enables, with a very compact design, a low-loss deflection of the air flow by 90°.

[0066] FIGS. **5** to **8** schematically show a third advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air, wherein the device as a whole is designated by reference sign **90**. The device **90** has a hood-like outflow housing **92** which, in contrast to the outflow housings **62** and **40** explained above, does not directly adjoin the bulkhead **32** of the axial fan **16**, but, rather, the outflow housing **92** adjoins the outflow channel **22** of the axial fan **16**, wherein it has a side wall **94** which is adjacent to the outflow channel **22** and which continuously widens with increasing distance from the axial fan **16** and which continuously merges, via a rounding **96**, into a rear wall **98** spirally widening in the circumferential direction.

[0067] In the device **90**, the axial fan **16** is inclined to the heat exchanger **12**, i.e., the axis of rotation **28** of the axial fan **16** is inclined at an angle α of at most 30°, in particular at an angle α of 5 to 10°, to the surface normal **100** of the flatly designed heat exchanger **12**. The inclination of the axial fan **16** supports the low-loss deflection of the air flow into the air outlet nozzle **102** of the outflow housing **92**, which defines an air outlet opening **104** and is arranged laterally offset from a center plane **106** which is aligned coaxially with the axis of rotation **28**. This is particularly evident from FIG. **7**. The volume flow of the conveyed air from the axial fan **16** increasing linearly in the circumferential direction is received by means of the expansion of the internal volume of the outflow housing **92** via the side wall **94** continuously expanding with increasing distance from the axial fan **16**, and the rear wall **96** continuously expanding in the circumferential direction, so that a substantially constant flow velocity can be achieved despite the volume flow of the conveyed air increasing linearly in the circumferential direction.

[0068] With the device **90** as well, the blading **30** of the impeller wheel **24**, in a rear view of the outflow housing **92** on the side of a center plane **106** shown in dash-dotted lines in FIG. **7**, on which the air outlet nozzle **102** and the air outlet opening **104** are arranged, rotates in the direction of the air outlet nozzle, so that the air flow conveyed by the axial fan **16** can be fed to the air outlet opening **104** substantially in a tangential direction with respect to the swirling movement of the air flow. On the opposite side of the center plane **106**, the air moves in a loop shape, in order to then also be fed substantially in a tangential direction to the air outlet nozzle **102** and the air outlet opening **104**.

[0069] The air outlet nozzle **102** has, between a nozzle rear wall **108** facing away from the axial fan **16** and a nozzle side wall **110** facing the center plane **106**, a wall flattening **112** which prevents an area with a lower flow velocity from forming in this region of the air outlet nozzle **102**.

[0070] In the transition area between the rounding **96** and the air outlet nozzle **102**, the outflow housing **92** has a tongue-shaped, inwardly directed flow guide element **114** which ensures a precise separation of the discharged and the circulating volume flow, wherein the volume flow to be discharged can reach the air outlet opening **104** via the air outlet nozzle **102**, and the circulating volume flow executes a loop-shaped movement about the axis of rotation **28**. The separation of the discharged and circulating volume flow improves the parallel flow in the air outlet nozzle **102**.

[0071] FIG. **9** schematically shows a fourth advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air, wherein the device as a whole is designated by reference sign **120**.

[0072] The device **120** has a hood-like outflow housing **122** which extends with a front housing section **124** to the heat exchanger **12**. The front housing section **124** surrounds the fan housing **18**, wherein, however, only a small amount of vibration is transmitted from the axial fan **16** to the outflow housing **122**; instead, vibrations of the axial fan **16** are primarily absorbed by the heat exchanger **12**.

[0073] With the exception of the front housing section **124**, the outflow housing **122** is designed in the same way as the outflow housing **92** explained above, so that reference can be made to the above explanations in this regard.

[0074] FIGS. **10** and **11** schematically show a fifth advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air, wherein the device as a whole is provided with reference sign **140**. The device **140** has a hood-like outflow housing **142** which is designed largely identically to the outflow housing **92** explained above with reference to FIGS. **5** to **8**. In contrast to the outflow housing **92**, the outflow housing **142** has an air outlet nozzle **144** with a nozzle side wall **146** which is inclined to a center plane **148** aligned coaxially with the axis of rotation **28** so that the flow cross-section of the air outlet nozzle **144** is reduced in the flow direction, and the flow velocity of the air flow in the air outlet nozzle **144** is thereby increased.

[0075] The air outlet nozzle **144** defines an air outlet opening **150** which, like the air outlet nozzle **144**, is arranged laterally offset from the center plane **148** as already explained above.

[0076] The extension of the air outlet opening **150** transverse to the axis of rotation **28** is smaller than the outer radius of the impeller wheel **24**, so that a nozzle effect is created, and the air flow conveyed by the axial fan **16** is ejected out of the air outlet opening **150** at a considerable flow velocity.

[0077] FIG. **12** schematically shows a sixth advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air. The device as a whole is designated by reference sign **160**.

[0078] The device **160** has a first heat exchanger **162** and a second heat exchanger **164** which are arranged one above the other and to which an axial fan **166** or **168** and a hood-like outflow housing **170** or **172** are each assigned. The two heat exchangers **162**, **164** are designed identically, and the two axial fans **166**, **168** are designed identically, as are the two outflow housings **170**, **172**. The two outflow housings **170**, **172** each have an air outlet nozzle **174** or **176** which opens into a common air outlet channel **178** via which the air flows conveyed by the two axial fans **166**, **168** are discharged to the environment. The identically designed axial fans **166**, **168** each have a center plane **180** or **182**, shown in dash-dotted lines in FIG. **12**, to which the air outlet nozzles **174**, **176** are arranged offset as already explained in detail above. With reference to the rear view of the device **160** shown in FIG. **12**, the axial fans **166**, **168** differ only in their rotational position relative to the respective fan axis of rotation, so that the air flows can be fed to the common air outlet channel with low flow losses.

[0079] FIG. **13** schematically shows a seventh advantageous embodiment of a device according to the invention for exchanging thermal energy with the ambient air, wherein the device is designated by reference sign **200**.

[0080] The device **200** differs from the embodiments explained above essentially in that it has a heat exchanger **202** in the form of a heat sink **204**. The heat sink **204** has fins **206** and serves to cool electronic components. An air flow can flow through the heat sink **18** and is conveyed by an axial fan **208** of the device **200** and fed to a hood-like outflow housing **210** of the device **200**. In the outflow housing **210**, the air flow is deflected by 90°, as already explained in detail above, and can be discharged via an air outlet nozzle **212** and an air outlet opening **214** to the environment or to an air channel **216** adjoining the air outlet nozzle **212**. The air channel **216** is shown in dashed lines in FIG. **13**.

[0081] The axial fan **208** is connected on the downstream side to a base plate **218**, which enables the outflow housing **210** to be mounted so as to be rotatable about the axis of rotation of the axial fan **208**, so that the outflow housing **210** can assume a predeterminable rotational position in which the air outlet nozzle **212** assumes a desired orientation.

[0082] In the outflow housing **210**, the air outlet nozzle **212** and the air outlet opening **214** are also aligned offset from a center plane which is coaxial with the fan axis of rotation as already explained in detail above. The device **200** also enables an energy-efficient exchange of thermal energy with the ambient air, wherein the air flow conveyed by the axial fan **208** can be deflected by 90° with low flow losses.

1-21. (canceled)

22. A device for exchanging thermal energy with ambient air, the device comprising:

a plurality of heat exchangers through which an air flow flows, each of the heat exchangers being assigned an axial fan and an outflow housing;

the axial fan being configured to convey the air flow through the heat exchangers, respectively, the axial fan having a motor and an impeller wheel with a blade which is driven by the motor to rotate about an axis of rotation; and

the outflow housing being configured to receive the air flow conveyed by the axial fan on an outflow side of the axial fan, respectively, the outflow housing forms an air intake chamber axially offset from the impeller wheel and the motor of the axial fan, which receives the conveyed air flow over an entire cross-section of the impeller wheel and the motor and is penetrated by the axis of rotation, the outflow housing, in a rear view, covers the impeller wheel and the motor as a hood, and is configured to supply the conveyed air flow to an air outlet opening of the outlet housing with a directional component tangential to a swirling movement imposed on the air flow by the axial fan; and

a common air outlet channel configured to receive the air flows conveyed by the axial fan from the air outlet opening of the outflow housing from each of the heat exchangers, the common air outlet channel being configured to discharge the air flow to the environment;

wherein the air outlet opening of the outflow housing of each of the heat exchangers are aligned obliquely to one another.

23. The device according to claim **22**, wherein the air outlet opening is arranged downstream of the axial fan in a region, laterally offset from a center plane of the axial fan of the outflow housing, wherein the center plane is aligned coaxially with the axis of rotation, and wherein the blade of the impeller wheel in the laterally offset region, in a rear view of the outflow housing, rotates towards the air outlet opening.

24. The device according to claim **22**, wherein an extension of the air outlet opening transverse to the axis of rotation is a maximum of 1.9 times an outer radius of the impeller wheel.

25. The device according to claim **24**, wherein the extension of the air outlet opening transverse to the axis of rotation is at least 0.5 times the outer radius of the impeller wheel.

26. The device according to claim **22**, wherein the outflow housing has an air outlet nozzle which defines the air outlet opening.

27. The device according to claim **26**, wherein the air outlet nozzle widens or tapers in a direction of the air flow.

28. The device according to claim **22**, wherein the outflow housing has a rear wall opposite the axial fan, which has at least one rear wall section inclined to the axis of rotation over which a distance of the rear wall to the axial fan increases.

29. The device according to claim **22**, wherein the outflow housing has a side wall running in a circumferential direction.

30. The device according to claim **29**, wherein the side wall widens with increasing distance from the axial fan.

31. The device according to claim **29**, wherein the side wall continuously merges into a rear wall of the outflow housing by way of a rounding.

32. The device according to claim **31**, wherein the rear wall widens spirally in the circumferential direction.

33. The device according to claim **22**, wherein the axial fan has a fan housing which defines an inflow channel and an outflow channel, wherein the inflow channel is arranged upstream of the impeller wheel, and the outflow channel surrounds the impeller wheel in a circumferential direction.

34. The device according to claim **33**, wherein the inflow channel extends to a bulkhead which has an opening to which the outflow channel is connected.

35. The device according to claim **34**, wherein the outflow channel forms a constriction, adjacent to an opening of the bulkhead, to which an annular wall is connected.

36. The device according to claim **34**, wherein the outflow housing is adjacent to the bulkhead and surrounds the outflow channel in the circumferential direction.

37. The device according to claim **22**, wherein each of the heat exchangers are flat, and the axis of rotation is aligned obliquely to each of the heat exchangers, respectively.

38. The device according to claim **37**, wherein the axis of rotation is aligned at a maximum angle of 30° to a surface normal of each of the heat exchangers, respectively.

39. The device according to claim **22**, wherein the outflow housing has a flow guide element directed inwards with respect to the axis of rotation and arranged in a transition region between an air outlet nozzle and a rounding of the outflow housing.

40. The device according to acclaim **22**, wherein the outflow housing is mounted on a base plate of the axial fan so as to be rotatable about the axis of rotation.

41. A use of the device according to claim **22** in a heat pump, an air conditioning system or for cooling electronic components.

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