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(71) Applicant: **Hidew S.r.l.**
35020 Tribano (PD) (IT)

(72) Inventor: **GRINZATO, Davide**
35020 TRIBANO (PD) (IT)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

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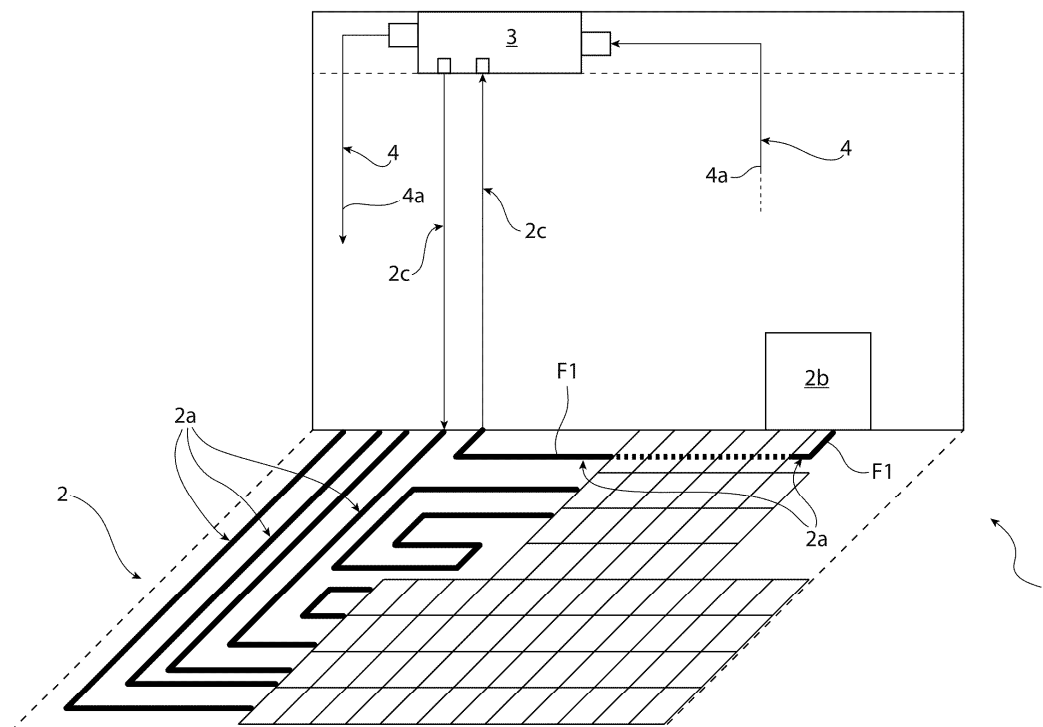
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(54) DEHUMIDIFIER APPARATUS FOR RADIANT SYSTEMS AND OPERATING METHOD THEREOF

(57) A dehumidifier apparatus (3) for radiant systems (2) comprising a boxed casing (5), a duct (6) extending within the boxed casing (5) between a first inlet opening (7) and a first outlet opening (8), a fan device (9) that is arranged in the boxed casing (5) within the duct (6), a

dehumidifier device (10) that is arranged in the boxed casing (5) within the duct (6), a heat exchanger module (19) that is hydraulically connected to a radiant system (2). The boxed casing (5) comprises a single body made by means of molding a thermoplastic polymeric material.

**FIG. 1**

Description

TECHNICAL FIELD

[0001] This invention concerns the treatment of air, in particular the dehumidification carried out by means of a dehumidifier apparatus, in domestic and public indoor rooms that are heated or cooled by a radiant system.

[0002] In particular, this invention concerns a dehumidifier apparatus that is suitable for being installed in a building and is configured for being hydraulically connected both to the radiant system, so as to conveniently use its refrigerant fluid in the air condensation cycle, and with a ventilation system, if included, so as to dehumidify the air in the same rooms.

STATE OF THE ART

[0003] As is known, in recent years, in the technical field of cooling and heating buildings, there has been a significant uptake in radiant systems. Radiant systems are designed to heat and cool a room by means of thermal radiation of a surface. To this end, radiant systems comprise radiant elements consisting of a coil of pipes arranged below the surface to be radiated and is traversed, in use, by water that is heated or cooled by a thermal machine.

[0004] Thermal radiation carried out through broad surfaces conveniently enables reducing the energy consumption required to heat and cool. The temperature that the water must reach to be able to heat or cool the rooms is actually lower and respectively higher than the corresponding temperatures of the water used in the conventional, "non radiant" systems.

[0005] In addition, it is known that in the radiant systems described above, during cooling, you need to control the temperature of the water so as to keep it below a predetermined (low) threshold temperature so as to generate enough cooling power to cool the room, without, in any case, reaching the so-called "dew point", so as to avoid forming dampness/condensation on the inner surfaces of the cooled room.

[0006] To this end, dehumidifier apparatuses have been devised that cooperate with the radiant system to dehumidify, in a controlled manner, the air cooled by the radiant system.

[0007] The above-mentioned dehumidifier apparatuses are generally installed in niches formed in false ceilings or walls, so that they are not visible, and are connected both to the radiant system to receive the water, and with the ventilation systems present in the rooms, to receive the air to dehumidify and then introduce it into the dehumidified room.

[0008] Currently known dehumidifier apparatuses comprise a containment casing that houses the various refrigeration circuits and components necessary to carry out the air dehumidification cycle.

[0009] The casing is commonly made using one or

more metal sheets/plates that are folded and/or fixed together using welding or screws. The production of the metal casing involves manually executing multiple mechanical joints to connect the metal plates composing it together, and significantly affects the assembly times and overall costs for producing the dehumidifier apparatus.

[0010] In addition, the metal casing does not ensure good thermal insulation inside since, due to its structure, it has numerous thermal bridges.

[0011] An additional technical problem for the dehumidifier apparatuses mentioned above consists in the fact that the metal structure of the casing significantly affects the overall weight of the dehumidifier apparatus and increases its installation/removal complexity, in particular in niches formed in false ceilings.

[0012] Finally, the structure of the boxed casing makes accessing the components inside complex when it is necessary to perform a maintenance operation on the dehumidifier apparatus to replace components. Solutions described in US6155074A, CN106123159A, EP2426425A, and US10753625B are also known.

DESCRIPTION OF THE INVENTION

[0013] The purpose of this invention is, thus, to provide a dehumidifier apparatus for radiant systems that overcomes the above-mentioned technical issues.

[0014] According to this invention, a dehumidifier apparatus for radiant systems is provided according to what is set forth in the appended corresponding claims.

[0015] According to this invention, a method for producing the dehumidifier apparatus for radiant systems is also provided according to what is set forth in the appended corresponding claims

[0016] The claims describe preferred embodiments of this invention forming an integral part of this description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] This invention will now be described with reference to the attached drawings that illustrate a non-limiting embodiment thereof, in which:

- Figure 1 schematically shows a thermal system comprising a dehumidifier apparatus produced according to the precepts of this invention,
- Figure 2 is a perspective view from above, with parts removed for clarity, of a dehumidifier apparatus produced according to a first embodiment of this invention,
- Figure 3 is a perspective view from below with parts removed for clarity, of a dehumidifier apparatus produced according to a first embodiment of this invention,
- Figure 4 is a perspective view of a boxed casing of the dehumidifier apparatus produced according to a

- first embodiment of this invention,
- Figures 5 and 6 are two perspective views from below and, respectively, from above of a cover included in the dehumidifier apparatus produced in the second embodiment of this invention,
 - Figure 7 is a perspective view from above, with parts removed for clarity, of a dehumidifier apparatus produced in a second embodiment of this invention,
 - Figure 8 is a perspective view of a boxed casing of the dehumidifier apparatus produced in the second embodiment of this invention
 - Figure 9 is a perspective view from above, with parts removed for clarity, of the dehumidifier apparatus produced in the second embodiment of this invention,
 - Figure 10 is a perspective view from below of the dehumidifier apparatus produced in the second embodiment of this invention,
 - Figures 11 and 12 are two perspective views of a pair of gates included in the dehumidifier apparatus produced in the second embodiment of this invention.
 - Figures 13 and 14 show the operation of the dehumidifier apparatus produced in the second embodiment of this invention according to two operating methods.

PREFERRED EMBODIMENTS OF THE INVENTION

[0018] With reference to Figure 1, the reference number 1 indicates, as a whole, a thermal system that is configured so as to cool, heat, and dehumidify or ventilate on command an indoor room (domestic or public) of a building.

[0019] The thermal system 1 comprises a radiant system 2 configured so as to heat and, alternatively, cool the indoor room, and a dehumidifier apparatus 3 configured to dehumidify the air in the indoor room.

[0020] According to the embodiment shown in Figure 1, the radiant system comprises multiple tubes or pipes 2a (preferably arranged so as to form a coil of tubes) that are hydraulically connected to a thermal machine 2b to receive, from the latter, a refrigerant fluid F1 that has a temperature controlled by the thermal machine 2b based on a (set) temperature to be reached/maintained in the room to be cooled or heated. The thermal machine 2b may comprise, for example, a heat pump or any similar machine. The refrigerant fluid F1 may, preferably, comprise water or a similar refrigerant fluid. In the example illustrated, the ducts 2a are arranged in contact with a (flat) surface in the room, one next to the other, and are traversed by the refrigerant fluid F1 so as to thermally radiate the room by means of the surface itself. The surface may comprise, for example, a floor and/or a wall and/or a ceiling of the indoor room; the pipes 2a are arranged inside the wall or (concealed) ceiling, or floor.

[0021] With reference to the embodiment shown in Figure 2, the dehumidifier apparatus 3 is installed in a niche formed in a false ceiling and/or technical space

and/or similar space in the room so as to be arranged horizontally. It is understood that this invention is not limited to the installation of the dehumidifier apparatus 3 in a horizontal position inside a niche of the false ceiling (to which the discussion below will make explicit reference, without any loss of generality thereby), but can be applied to any positioning of the dehumidifier apparatus, like, for example, a vertical positioning in a vertical wall outside or inside the wall.

[0022] With reference to the embodiment shown in Figure 2, the dehumidifier apparatus 3 is provided with two connectors 2d hydraulically connected to the radiant thermal system 2 by means of hydraulic pipes 2c to receive the refrigerant fluid F1 so as to operate in the way described below. The dehumidifier apparatus 3 is also aerally connected to a ventilation system 4 that is provided, in turn, with a series of ventilation pipes 4a (only two of which are shown in Figure 1 to increase clarity of explanation) that communicate with the environment (Figure 1).

[0023] With reference to an embodiment shown in Figures 2, 3, and 4, the dehumidifier apparatus 3 comprises a container or boxed casing 5. In the example illustrated in Figures 2-4, the boxed casing 5 has an approximately parallelepiped shape and has a reference axis A. The boxed casing 5 has an upper opening designed to be closed by a cover (not illustrated) and comprises a base wall 15 (lower in Figures 2-4) and a series of side perimeter walls (four in Figure 2) that are approximately orthogonal to the base wall 15. In the example illustrated, two walls 16 are parallel to the axis A and two walls 18 are orthogonal to the axis A.

[0024] The dehumidifier apparatus 3 comprises two openings 7 and 8 (or two mouths): an inlet one and an outlet one, that are formed on the boxed casing 5. The dehumidifier apparatus 3 also comprises a duct 6, which is formed inside the boxed casing 5 and extends longitudinally between the inlet opening 7 and the outlet opening 8. The duct 6 is designed to be traversed, in use, by an air flow K1 along a direction D1.

[0025] The inlet opening 7 can be configured so as to be connected to a pipe of the ventilation system 4 to suck in the air to be dehumidified that is present in the indoor room. The outlet opening 8 can be configured so as to be connected to another pipe of the ventilation system 4 to provide the dehumidified air to the indoor room.

[0026] The dehumidifier apparatus 3 comprises, in addition, a fan device 9, which is arranged in the boxed casing 5 inside the duct 6. The fan device 9 is configured so as to suck in the air from the inlet opening 7, generate the air flow K1 in the duct 6 along the direction D1, and expel the dehumidified air through the outlet opening 8.

[0027] According to an embodiment illustrated in Figures 2 and 3, the fan device 9 can, preferably, be arranged in a section of the duct 6 adjacent to the outlet opening 8.

[0028] With reference to Figure 2, the dehumidifier apparatus 3 also comprises a dehumidifier apparatus

10, which is housed in the boxed casing 5 inside the duct 6 so as to be crossed by the air flow K1. The dehumidifier device 10 is preferably arranged in the duct 6 upstream of the fan device 9.

[0029] The dehumidifier device 10 preferably comprises: an evaporator 11, a condenser 12 (schematically shown in Figure 2), and a compressor 13 communicating between them by means of the pipes of a refrigerating circuit in which a refrigerant fluid circulates. As shown in Figure 2, the condenser 12 is preferably arranged in the duct 6 downstream of the evaporator 11 along the direction D1.

[0030] With reference to Figure 2, the dehumidifier apparatus 3 also comprises a heat exchanger module 19 that is arranged in the boxed casing 5 inside the duct 6 and is designed to be hydraulically connected by means of the connectors 2d to the two pipes 2c of the radiant system 2 to receive the refrigerant fluid F1. The heat exchanger module 19 is configured so as to carry out a heat exchange between the refrigerant fluid F1 and the air flow K1.

[0031] The evaporator 11 and the condenser 12 preferably, respectively comprise an evaporator assembly and a condenser assembly. Conveniently, the heat exchanger module 19 may comprise an exchanger assembly. The evaporator assembly, the condenser assembly, and the exchanger assembly may preferably be arranged adjacent to each other (packed) so as to form a compact pack structure with reduced dimensions. In the embodiment shown in Figure 2, the evaporator assembly, the condenser assembly, and the exchanger assembly are arranged inside a shared casing.

[0032] With reference to Figures 2-4, the boxed casing 5 comprises a single body (single block) produced by means of injection molding of a thermoplastic polymeric material. The thermoplastic polymeric material may preferably comprise, as desired: polypropylene, expanded propylene, or polyethylene.

[0033] A technical result of the boxed casing produced by means of molding a thermoplastic polymeric material is that of simplifying the production of the casing and, thus, reducing its costs. Both the sheets and their manual assembly are actually eliminated.

[0034] An additional technical result is that of eliminating the presence of thermal bridges and increasing the level of thermal insulation.

[0035] An additional technical result consists in reducing the weight of the dehumidifier apparatus and, therefore, simplifying its installation/removal, including in the niches formed on false ceilings and/or technical spaces and/or similar ones, while also improving the safety of the installers since they are not exposed to the risk of being injured by the edges/sides of the metal sheets.

[0036] An additional technical result consists in reducing the environmental impact, since the polymer material is easily recycled.

[0037] An additional technical result consists, on the one hand, in eliminating from the casing the need to use

the gaskets commonly used in known casings to reduce air leakages. The use of a single body made of thermoplastic polymeric material actually makes it possible to basically entirely reduce any issue with air leaking out through the casing, both inside/outside the casing and within the casing itself, among various ducts/spaces.

[0038] An additional technical effect consists in increasing the sound-proofing of the dehumidifier apparatus with all the benefits that entails for users of the thermal system 1.

[0039] It is understood that the dehumidifier apparatus 3 comprises a plate-like cover (not illustrated) removably (separably) coupled to the boxed casing 5.

[0040] With reference to Figure 3, a through opening 20 is formed on the base wall 15, arranged below the dehumidifier device 10.

[0041] With reference to the embodiment shown in Figures 3, 5, and 6, the boxed casing 5 also comprises a cover 21 that is stably coupled to, but easily removable (separable) from, the base wall 15 so as to close the opening 20. The cover 21 may, conveniently, be plate-like and have a flat lower surface 21a coplanar with the base wall 15. The cover 21 is made by means of molding a thermoplastic polymeric material. The through opening 20 is conveniently sized so as to allow the maintenance of the dehumidifier device 10 inside the boxed casing 5.

[0042] A technical result thanks to this feature consists in allowing maintenance workers to carry out maintenance on the dehumidifier device 10 by removing the lower cover 21.

[0043] As shown in the embodiment in Figure 6, the cover 21 has an inner surface 21b facing the duct 6 and opposite the outer surface 21a, which is arranged facing, and below, the dehumidifier device 10 and is shaped so as to form a basin 22 configured so as to collect the water that is condensed by the dehumidifier device 10.

[0044] A technical result thanks to the production of the basin 22 on the cover 21 consists in allowing maintenance workers to act simply and quickly when maintaining the condensation collection system or when, for example, a blockage occurs in the drain opening 22b, without needing to separate the whole dehumidifier apparatus from the wall to which it is connected so as to reduce maintenance times and costs.

[0045] Conveniently, the basin 22 comprises: a back wall 22a on which a drain opening 22b for the condensed water is formed. The back wall 22a is shaped so that it is tilted centrally towards the drain opening 22b. The basin 22 also comprises a drain syphon 23 (Figure 3) that is connected to said drain opening 22b and is arranged below the lower surface 21a. The drain syphon 23 may be conveniently produced by means of the injection molding of the thermoplastic polymeric material.

[0046] A technical result thanks to the tilted back wall 22a and the presence of the syphon 23 consists in simplifying the installation of the dehumidifier apparatus. The installer does not have to worry about calculating the inclination needed to drain the water and creating the

syphon. In addition, the removable basin 22 allows the maintenance worker to clean the drain of the basin 22b in the event of obstructions or during maintenance very quickly, thus simplifying the cleaning of the machine and reducing ordinary maintenance times.

[0047] According to a convenient embodiment shown in Figures 2 and 3, the fan device 9 may be centrifugal and comprise an impeller 9a (fan) designed to rotate around an axis rotated by an electric motor (not illustrated), and a volute 9b that houses the impeller 9a inside.

[0048] According to a preferred embodiment shown in Figure 3, the volute 9b is shaped so as to comprise, above, a cup-shaped body that houses the impeller 9a inside and, below, a plate-like base. The base of the volute 9b is shaped so as to close a through opening 24 formed on the base wall 15. The through opening 24 has a complementary shape to the plate-like base of the volute 9b and is sized so as to allow the insertion and extraction of the volute 9b in the/from the duct 6. The plate-like base of the volute 9b is stably coupled to the base wall 15 but is easy to remove (separate).

[0049] Conveniently, the volute 9b is produced by means of injection molding of said thermoplastic polymeric material.

[0050] A technical result thanks to the production of the volute 9b in the above-mentioned way consists in reducing the costs of producing the dehumidifier apparatus 3.

[0051] Another technical result thanks to the production of the volute 9b in the above-mentioned way consists in allowing maintenance workers to act simply and quickly if the fan device 9 malfunctions since they can extract it from the boxed casing 5 and reinsert it in this casing without needing to remove access panels to access the fan, thus reducing maintenance times and costs.

[0052] According to a preferred embodiment shown in Figures 2 and 3, the dehumidifier apparatus 3 comprises, in addition, a filtering module 26 that is arranged in the duct 6 and is structured so as to filter the air sucked in from the room. Conveniently, the filtering module 26 may be arranged in a section of the duct 6 in a position adjacent to the inlet opening 7. Conveniently, a through opening 25 is formed on the base wall 15 below filtering module 26. The through opening 25 is conveniently sized so as to allow the insertion/extraction of the filtering module 26 in the/from the duct 6 of the boxed casing 5 through the opening 25 itself.

[0053] With reference to the embodiment shown in Figure 3, the boxed casing 5 also comprises a plate-like cover 28 that is stably coupled to, but easily removable (separable) from, the base wall 15 so as to close the opening 25. The cover 28 may be, conveniently, flat and plate-like and have a flat lower (outer) surface that is coplanar to the lower surface of the base wall 15. The cover 28 is, conveniently, made by means of injection molding of a thermoplastic polymeric material.

[0054] One technical result consists in allowing the maintenance workers to act simply and quickly if the filtering module 26 malfunctions since they can extract

it easily from the boxed casing 5.

[0055] The method for producing the dehumidifier apparatus 3 described above involves the step of creating the boxed casing 5 that has the features described above by means of injection molding of the thermoplastic polymeric material. The method also comprises the steps of creating the cover 21 by means of injection molding of the thermoplastic polymeric material. The method also comprises the steps of creating the volute 9b by means of injection molding of the thermoplastic polymeric material. The method also comprises the steps of creating the cover 28 by means of injection molding using the thermoplastic polymeric material.

[0056] The method also comprises the step of assembling the fan device 9 by mounting the impeller 9a in the volute 9b and mechanically connecting (for example using screws) the fan device 9 in the duct 6 of the boxed casing 5 so as to arrange its plate-like base in the through opening 24 so as to close it.

[0057] The method also comprises the step of mechanically connecting the dehumidifier device 10 to the boxed casing 5 in the duct 6 above the opening 20 and fastening the cover 21 to the base wall 15 so as to close the opening 20 so as to position the basin 22 and the drain syphon 23 below the dehumidifier device 10. The method also comprises the step of mechanically connecting the filtering module 26 to the boxed casing 5, positioning it in the duct 6 above the opening 25, and coupling the cover 28 to the base wall 15 so as to close the opening 25.

[0058] The method also comprises the step of mechanically fastening the compressor 13 to a cover above (not illustrated) the casing 5.

[0059] The benefits of the dehumidifier apparatus 3 described above are at least the following: the production of the boxed casing is simplified and, thus, the related costs reduced; the presence of thermal bridges is eliminated and the degree of thermal insulation of the boxed casing is increased; the weight of the dehumidifier apparatus is reduced and its installation and removal are simplified; the environmental impact is reduced since the polymer material is easily recycled; the sound-proofing of the dehumidifier apparatus is improved. The solution also makes it possible to reduce air leakages both inside and outside.

[0060] The embodiment shown in Figures 7-12 relates to a dehumidifier apparatus 30, which is similar to the dehumidifier apparatus 3, and whose parts will be identified, where possible, with the same reference numbers that identify corresponding parts of the dehumidifier apparatus 3.

[0061] As shown in Figures 7-14, the dehumidifier apparatus 30 differs from the dehumidifier apparatus 3 in that it comprises five openings (or five mouths) formed in the boxed casing 5. Conveniently, two openings may be formed on one side (for example, the front) and three openings may be formed on an opposite side (for example, the rear).

[0062] The dehumidifier apparatus 30 also differs from

the dehumidifier apparatus 3 in that it is configured so as to selectively operate in various operating modes, comprising: an air recirculation operating mode, an air replacement operating mode, and a combined recirculation and air replacement operating mode.

[0063] The polypropylene construction of the boxed casing with five openings advantageously makes it possible to perform, with a single device, a series of functions, as a heat recovery device and dehumidifier, while maintaining the possibility of treating the air with functions like dehumidification, heating, cooling, or ventilation, eliminating leaks, reducing noise, and all the advantages deriving from the polypropylene construction, etc.

[0064] With reference to Figures 7-14, the dehumidifier apparatus 30 comprises:

a duct 31 extending longitudinally within the boxed casing 5 between an inlet opening 32 and an outlet opening 33 and configured, in use, to be traversed by an air flow K2,

a fan device 36 that is arranged in the boxed casing 5 inside a section of the duct 31 positioned at the outlet opening 33 and configured to generate the air flow K2; the fan device 36 conveniently has a volute 36a and an impeller 36b wherein the volute 36a (Figure 9) is conveniently produced using injection molding of a thermoplastic polymeric material,

a gate 34 that is arranged in an air intake section of the duct 6 at the inlet opening 7 and is configured to operate between a closed position (Figure 12) in which it closes the duct 6 and, alternately, an open position (Figure 11) in which it opens the duct 6, and vice versa,

a gate 35 that is arranged immediately upstream of the section of the duct 31 comprised between the fan device 36 and the outlet opening 33 and is configured to operate between a closed position (Figure 12) in which it closes the duct 31 and, alternately, an open position (Figure 11) in which it opens the duct 31, and vice versa,

a heat recovery device 37 that is arranged inside a heat exchange chamber 38 that is formed in the boxed casing 5 so as to be in communication with the first duct 6 and the second duct 31; the heat recovery device 37 is configured so as to be traversed transversely by the air flows K1 and K2, preferably in opposite directions, and transfer heat from the air flow K2 to the air flow K1; the heat recovery device 37 is preferably arranged upstream of the dehumidifier device 10,

a duct 39 that extends inside the boxed casing 5 between an inlet opening 40 to receive an air flow K3 and the end section of the duct 6 so as to traverse the dehumidifier device 10 downstream of the heat recovery device 37.

[0065] As shown in Figure 10, the dehumidifier appa-

ratus 30 also differs from the dehumidifier apparatus 3 in that, on the base wall 15, a through opening 41 is formed arranged at the heat exchange chamber 38 below the heat recovery device 37. The through opening 41 is conveniently sized so as to allow the insertion/extraction of the heat recovery device 37 in the heat exchange chamber 38 through the opening 41 itself.

[0066] A technical result thanks to this feature consists in allowing maintenance workers to carry out maintenance on the heat recovery device 37 by extracting it from the boxed casing 5, without separating the whole dehumidifier apparatus from the wall.

[0067] With reference to the embodiment shown in Figure 10, the boxed casing 5 also comprises a cover 42 that is stably coupled to, but easily removable (separable) from, the base wall 15 so as to close the opening 41. The cover 41 may be, conveniently, plate-like and have a flat lower surface coplanar to the lower surface of the base wall 15.

[0068] With reference to Figures 11 and 12, the gate 35 is structured so as to be brought into the open position (Figure 11) when the fan device 36 is activated, or in response to the air flow K2 (depression) generated by the fan device 36, and into the closed position (Figure 12) in response to the action of gravity, when the fan device 36 is deactivated, or in the absence of the air flow K2 (absence of depression).

[0069] The gate 34 is coupled to the gate 35 using a connection mechanism that is configured so as to:

transmit to the gate 34 the movement performed by the gate 35 to be brought from the open position to the closed position caused by gravity so as to ensure that the gate 34 is brought from the open position to the corresponding closed position, and, alternatively, transmit to the gate 34 the movement performed by the gate 35 to be brought from the closed position to the open position in response to the activation of the fan device 36 so as to ensure that the gate 34 is brought from the closed position to the corresponding open position.

[0070] According to one embodiment shown in Figures 11 and 12, the gates 34 and 35 have multiple plate-like elements 34a and, respectively, 35a that are hinged on the side on two inner walls of the boxed casing 5 so as to be arranged in pairs next to each other and to swivel around the respective rotation axes Ci (i ranging between 1 and n).

[0071] The plate-like elements 35a of the gate 35 are axially connected by means of connection mechanisms 37 to corresponding plate-like elements 34a of the gate 34 arranged to the side, so that the rotation of the plate-like elements 35a around the corresponding rotation axes Ci causes the rotation of the respective plate-like elements 34a of the gate 34 around the rotation axes Ci.

[0072] In the example illustrated in Figures 11 and 12, a

connection mechanism 37 preferably comprises a connection shaft or rod that extends along the rotation axis of the plate-like elements 34a and 35a and is structured so as to angularly connect a plate-like element 34a with a plate-like element 35a.

[0073] In the example illustrated in Figures 11 and 12, the rotation of the plate-like elements 35a of the gate 35 around the corresponding rotation axes conveniently rotates the corresponding plate-like elements 34a of the gate 34 around the corresponding rotation axes Ci.

[0074] Conveniently, in use, the rotation of the plate-like elements 35a of the gate 35 around the corresponding rotation axes Ci rotates the corresponding plate-like elements 34a of the gate 34 around the corresponding rotation axes Ci from the open position (shown in Figure 11) to the closed position (Figure 12) when the fan device 36 is switched off. In this state, the plate-like elements 35a of the gate 35 not being kept open by the air flow of the fan device 36 are rotated thanks to the force of gravity downwards, closing the opening 33. The rotation of the plate-like elements 35a rotates the plate-like elements 34a in the closed position, closing the opening 7.

[0075] The technical result is that of simplifying the drive opening/closing system of the gates 34 and 35 since, on the one hand, any actuator/electric motor is conveniently eliminated and, on the other hand, only the fan device 36 is used that, instead of the force of gravity, selectively opens/closes the gates 34 and 35.

[0076] Figure 13 schematically shows the dehumidifier apparatus 30 operating in the air recirculation operating mode during which only air in a room is treated (dehumidified, heated, cooled, or fanned) without replacing or exchanging it with the air present outside the room (outer air). In this operation mode, the fan 9 is activated while the dehumidifier 10 can be activated or deactivated in a controlled way based on reaching the temperature and/or humidity values that the user requests. In this operation mode, the gate of the duct 39 is open. The air enters via the inlet 40, passes through the battery pack 11, and leaves via the outlet 8.

[0077] Figure 9 schematically shows the dehumidifier apparatus 30 that operates in the air replacement operating mode in order to renew/replace the air present in the room, recovering the heat present in all seasons irrespective of the operation of the unit (dehumidify, heat, cool, or fan).

[0078] During the air replacement operating mode, the dehumidifier apparatus 30 activates the fan 9 and the other fan 36. In this step, the movement of the gates 34 and 35 is automatically, and conveniently, adjusted by the fan 36. In this mode, the dehumidifier 10 can be activated or deactivated in a controlled way as a function of reaching the temperature and/or humidity values that the user requests.

[0079] Figure 14 schematically shows the dehumidifier apparatus 30 that operates in the replacement or recirculation operating mode to renew/replace the air present in the room recovering the heat.

[0080] During the replacement or recirculation operating mode the fan 9 is activated, the other fan 36 is activated, the gate of the duct 39 is open, the gates 34 and 35 are automatically adjusted by the fan 36, while the dehumidifier 10 is activated or deactivated based on reaching the temperature and/or humidity values that the user requests.

Claims

1. A dehumidifier apparatus (3) for radiant systems (2), the dehumidifier apparatus (3) is configured in order to be hydraulically connected to a radiant system (2) installed in at least one indoor room of a building, and is configured to dehumidify the air present in at least said room, the dehumidifier apparatus (3) comprises:

- a box-shaped casing (5) comprising a base wall (15), a plurality of side perimeter walls, and an upper opening configured to be closed by a cover,
- five openings that are made in the box-shaped casing (5), where two openings are made in a first side, and three openings are made in an opposite side,
- a first channel (6) that extends within said box-shaped casing (5) between a first inlet opening (7) and a first outlet opening (8) and is configured to be traversed by a first flow of air (K1),
- at least one first fan device (9) which is arranged in said box-shaped casing (5) within said first channel (6) and is configured to generate at least said first air flow (K1) in said first channel (6) along a first direction (D1) between said first inlet opening (7) and said first outlet opening (8),
- a dehumidifier device (10) which is arranged in said box-shaped casing (5) within said first channel (6) in order to be traversed at least of said first air flow (K1) and comprises an evaporator (11), a condenser (12) and a compressor (13),
- a heat exchanger module (19) which is configured to be hydraulically connected to said radiant system (2) in order to be traversed by the carrier fluid circulating in said radiant system (2) and is arranged in said box-shaped casing (5) within said first channel (6) so as to perform a thermal exchange between said vector fluid circulating in said radiant system (2) and said first air flow (K1).

2. A dehumidifier apparatus according to claim 1, configured to selectively operate in three operating modes comprising: an air recirculation operating mode, an air exchange operating mode, and a combined recirculation and air exchange operating

mode.

3. A dehumidifier apparatus according to claims 1 or 2, wherein a first through opening (20) is provided on said base wall (15) which is arranged below said dehumidifier device (10). 5
4. A dehumidifier apparatus according to claim 3, wherein said box-shaped casing (5) comprises a first lower cover (21) which is stably but easily removable coupled to the base wall (15) in order to close said first opening (20) and is formed of a tiled body made by moulding by means of a thermoplastic polymeric material. 10
5. A dehumidifier apparatus according to claim 4, wherein said first cover (21) has an inner surface which is arranged facing, and below, said dehumidifier device (10) and is shaped so as to form a condensate containment basin (22) configured to collect the water condensed by said dehumidifier device (10). 20
6. A dehumidifier apparatus according to claim 5, wherein said basin (22) is shaped in order to comprise a back wall on which a drain opening is provided for discharging water outside said dehumidifier apparatus (3), inner perimeter walls inclined towards said drain opening (22b) so as to discharge the water collected in said basin (22) towards said drain opening, and a drain trap which is hydraulically connected to said drain opening (22b). 25 30
7. A dehumidifier apparatus according to any one of the preceding claims, comprising at least a second channel (31) extending within said boxed casing (5) between a second inlet opening (32) and a second outlet opening (33) and being configured to be traversed by a second air stream (K2). 35 40
8. A dehumidifier apparatus according to claim 7, comprising: a heat recovery device (37) which is arranged within a heat exchange chamber (38) formed in said box-shaped casing (5) and is in communication with said first (6) and second channels (31). 45
9. A dehumidifier apparatus according to claim 8, wherein the heat recovery device (37) is configured to transfer heat from said second air stream (K2) to said first air stream (K1); and wherein on said base wall (15) a third through opening (41) is arranged at a position of said heat exchange chamber (38) below said heat recovery device (37). 50
10. A dehumidifier apparatus according to claim 9, wherein said third opening (41) is dimensioned to allow insertion/extraction of the heat recovery device (37) in the heat exchange chamber (38) through the 55

third through opening (41).

11. A dehumidifier apparatus according to claim 10 comprising a second cover (42) configured to be stably but easily removable coupled to said base wall (15) in order to close the third through opening (41).
12. A dehumidifier apparatus according to any one of the preceding claims wherein said box-shaped housing (5) comprises a single body made by injection moulding of a thermoplastic polymeric material.
13. A dehumidifier apparatus according to claim 12, wherein the thermoplastic polymeric material optionally comprises: polypropylene, expanded propylene or polyethylene.
14. A thermal system that is installed in a room of a building and comprises a radiant system (2) and a dehumidifier apparatus (3) that is connected to the radiant system (2) and is made according to any one of claims 1 to 13.

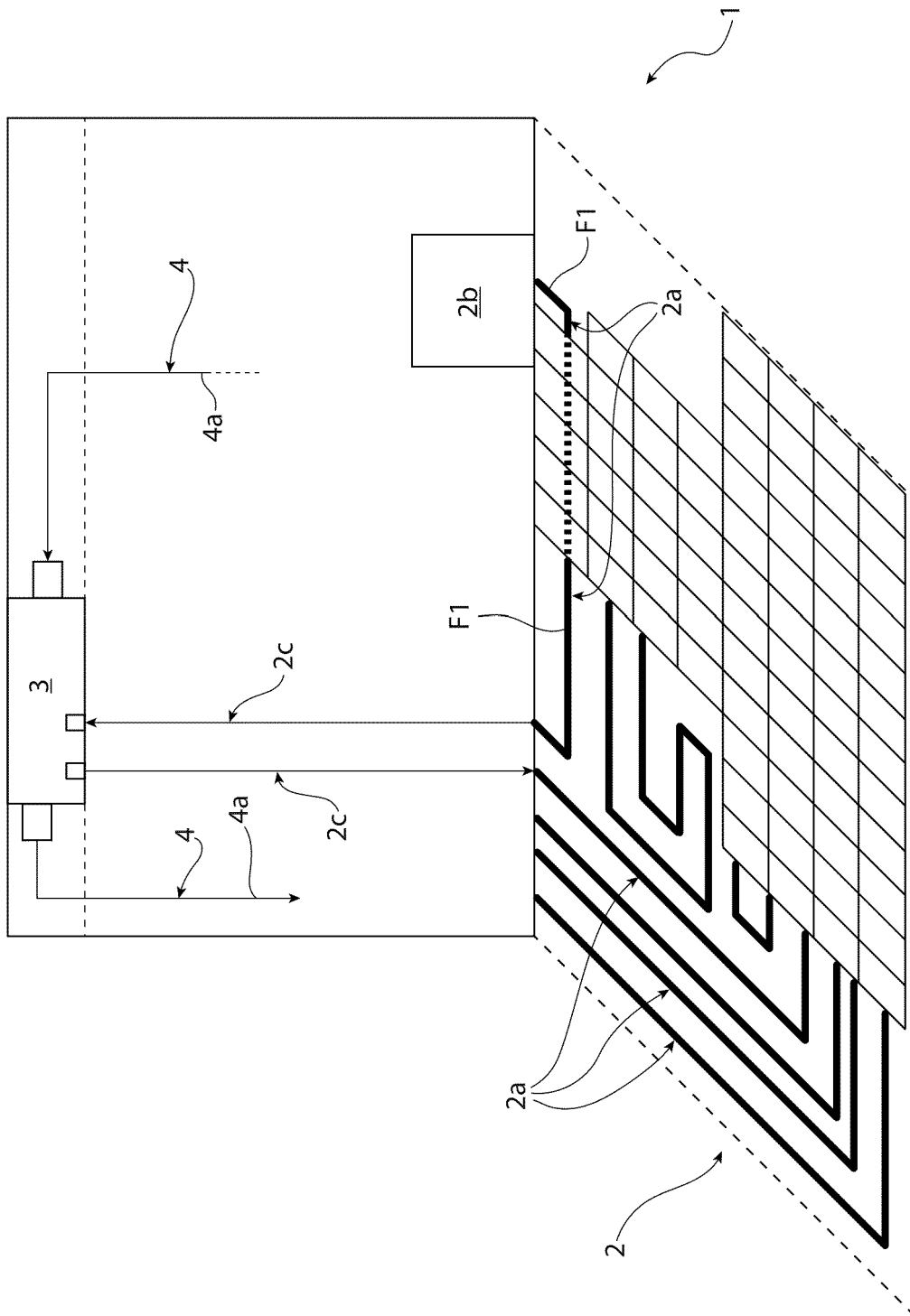


FIG. 1

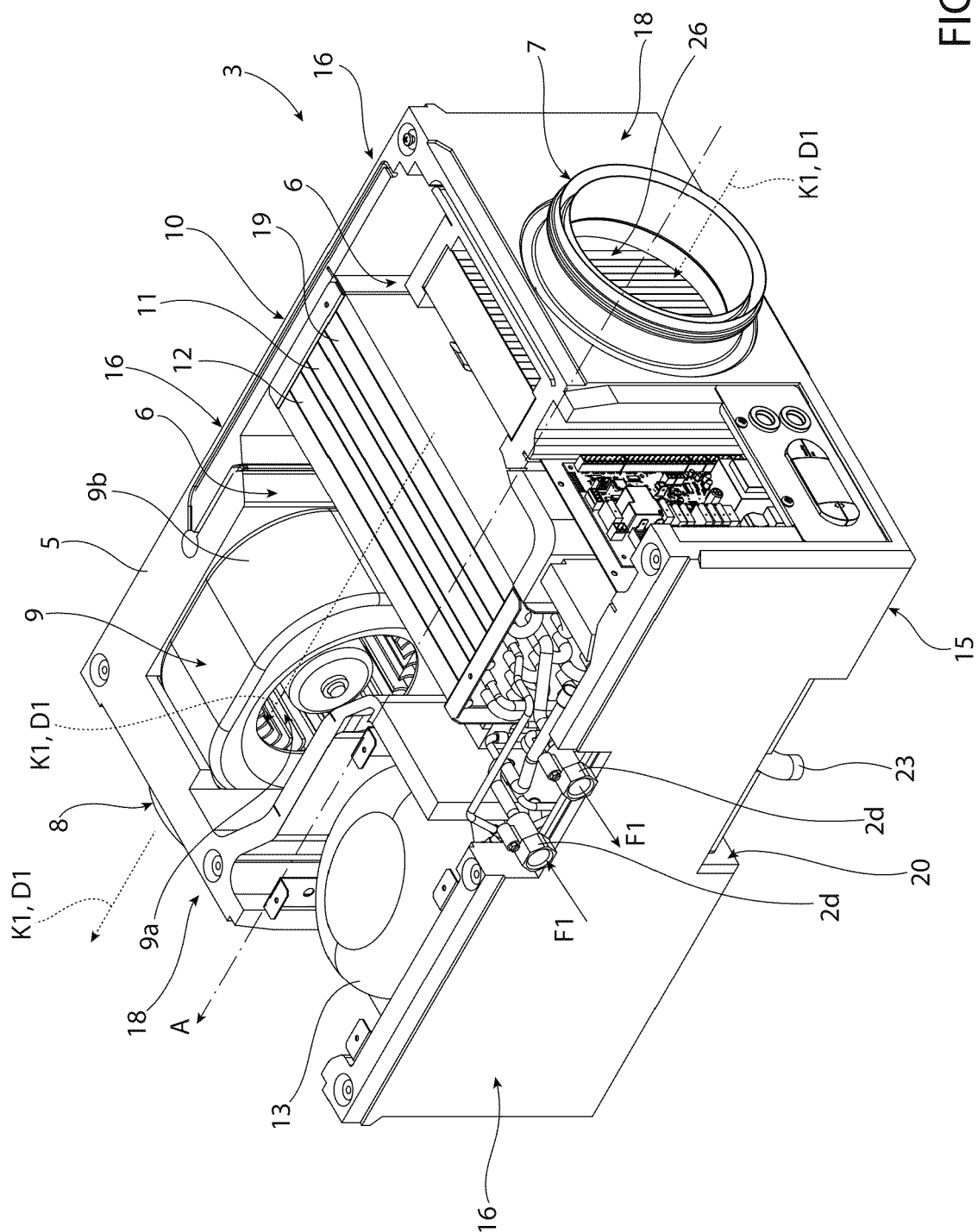


FIG. 2

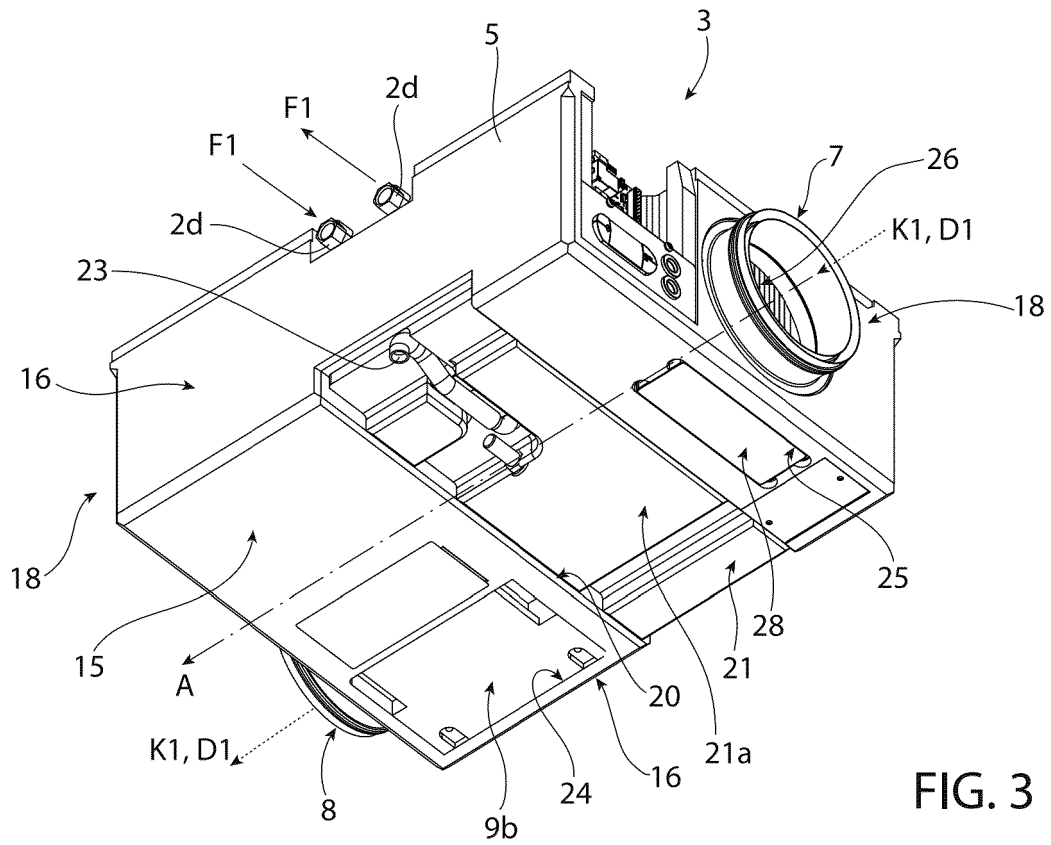


FIG. 3

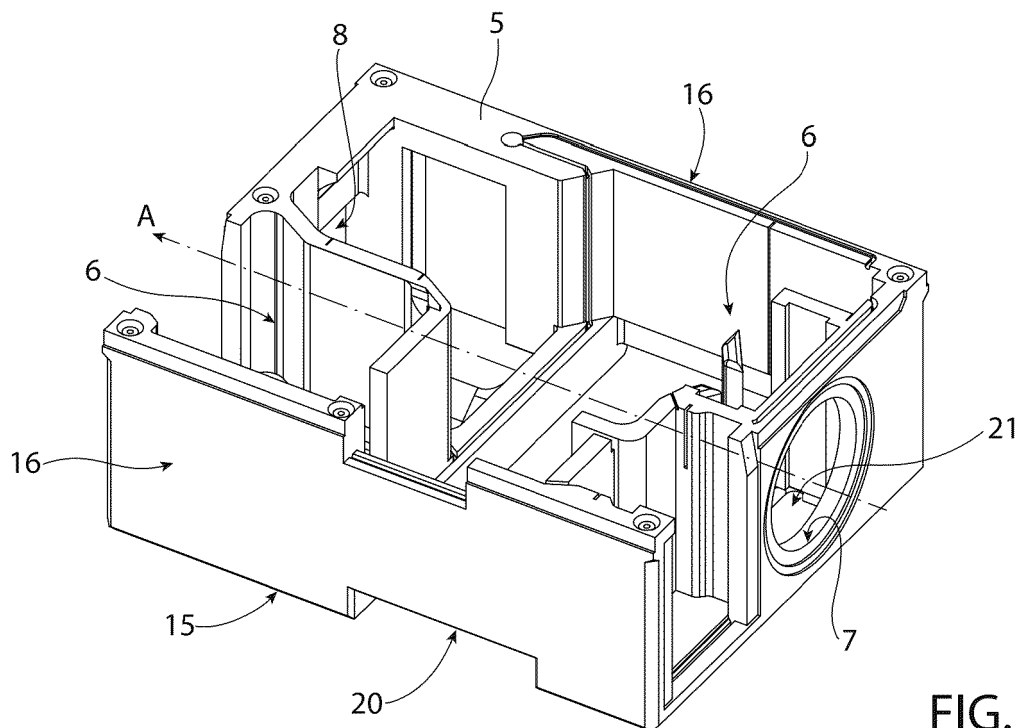
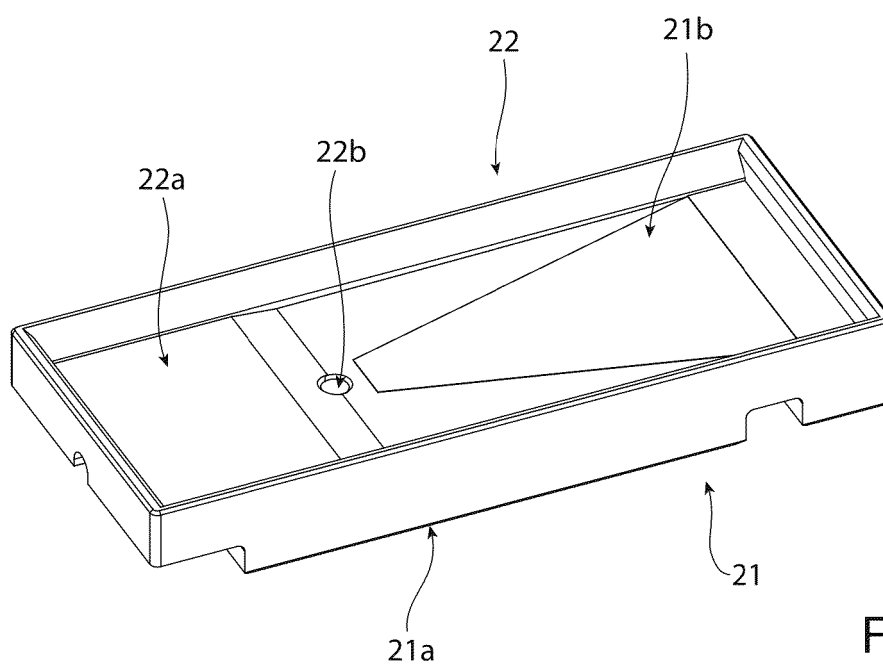
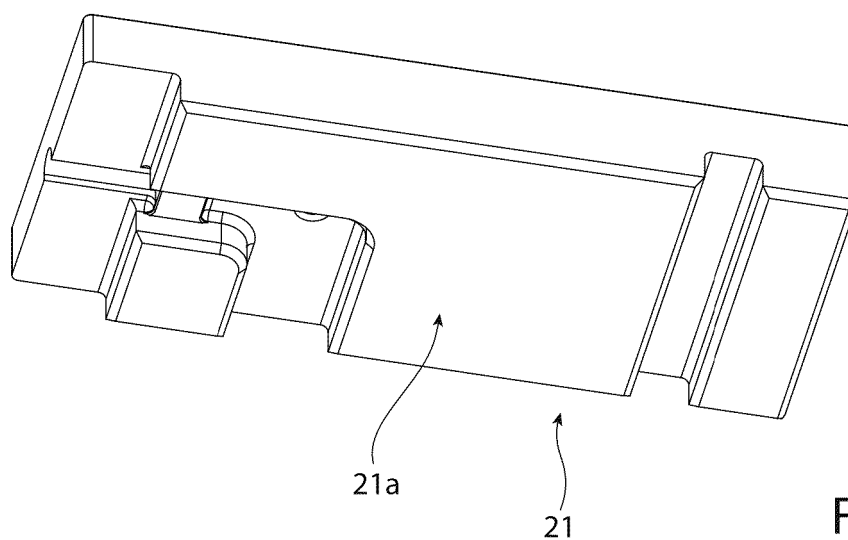


FIG. 4



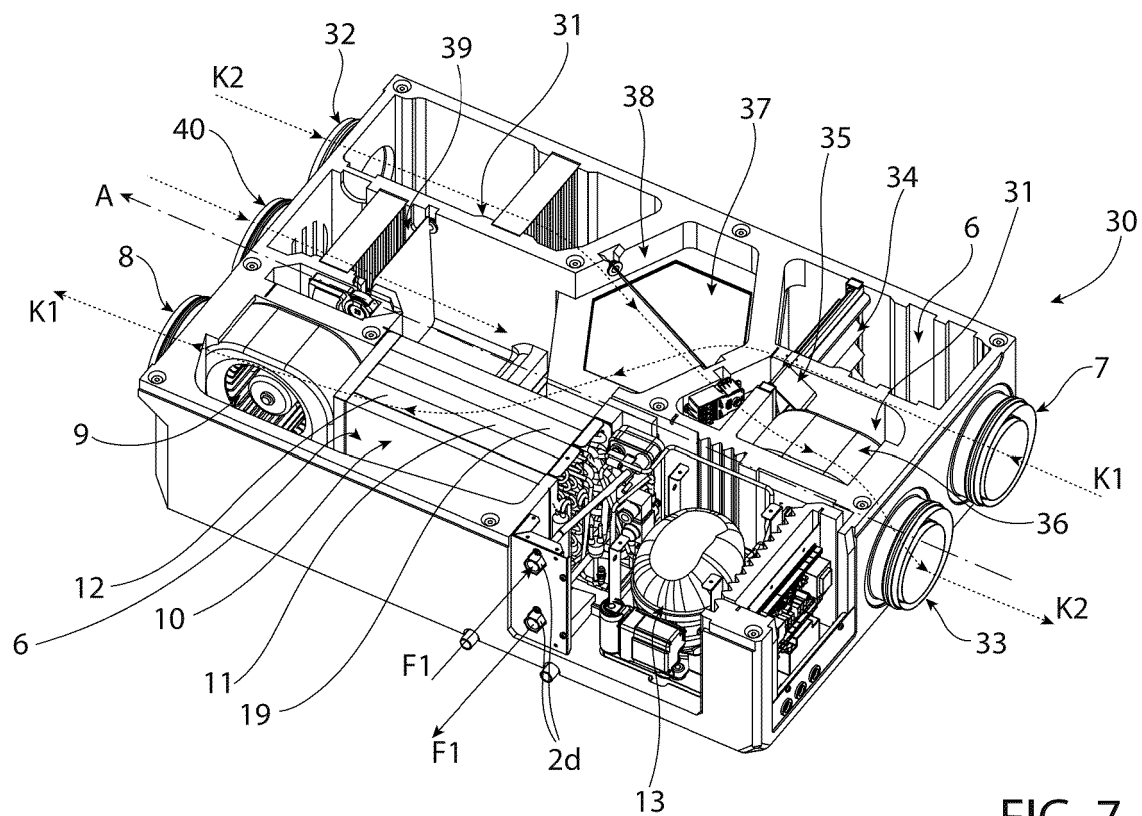


FIG. 7

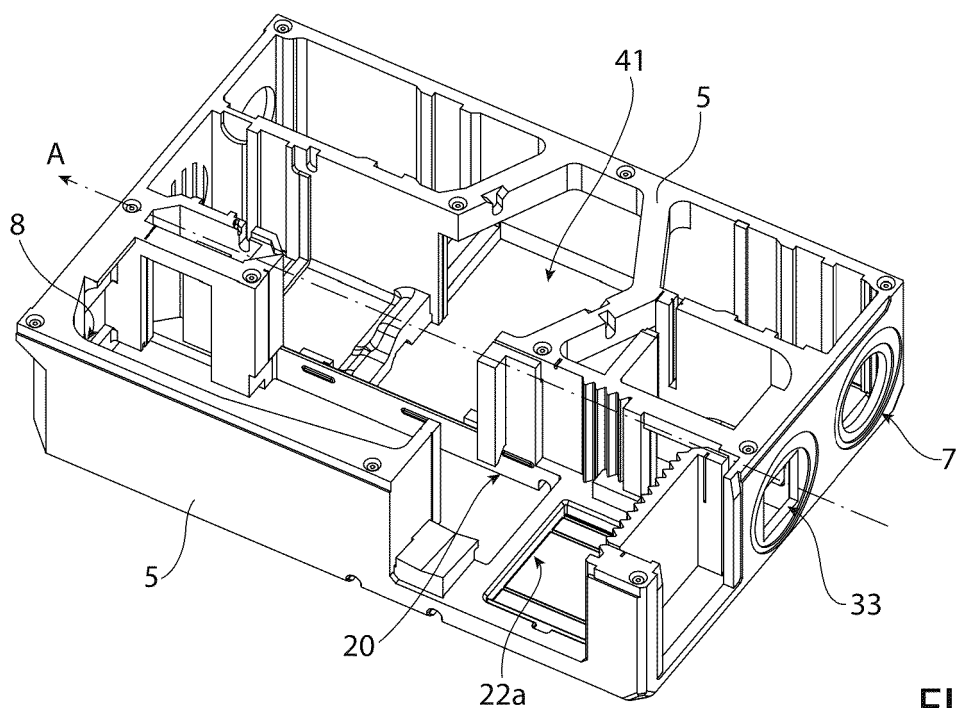
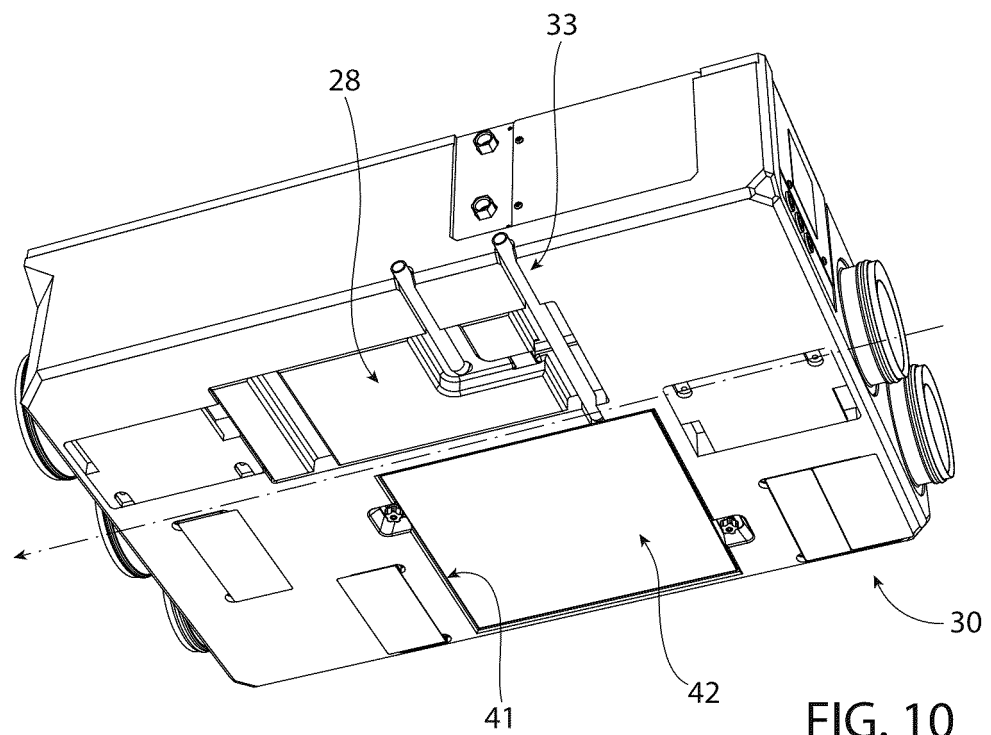
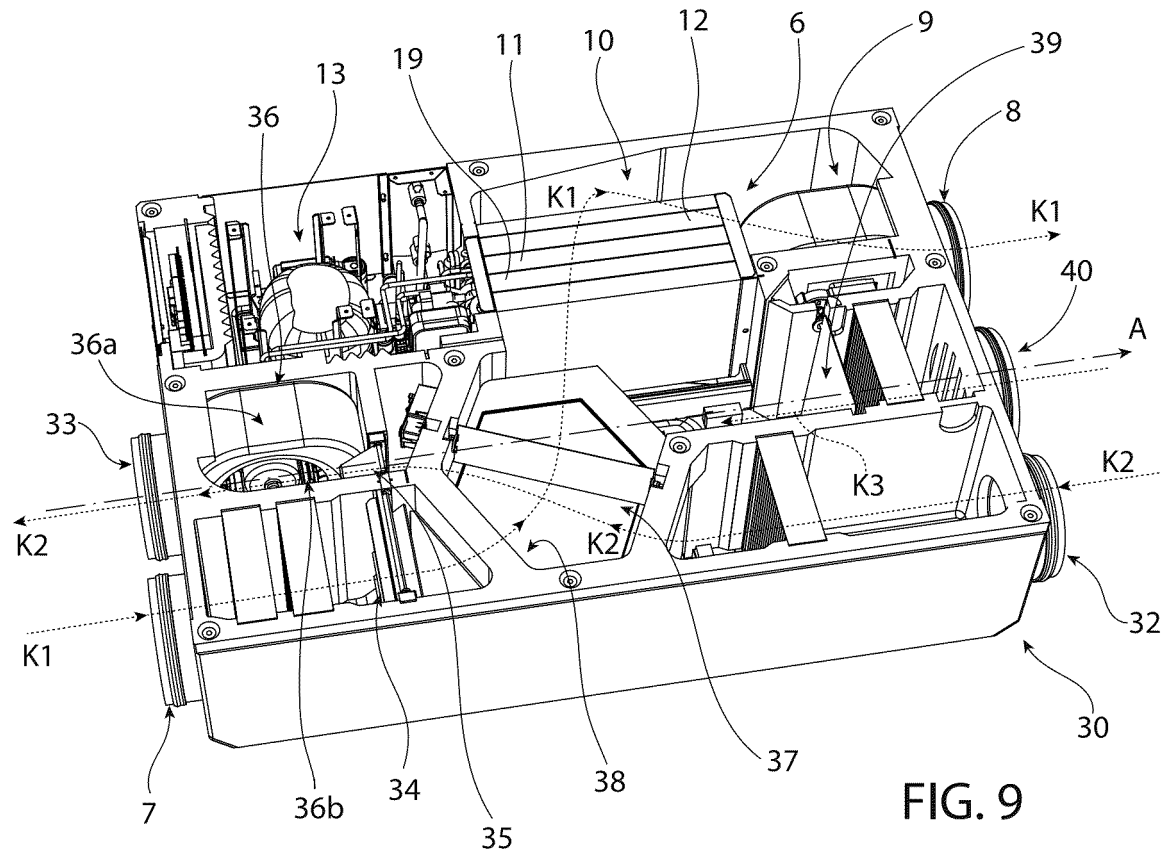


FIG. 8



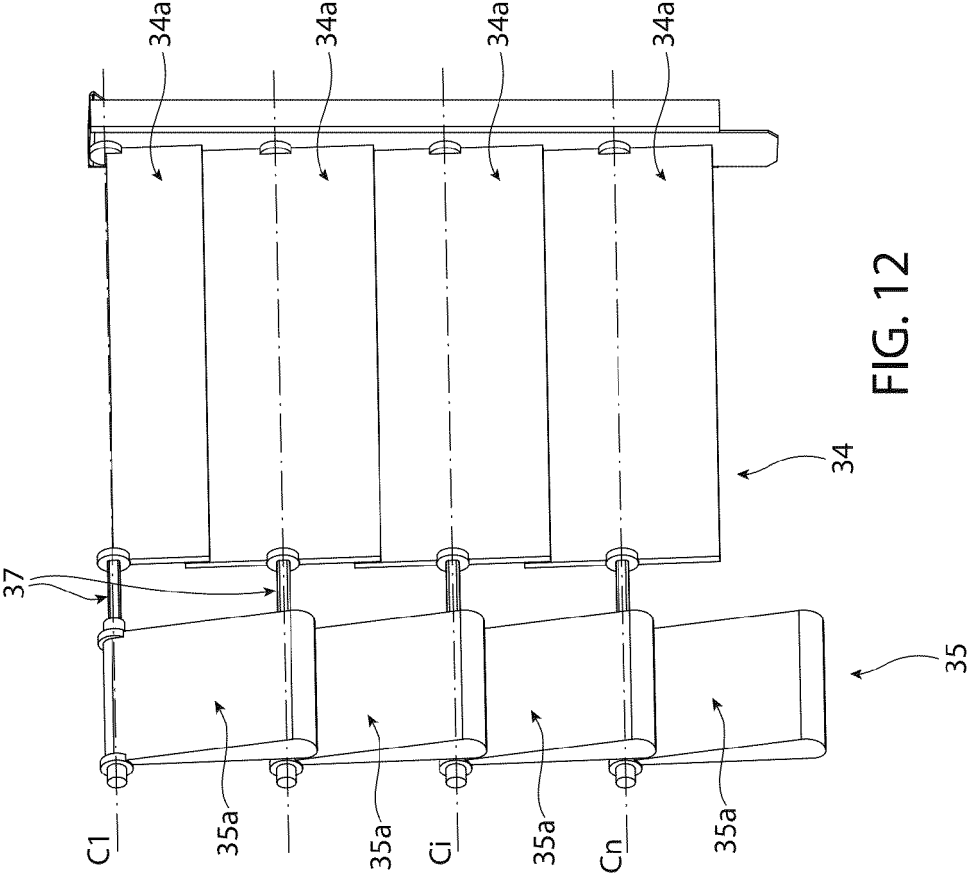


FIG. 12

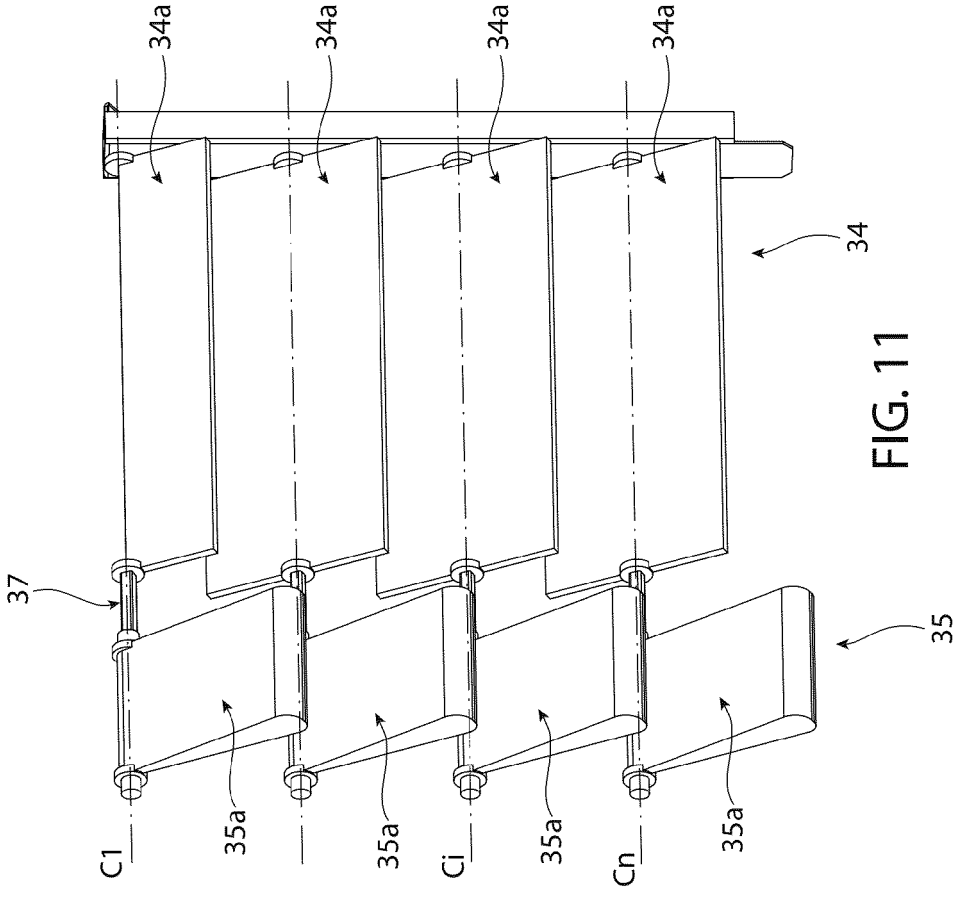
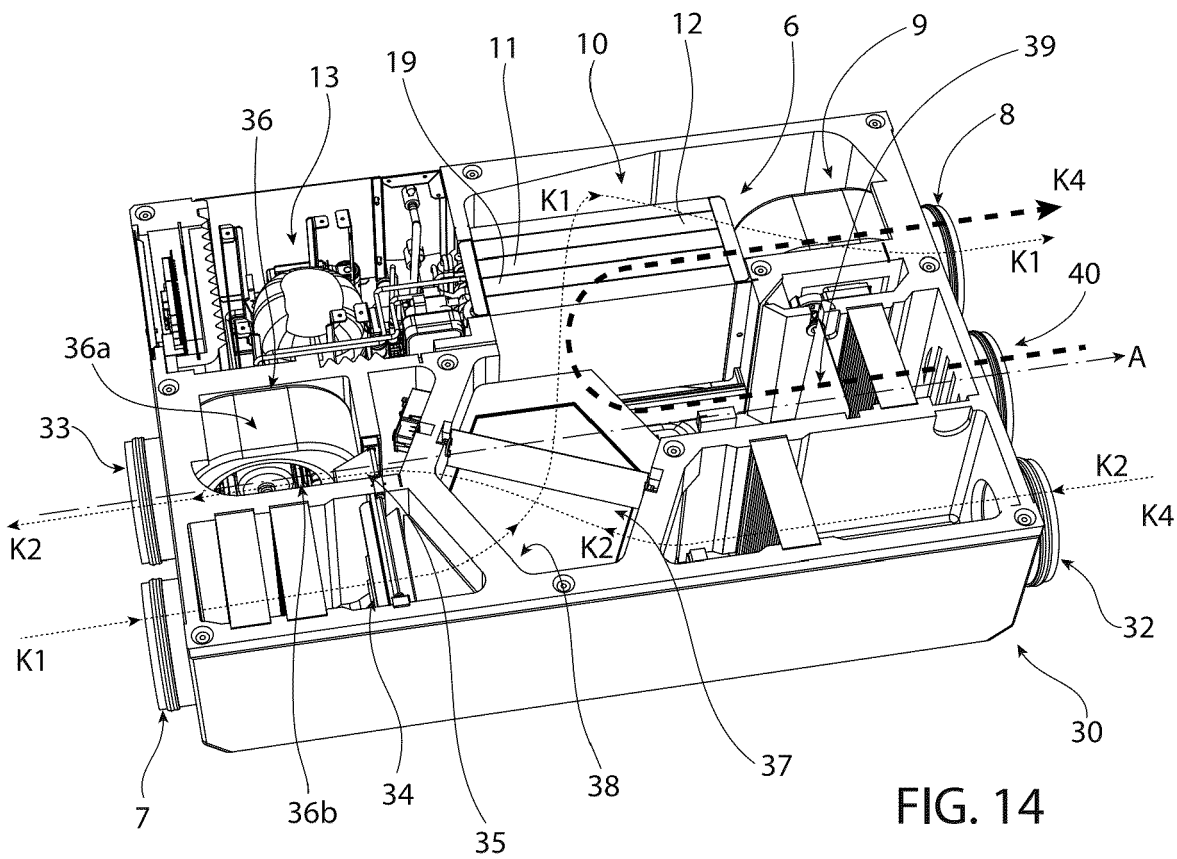
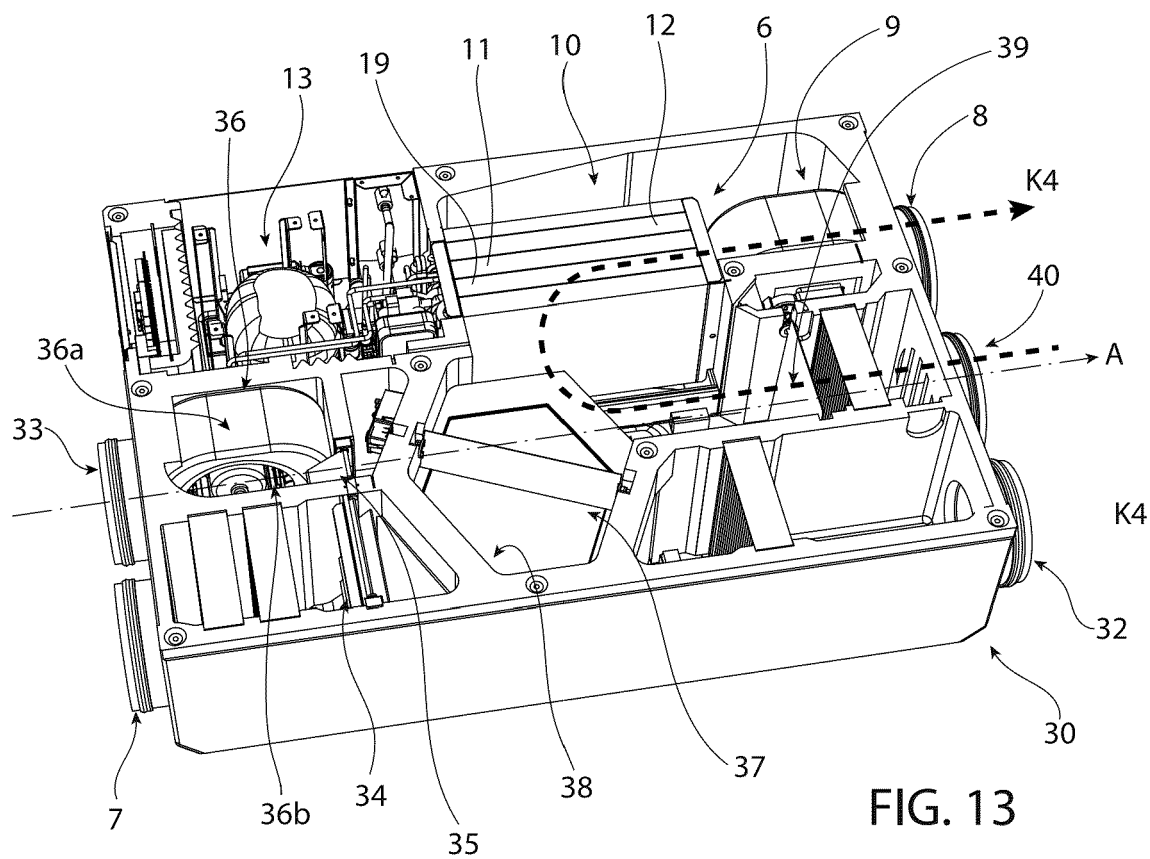


FIG. 11



REFERENCES CITED IN THE DESCRIPTION

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