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(54) **AIR CONDITIONING SYSTEM**

(57) A device (20) for the thermal conditioning of an indoor environment (2), which may be used in combination with a CMV apparatus, comprises an inner compartment (24) connectable to an inlet duct (8) for an incoming air flow (Q_{in}), an additional mouth (28) in communication with the inner compartment (24) for the entry from the indoor environment (2) of an additional air flow (Q'_{in}), a shutter assembly (30) electrically operable to open or close the additional mouth (28), an outlet mouth (40) connected to the inner compartment (24) for feeding into the indoor environment (2) a total air flow (Q_{tot}) consisting of the incoming flow (Q_{in}) and the additional flow (Q'_{in}), a nozzle assembly (50) configured to receive the incoming flow (Q_{in}) at low speed, accelerate it and feed it at high speed into the inner compartment (24) to draw the additional flow (Q'_{in}) back into the inner compartment (24) through the additional mouth (28), and an exchanger (70) located between the additional mouth (28) and the outlet mouth (40) to thermally condition the total flow (Q_{tot}) that hits it before exiting the outlet mouth (40).

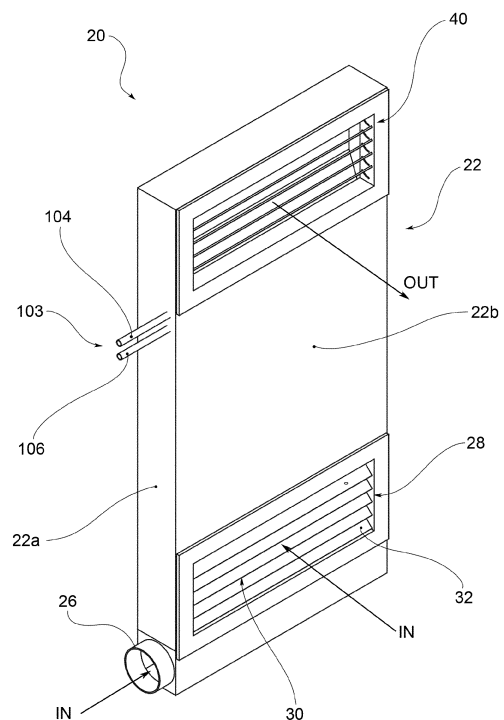


FIG.2

Description

[0001] The present invention is in the field of devices for the thermal conditioning of civil or industrial spaces, such as homes, offices, premises for production activities, etc.

[0002] In the construction of new buildings, it is common to use techniques and materials that may ensure a high thermal insulation of a room from the outside environment: insulated walls, windows fitted with gaskets and equipped with double or triple chambers, etc. In particular, if, on the one hand, the use of these windows ensures a high thermal insulation from the outside environment, on the other, it strongly limits the natural ventilation of the rooms, causing stains from moisture and mold to form on the walls. For this reason, recent buildings are almost always equipped with a controlled mechanical ventilation (CMV) apparatus that allows the forced intake of air from the outside environment and the forced withdrawal of air from the room in order to ensure adequate air exchange.

[0003] It is obvious that a CMV apparatus is to be added to the usual heating and cooling system which the room must be provided with, which thus increases the implementation costs for labor and installation of the devices. This is obviously an inconvenience that sometimes discourages the installation of such an apparatus.

[0004] An example of an air conditioning device is illustrated in WO-A1-2014/111742, according to which, however, air is fed into the device via a motor.

[0005] The object of the present invention is to overcome this drawback; in particular, according to the invention, the CMV apparatus is used simultaneously in the implementation of a heating or cooling system, avoiding the need to implement them separately.

[0006] Said object is achieved by a thermal conditioning device according to claim 1. The dependent claims identify additional advantageous embodiments of the invention.

[0007] The features and advantages of the thermal conditioning device according to the present invention will be apparent from the description below, given by way of non-limiting example in accordance with the figures in the attached drawings, wherein:

- Fig. 1 depicts an implementation diagram of an air conditioning system according to an embodiment of the present invention;
- Fig. 2 illustrates a thermal conditioning device according to an embodiment of the present invention;
- Fig. 3 is a front view of the device in Fig. 2;
- Fig. 4 is a cross-sectional side view of the device in Fig. 2;
- Fig. 5 shows the device in Fig. 2 from the front, in separate parts;
- Fig. 6 shows the device in Fig. 2 from the rear, in separate parts; and
- Fig. 7 represents an enlargement of the box VII in Fig. 6.

[0008] For reasons of clarity, explicit reference will be made in the following to the application of the present invention to a single room in a building; it is understood, however, that the invention is equally applicable to multiple rooms.

[0009] With reference to the figures in the attached drawings, 1 denotes a room in a building, having an indoor environment 2. The room is served by a controlled mechanical ventilation apparatus (CMV apparatus 4) adapted to forcibly feed a predefined incoming air flow Q_{in} to the indoor environment 2 and to forcibly draw a predefined outgoing air flow Q_{out} from the indoor environment 2. Said apparatus comprises filtration means to filter incoming or outgoing air, and exchanger means to exchange heat between incoming or outgoing air flows and outgoing or incoming air flows, respectively.

[0010] For example, for the sole purpose of better illustrating the functional features of the invention, a 40 m³ room for which the standards require minimum incoming air flow $Q_{in} = Q_{out} = 20 \text{ m}^3/\text{h}$ is assumed.

[0011] For example, the CMV apparatus 4 comprises a ventilation device 6, generally affixed to a wall of the building and comprising a motorized fan, an air inlet duct 8, operatively connected to the outflow of the fan for the forced intake of air from the outside environment to the indoor environment 2, and an air outlet duct 10, operatively connected to the intake of the fan for the forced extraction of air from the indoor environment 2 to the outside environment.

[0012] According to the invention, the CMV apparatus 4 is coupled to a thermal conditioning device 20 applicable to the air inlet duct 8 of the CMV apparatus 4, adapted to draw in a predetermined additional air flow Q' from the indoor environment 2 of the room 1 by means of a Venturi effect activated by the incoming air flow Q_{in} of the CMV apparatus 4, combining it with said incoming air flow Q_{in} of the CMV apparatus 4 and feeding, into the indoor environment 2, a total air flow Q_{tot} after conditioning it, i.e., after heating or cooling it.

[0013] In other words, as better illustrated below, the device 20 exploits a negative pressure activated by the incoming air flow Q_{in} of the CMV apparatus 4 to draw in an additional flow Q'_{in} coming from the indoor environment 2 and is able to feed into the indoor environment 2 a total air flow Q_{tot} , after heating or cooling it, as required.

[0014] The device 20 is part of an apparatus 100 for the thermal conditioning of a room comprising, in addition to said device 20, a generator device 102 adapted to heat or cool a carrier fluid F_v , e.g., water, by an energy transformation, e.g., by electrical energy transformation, by combustion of gas, diesel, or other hydrocarbons, or by heat exchange. For example, the generator device 102 is a boiler or heat pump or is an exchanger connected to a district heating or cooling system.

[0015] The generator device 102 is operatively connected to the device 20 via a carrier duct 103, comprising a forward branch 104, through which hot or cold carrier fluid F_v is sent to the device 20, and a return branch 106,

through which thermally depleted carrier fluid Fv returns from the device 20 to the generator device 102.

[0016] The apparatus 100 further comprises typically electronic management means 110, comprising, for example, a circuit board or microchip, operatively connected to the device 20 and to the generator device 102, to control their actuation based on the processing of received signals.

[0017] In addition, the apparatus 100 comprises:

- first temperature detection means 120, operatively connected to the management means 100, adapted to detect the temperature in the indoor environment 2 of the room 1 and to transmit a temperature signal Ts to said management means 110, which process the signal; and
- in a variant embodiment, second temperature detection means 120', operatively connected to the management means 100, adapted to detect the temperature in the outside environment and to transmit a temperature signal Ts' to said management means 110, which process it.

[0018] According to a preferred embodiment, the device 20 comprises a casing 22 delimiting an inner compartment 24 and is provided with an inlet mouth 26 for connecting the air inlet duct 8 of the CMV apparatus 4 that supplies the incoming air flow Qin. For example, the inlet mouth 26 is obtained through a side wall 22a of the casing 22.

[0019] The device 20 further comprises an additional mouth 28 connectable to the inner compartment 24, for suctioning the additional flow Q'in from the indoor environment 2 of the room 1; preferably, said additional mouth 28 is obtained through the casing 22, and in particular through a front wall 22b of said casing 22, preferably at a height corresponding to that of the inlet mouth 26.

[0020] The device 20 further comprises a shutter assembly 30 adapted to open or close on command the additional mouth 28, to allow or prevent the intake of air from the indoor environment 2 to the inner compartment 24, respectively.

[0021] The shutter assembly 30 is operatively connected, for example electrically, to the management means 110 of the apparatus 100.

[0022] For example, the shutter assembly 30 comprises a plurality of movable, e.g., rotatable, shutter flaps 32, which, in a closed configuration, obstruct the additional mouth 28 and, in an open configuration, at least partially release said additional mouth 28. The shutter assembly 30, comprising, for example, an actuator, such as an electric motor, connected to said shutter flaps 32, is controllable by the management means 110 that control said actuator to bring the shutter flaps 32 from the closed configuration to the open configuration and, preferably, vice versa.

[0023] The device 20 further comprises an outlet mouth 40 connected to the inner compartment 24, to

feed, to the indoor environment 2, the total flow Qtot, given by the combination of the incoming flow Qin coming from the CMV apparatus 4 and the additional flow Q'in sucked in from the indoor environment 2 (generally, $Q_{tot} = Q_{in} + Q'_{in}$).

[0024] For example, the outlet mouth 40 is formed through the front wall 22b of the casing 22, spaced apart from the additional mouth 28.

[0025] The device 20 further comprises a nozzle assembly 50, connected to the inlet mouth 26, which is adapted to receive the incoming flow Qin, accelerate it, and feed it into the inner compartment 24 to create a negative pressure in at least one region 52 of said inner compartment 24, flanked by the additional mouth 28, for example in the direction of the thickness of the casing 22.

[0026] Preferably, the nozzle assembly 50 is received in the casing 22 and comprises a distribution duct 54 into which the inlet mouth 26 flows, having a main extension along a transverse direction Y, preferably open at the top, and a nozzle 56 that surmounts the distribution duct 54, configured to receive the low speed incoming flow Qin and provided with a plurality of ports 58, preferably open at the top of the nozzle 56 and distributed transversely.

[0027] Said ports 58 collectively form a narrowing of the passage section of the incoming flow Qin and thus cause high speed air to escape into the region 52, which will experience a negative pressure. Said negative pressure draws, through the additional mouth 28, the additional flow Q'in when the shutter assembly 30 is in the open configuration.

[0028] For example, the nozzle 56 comprises a transversely extending profile 60 having longitudinally a cross section converging toward a base 62 through which the ports 58 are formed. For example, the longitudinal cross section of the profile 60 is trapezoidal, wherein the major base is located above the distribution duct 54 and the minor base forms said base 62 for the ports 58.

[0029] Moreover, the device 20 comprises an exchanger 70, housed in the casing 22, operatively located between the additional mouth 28 and the outlet mouth 40 to condition the air flow passing through the inner compartment 24 between said mouths 28, 40.

[0030] The exchanger 70 is configured to cooperate with the generator device 102, for example through the carrier duct 103.

[0031] For example, the heat exchanger 70 comprises a heat exchanger body 72 for example made in one piece of a highly thermally conductive material, for example, aluminum, preferably extruded, traversed by the carrier duct 103 and provided with surfaces placed in contact with said carrier duct 103 to achieve a heat exchange.

[0032] Preferably, the exchanger body 72 comprises a plurality of exchange fins 74, for example having a mainly longitudinal extension and being placed transversely side by side to one another, between which the carrier duct 103 forms a coil.

[0033] According to an embodiment, the carrier duct

103 has a circular cross section; according to a further embodiment, the carrier duct 103 has an oblong cross section in contact with the exchanger body 72 so as to maximize the extent of the contacting surfaces.

[0034] According to a preferred embodiment, the heat exchanger body 72 is in contact with the front wall 22b of the casing 22; during operation of the device, the hot or cold heat exchanger body heats or cools the front wall 22b of the casing 22, thereby also contributing to conditioning the indoor environment via conduction.

[0035] In a first operating condition of an air conditioning system comprising the CMV apparatus 4 and the air conditioning apparatus 100, the first temperature detection means 120 detect a temperature in the indoor environment 2 of the room 1 greater than a predetermined threshold temperature and transmit the corresponding temperature signal Ts to the management means 110.

[0036] In such a condition, the management means 110, based on a processing of the temperature signal Ts, and preferably the temperature signal Ts', control the shutter assembly 30 of the additional mouth 28 to bring it or keep it in the closed configuration, in which it closes said additional mouth 28, and deactivates the generator device 102 or keeps it deactivated, whereby the exchanger 70 is unable to heat or cool any air flow.

[0037] At the same time, in this condition, the CMV apparatus 4 continues to operate by feeding an incoming air flow Qin into the air inlet duct 8. The incoming flow Qin enters the device 20, flows through the inner compartment 24, and flows through the exchanger 70, but is neither heated nor cooled appreciably because the generating device 102 is deactivated.

[0038] The incoming flow Qin therefore flows out of the outlet mouth 40 into the indoor environment 2. By way of example, in order to better illustrate the operation of the air conditioning system, in said operating condition the CMV apparatus feeds an incoming flow Qin = 20 m³/h to the indoor environment 2.

[0039] In a second operating condition of the air conditioning system, the temperature detecting means 120 detect a temperature in the indoor environment 2 of the room 1 that is lower than a predefined threshold temperature and transmit the corresponding temperature signal Ts to the management means 110.

[0040] In said condition, the management means 110, based on a processing of the temperature signal Ts, and preferably the temperature signal Ts', control the shutter assembly 30 of the additional mouth 28 to bring it or keep it in the open configuration, wherein the additional mouth 28 is open, and activates the generator device 102 or keeps it activated, whereby the exchanger 70 is able to heat or cool an air flow.

[0041] In this condition, the CMV apparatus 4 continues to operate by feeding an incoming air flow Qin into the air inlet duct 8. The incoming flow Qin enters the device 20 from the inlet mouth 26, flows through the distribution duct 54 at low speed, flows through the nozzle 56, and exits the ports 58 at high speed, causing a neg-

ative pressure in at least one region 52 of the inner compartment 24 adjacent to the additional mouth 28. Through said additional mouth 28, the additional flow Q'in is thus drawn into the inner compartment 24, which is combined with the incoming flow Qin.

[0042] The Applicant was able to experiment with how, in a first prototype of the device 20, an incoming flow Qin = 20 m³/h is able to draw an additional flow, for example up to Q'in = 80 m³/h.

[0043] The total flow Qtot (= Qin + Q'in) passes through the inner compartment 24 and hits the exchanger 70, thus being heated or cooled to the desired extent, before being fed into the indoor environment 2 through the outlet 40. In the aforesaid example, a flow Qtot = Qin + Q'in, e.g., equal to 100 m³/h, heated or cooled, is fed into the indoor environment 2.

[0044] Innovatively, the above-described device overcomes the drawbacks discussed above with reference to the prior art in that, by integrating a CMV apparatus with a thermal conditioning apparatus, labor and component costs may be reduced. In particular, this device exploits the pressure generated by the CMV apparatus to create air circulation in the indoor environment without the aid of additional fans.

[0045] Advantageously, with respect to certain solutions of the prior art, the device according to the invention allows, when no heating or cooling is required, for only the air flow coming from the CMV apparatus to be sent into the indoor environment, avoiding sending a flow that is oversized for the volume of the indoor environment, which would cause discomfort.

[0046] Furthermore, in the device according to the invention, the additional flow is drawn into the inner compartment by the incoming flow, without said incoming flow having undergone thermal conditioning. Advantageously, this allows the negative pressure generated by the incoming flow to be fully utilized to draw in an elevated additional flow.

[0047] It is clear that a person skilled in the art, in order to satisfy current needs, could make modifications to the conditioning system described above, all of which are contained within the scope of protection as defined in the following claims.

Claims

1. A system for conditioning an indoor environment (2) of a room (1), comprising:

- a device (20) comprising an inner compartment (24) which is connectable to an inlet duct (8) for an incoming air flow (Qin), an additional mouth (28) in communication with the inner compartment (24) to feed, from the indoor environment (2), an additional air flow (Q'in), a shutter assembly (30) which may be electrically operated to open or close the additional mouth (28), an

- outlet mouth (40) connected to the inner compartment (24) for feeding, into the indoor environment (2), a total air flow (Q_{tot}) consisting of the incoming flow (Q_{in}) and the additional flow (Q'_{in}), a nozzle assembly (50) configured to receive the incoming flow (Q_{in}) at low speed, accelerate it and feed it at high speed into the inner compartment (24) to draw into the inner compartment (24), through the additional mouth (28), said additional flow (Q'_{in}), an exchanger (70) operatively located between the additional mouth (28) and the outlet mouth (40) to thermally condition the total flow (Q_{tot}) which hits it before exiting from the outlet mouth (40);
- a controlled mechanical ventilation apparatus (4) connected to the device (20) of the apparatus (100) to supply the incoming flow (Q_{in}).
2. The system according to claim 1, comprising:
- a generator device (102) adapted to heat or cool a carrier fluid (F_v), operatively connected to the exchanger (70) of the device (20) by means of a carrier duct (103).
3. The system according to claim 2, further comprising:
- electronic management means (110), operatively connected to the device (20) and to the generator device (102), and
 - first temperature detection means (120), operatively connected to the management means (100), adapted to detect the temperature in the indoor environment (2) of the room (1) and to transmit a temperature signal (T_s) to said management means (110);
 - wherein the management means (110) are configured to process the temperature signal (T_s) and then operate the shutter assembly (30) of the device (20) to open or close and activate or deactivate the generator device (102).
4. The system according to claim 3, further comprising:
- second temperature detection means (120'), operatively connected to the management means (100), adapted to detect the temperature in the outside environment and transmit a temperature signal (T_s') to said management means (110);
 - wherein the management means (110) are configured to process the temperature signal (T_s') and then operate the shutter assembly (30) of the device (20) to open or close and activate or deactivate the generator device (102).
5. The system according to any of the preceding claims, wherein the shutter assembly (30) comprises a plurality of movable shutter flaps (32), which, in a closed configuration, obstruct the additional mouth (28) and, in an open configuration, at least partially free said additional mouth (28), and an actuator operatively connected to the shutter flaps (32) to move them.
6. The system according to any of the preceding claims, wherein the nozzle assembly (50) comprises a distribution duct (54), which is connectable to the inlet duct (8), having a main extension along a transverse direction (Y) and being open at the top, and a nozzle (56) which surmounts the distribution duct (54) and is provided with a plurality of ports (58) for feeding the air at high speed into a region (52) of the inner compartment (24) adjacent to the additional mouth (28).
7. The system according to claim 6, wherein the nozzle (56) consists of a profile (60) which extends transversely, longitudinally having a section converging towards a base (62) through which the ports (58) are obtained.
8. The system according to any of the preceding claims, wherein the exchanger (70) comprises an exchanger body (72) with high thermal conduction and a carrier duct (103) for a carrier fluid (F_v), in contact with the surfaces of the exchanger body to obtain a heat exchange.
9. The system according to claim 8, wherein the exchanger body (72) comprises a plurality of exchange flaps (74) having a mainly longitudinal extension and being transversely placed side by side to one another, between which the carrier duct (103) forms a coil.
10. The system according to claim 9, wherein the carrier duct (103) has a circular cross section.
11. The system according to claim 9, wherein the carrier duct (103) has an oblong cross section and is in contact with the exchanger body (72) to maximize the contact.
12. The system according to any of claims 8 to 11, wherein the exchanger body (72) is in contact with a front wall (22b) of the casing (22), on which the outlet mouth (24) is also obtained.

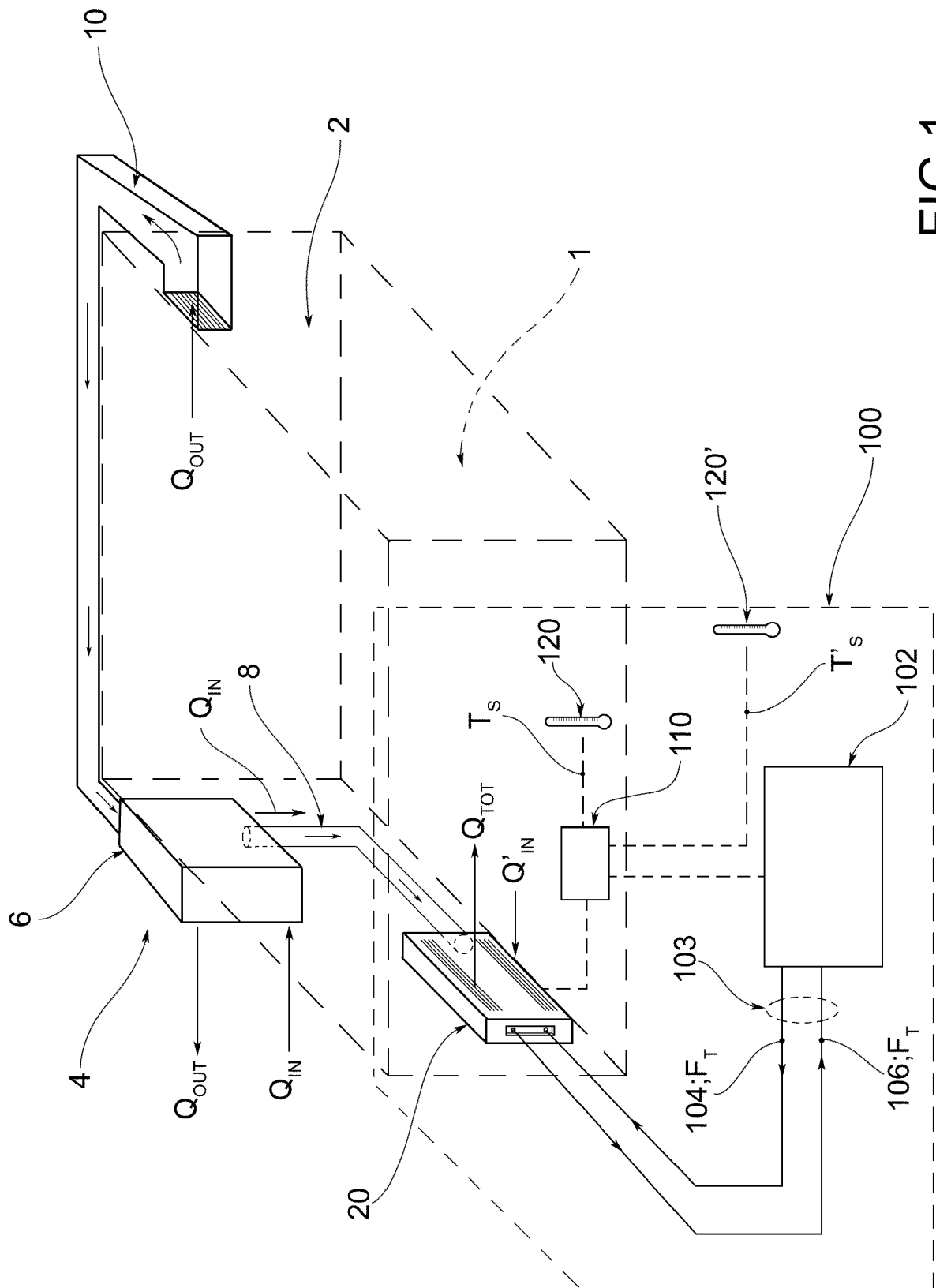


FIG.1

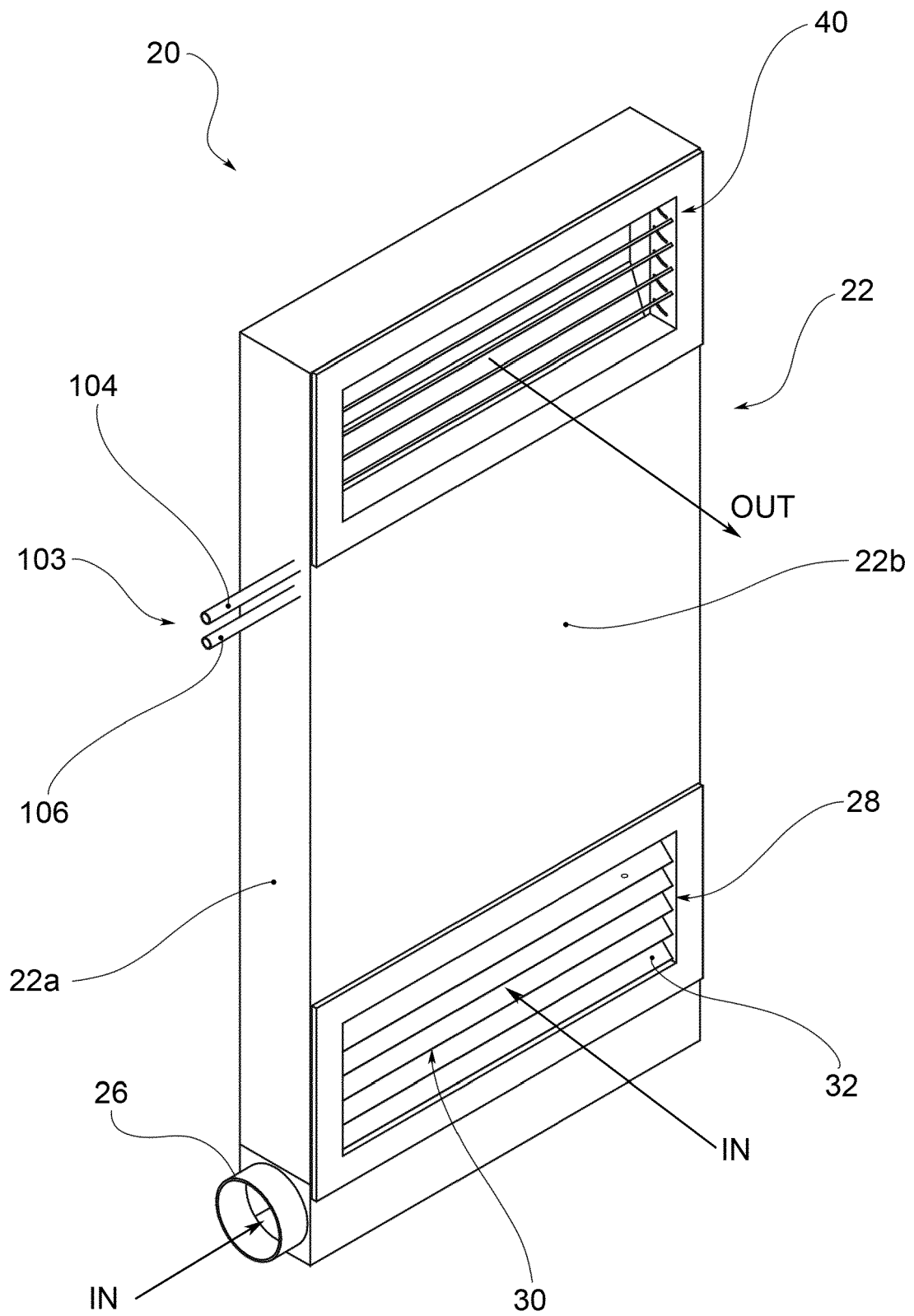
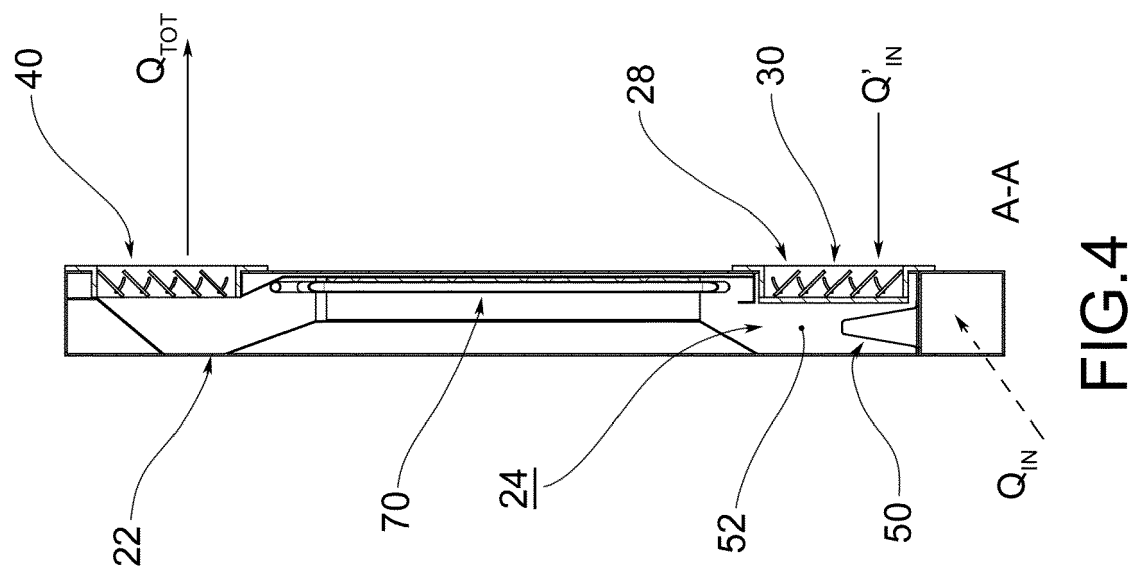
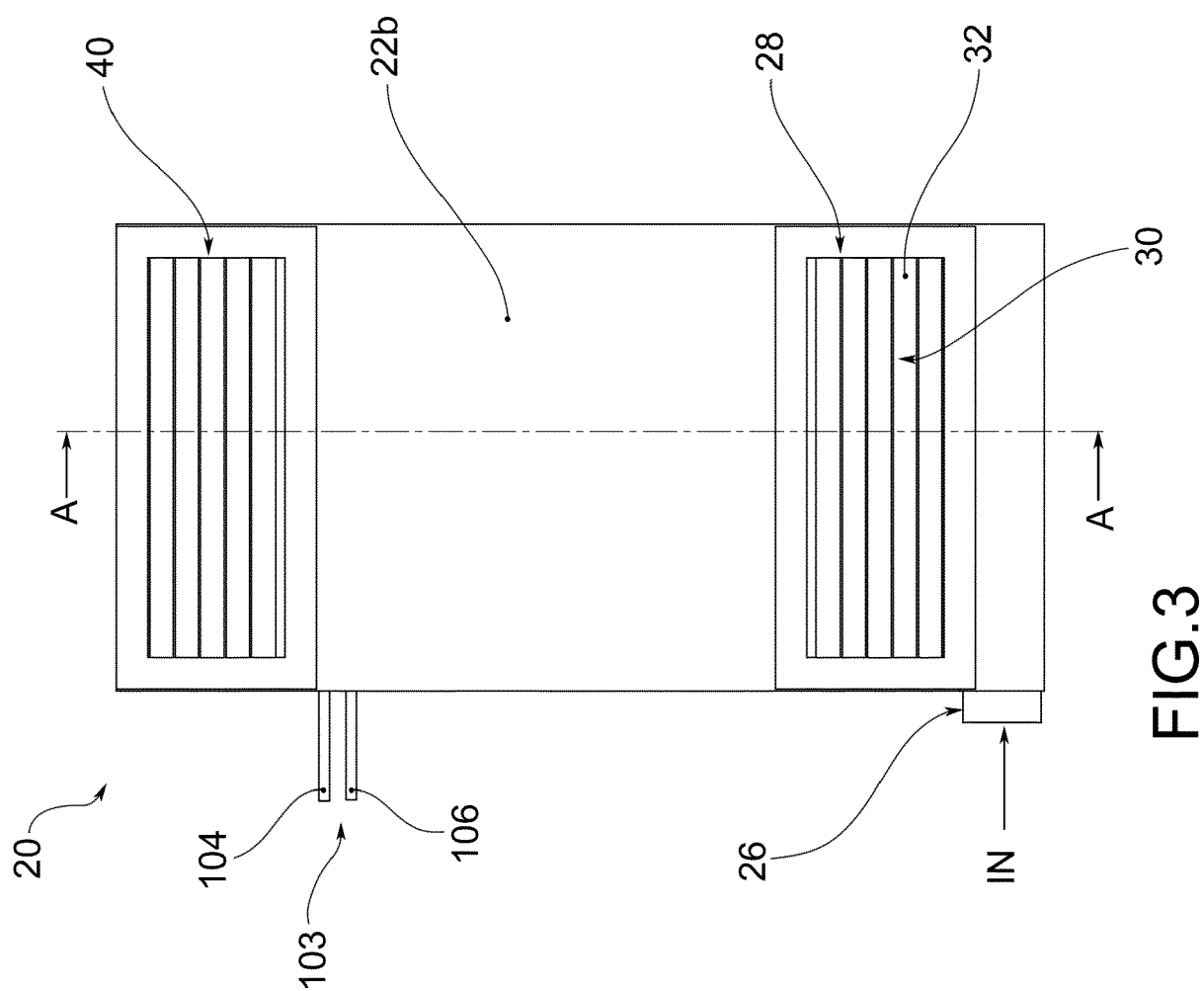


FIG.2



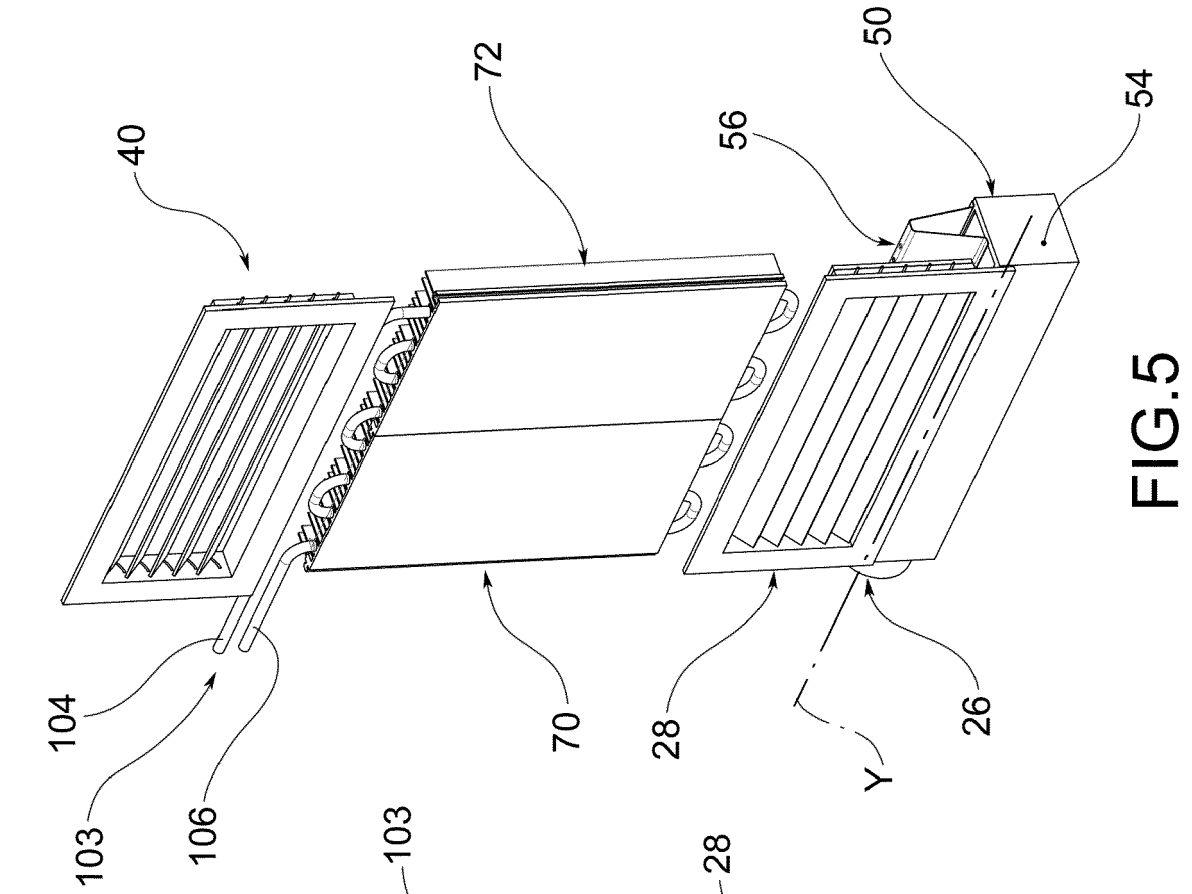


FIG. 5

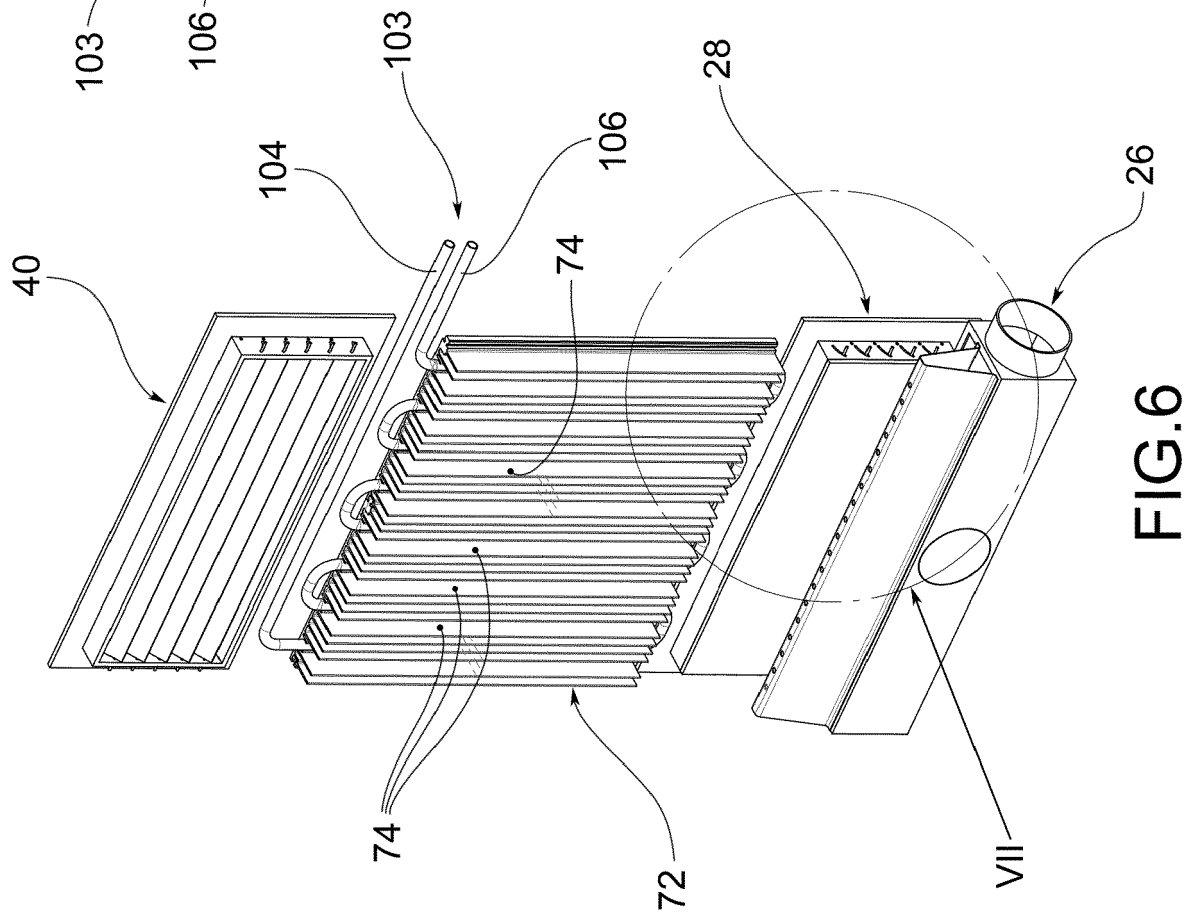


FIG. 6

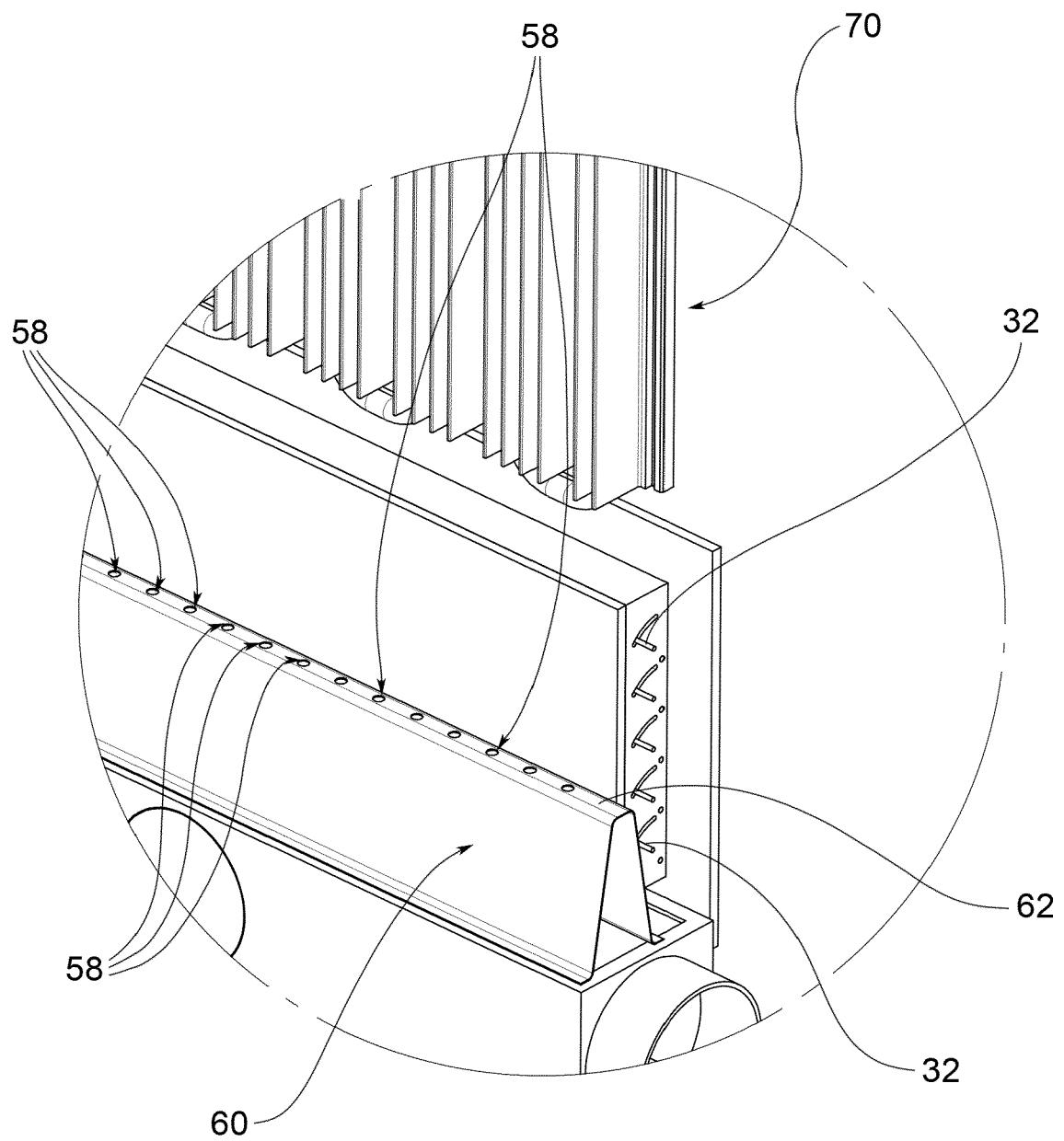


FIG.7



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Application Number
EP 21 18 9332

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Place of search Munich		Date of completion of the search 26 November 2021	Examiner Anconetani, Mirco
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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