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(54) INDOOR AIR-CONDITIONING UNIT

(57) Air-conditioning unit (1) comprising: a box-like container (2) adapted to receive at inlet an air flow (f) from an external aeraulic source; and at least one heat exchanger (4) that is adapted to be crossed by a heat-transfer fluid, and skimmed over said box-like container (2) so as to form/ delimit, on the side of the box-like container (2), a corresponding gap (5); the box-like container (2) being moreover provided with a series of air-outlet openings (6) that are adapted to direct, inside said gap (5), corresponding air jets (g) adapted to create an additional convective motion that drives the ambient air through the heat exchanger (4); the air-conditioning unit (1) furthermore comprising a series of converging nozzles (10), each of which joins to a respective air-outlet opening (6) to reduce the pressure drops of the air flowing out from the box-like container (2) through the same air-outlet opening (6).

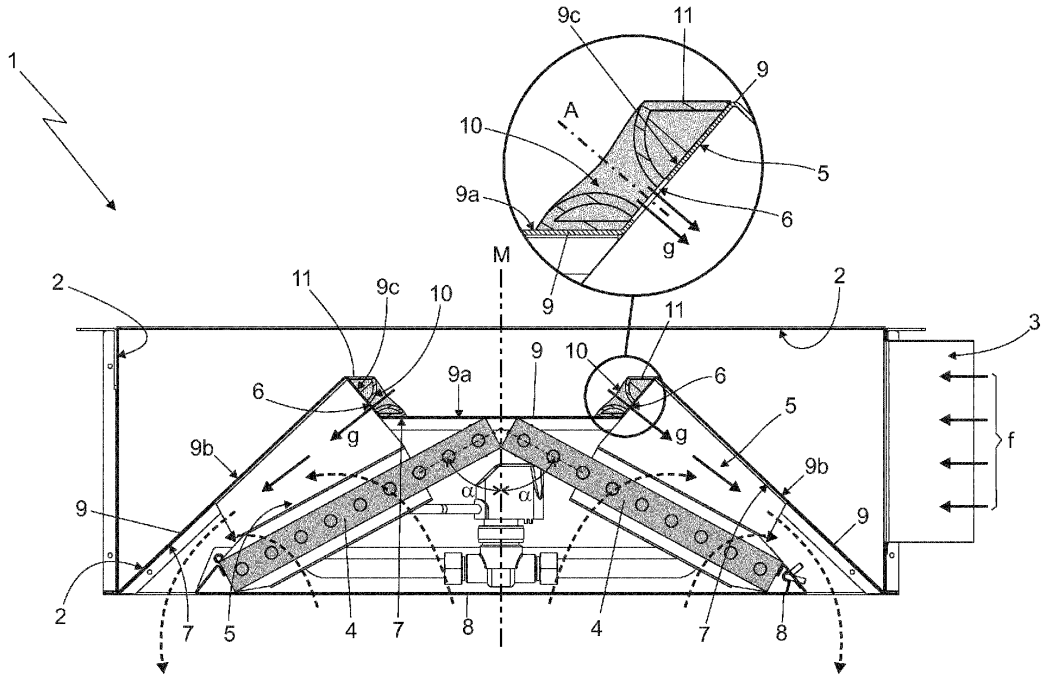

Fig. 3

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Patent Application claims priority from Italian Patent Application No. 102018000003335 filed on March 7, 2018.

TECHNICAL FIELD

[0002] The present invention relates to an indoor air-conditioning unit.

[0003] More in detail, the present invention relates to an active chilled beam to which the following description will make explicit reference without however losing in generality.

BACKGROUND ART

[0004] As already known, active chilled beams are apparatuses that are usually fixed on the ceiling of the room to be conditioned and are designed to continuously introduce fresh air (i.e. air that has been dehumidified, filtered and conditioned by an air-handling unit that drives and treats external air inside the room), simultaneously heating or cooling the air already present in the room.

[0005] The most common active chilled beams on the market basically consist of a large and oblong box-like container, usually rectilinear and having a circular or rectangular cross-section, which extends horizontally close to the ceiling and is adapted to receive a flow of fresh air from an external aeraulic source; and of an air/liquid heat exchanger which extends adjacent to the box-like container, substantially for the whole length of the container, and is connected to an external hydraulic circuit so as to be continuously crossed by a flow of hot or cold water.

[0006] The box-like container, traditionally called plenum, is provided with a series of small air-outlet holes that are formed on the wall of the box-like container near the heat exchanger so that the air flow coming out from the single holes of the box-like container creates, in the immediate vicinity of the heat exchanger, an additional convective motion that drives the ambient air through the heat exchanger, where it is heated or cooled according to the temperature difference existing between the ambient air and the water circulating in the exchanger.

[0007] Unfortunately, despite having a considerable energy efficiency, the active chilled beams described above have a rather limited use because the pressure drops created in the air flowing inside the box-like container do not allow realizing cold beams with a length over 2-3 meters.

[0008] The speed of the air flowing out from the individual air-outlet holes of the box-like container, in fact, rapidly decreases by increasing the distance to the fresh air inlet in the box-like container, and with it the strength of the additional convective motion driving the ambient air through the heat exchanger.

DISCLOSURE OF INVENTION

[0009] Aim of the present invention is therefore to improve the performance of the active chilled beams described above.

[0010] In compliance with these aims, according to the present invention there is provided an indoor air-conditioning unit as defined in claim 1 and preferably, though not necessarily, in any of the claims dependent on it.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention will now be described with reference to the annexed drawings showing a non-limiting embodiment, in which:

- Figures 1 and 2 are two perspective views of an air-conditioning unit realized according to the teachings of the present invention, with parts in section and parts removed for clarity's sake; whereas
- Figure 3 is a sectioned front view of the air-conditioning unit shown in Figures 1 and 2, with parts removed for clarity's sake.

BEST MODE FOR CARRYING OUT THE INVENTION

[0012] With reference to Figures 1, 2 and 3, the number 1 denotes as a whole an indoor air-conditioning unit that is adapted to continuously add fresh air (i.e. air that has been dehumidified, filtered and conditioned by an air handling unit that drives and treats external air) inside the room to be conditioned, while heating or cooling the air already present inside the room. Furthermore, the air-conditioning unit 1 is particularly adapted to be fixed to, or recessed in, the ceiling of the room to be conditioned, preferably in a substantially horizontal position.

[0013] The air-conditioning unit 1 in particular comprises: a large box-like container or plenum 2 that is preferably structured to be fixed to, or recessed in, the ceiling of the room to be conditioned, preferably in a substantially horizontal position, and is provided with an inlet mouth 3 adapted to be connected to an external aeraulic source of known type (not shown) so as to receive at inlet a flow of fresh air f having a pressure slightly higher than the ambient pressure; and at least one, preferably air/liquid and preferably with a plate-like structure, heat exchanger 4 that extends next to the box-like container 2 locally substantially skimmed over the box-like container 2, preferably substantially for the whole length of heat exchanger 4 and/or of box-like container 2, and is adapted to be connected to an external hydraulic circuit (not shown) so as to be continuously crossed by a flow of water or other heat-transfer fluid at a given temperature which is preferably controlled by an external cooling and/or heating unit.

[0014] More in detail, the temperature of the heat-transfer fluid circulating in the heat exchanger(s) 4 is preferably higher or lower than that of the air present in the

room accommodating the air-conditioning unit 1.

[0015] Moreover, the/each heat exchanger 4 extends beside the box-like container 2 so as to form/delimit, on the side of the box-like container 2, a respective gap 5; and the box-like container 2 is moreover provided with a series of small air-outlet openings 6, which are adapted to direct/project inside the gap 5 as many air jets g adapted to generate /create, in the immediate vicinity of heat exchanger 4, an additional convective motion that drives/brings the ambient air through the same heat exchanger 4.

[0016] More in detail, the air-outlet openings 6 are preferably arranged on the wall of box-like container 2 so as to face the gap(s) 5.

[0017] Furthermore, each opening 6 is adapted to continuously remove air from the box-like container 2, so that the outgoing air jet g can flow through the gap 5 preferably lapping the face of the heat exchanger 4, and can create, in the immediate vicinity of heat exchanger 4, an additional convective motion that drives the ambient air through the heat exchanger 4, where it is heated or cooled based on the temperature difference between the ambient air and the water or other heat-transfer liquid circulating in the exchanger.

[0018] More in detail, with reference to Figures 1, 2 and 3, the box-like container or plenum 2 is preferably oblong in shape, and the heat exchanger(s) 4 extend next to the box-like container 2 while remaining locally substantially parallel to the box-like container 2.

[0019] Furthermore, the air-outlet openings 6 are preferably formed on the wall of box-like container 2 spaced one after the other preferably in regular manner, so as to form at least one row of openings that extends beside the or a respective gap 5, preferably for the whole length of the same gap 5.

[0020] Even more in detail, the oblong box-like container 2 preferably extends parallel to a given longitudinal axis L, and the heat exchanger(s) 4 extend alongside the box-like container 2 parallel to the longitudinal axis L, preferably substantially for the whole length of the container.

[0021] In other words, the oblong box-like container 2 is preferably substantially rectilinear.

[0022] Moreover, the air-outlet openings 6 are preferably formed on the wall of box-like container 2 spaced one after the other preferably in regular manner, so as to form at least one row of openings that preferably extends parallel to the longitudinal axis L of box-like container 2.

[0023] With reference to Figures 1, 2 and 3, in particular the box-like container 2 preferably has a substantially regular prism-shaped structure.

[0024] Preferably the box-like container 2 furthermore has, on its lower face (i.e. on the face turned towards the floor), a longitudinal recess or indentation 7 that preferably extends parallel to the container longitudinal axis L, preferably substantially for the whole length of the box-like container 2, and is dimensioned so as to be able to accommodate the heat exchanger(s) 4.

[0025] Preferably, the heat exchanger(s) 4 additionally extend inside the longitudinal recess or indentation 7 parallel to the container longitudinal axis L.

[0026] The air-conditioning unit 1, in addition, is preferably also provided with an air-permeable plate-shaped cover 8, which preferably has a grid structure and closes the opening of said longitudinal recess or indentation 7. Preferably, the longitudinal recess or indentation 7 moreover has a substantially W-shaped cross-section, and is preferably arranged astride of the mid-plane of box-like container 2.

[0027] With reference to Figures 1, 2 and 3, in the shown example, in particular, the box-like container 2 is preferably substantially parallelepiped in shape and is preferably made of metal sheet.

[0028] Furthermore, the air-conditioning unit 1 is preferably provided with two oblong heat exchangers 4 with a plate-like structure, which extend side by side to one another roughly parallel to the container longitudinal axis L and are preferably fully accommodated/contained within the longitudinal recess or indentation 7.

[0029] With particular reference to Figure 3, the two heat exchangers 4 are moreover preferably arranged in a substantially upside-down V-shaped configuration so as to extend inside the longitudinal recess or indentation 7 with a substantially W-shaped cross section, each locally substantially skimmed over a respective flat side portion of the bottom wall 9 of the same longitudinal recess or indentation 7.

[0030] More in detail, the bottom wall 9 of the longitudinal recess or indentation 7 with a substantially W-shaped cross section has a central flat strip 9a and two lateral flat strips 9b that are inclined with respect to the central flat strip 9a and are connected to the central flat strip 9a by two substantially S-shaped longitudinal folds 9c.

[0031] The central flat strip 9a is substantially perpendicular to the mid-plane M of the longitudinal recess or indentation 7, whereas the two lateral flat strips 9b are inclined in a substantially specular manner with respect to the mid-plane M.

[0032] Preferably, each heat exchanger 4 is arranged close to a respective lateral flat strip 9b of the bottom wall 9 of the longitudinal recess or indentation 7 so as to form a longitudinal gap 5 with a preferably convergent-divergent profile towards the mouth of the longitudinal recess or indentation 7.

[0033] The air-outlet openings 6 of box-like container 2, in turn, are preferably realized on the bottom wall 9 of the longitudinal recess or indentation 7 with a substantially W-shaped cross section, and are preferably arranged so as to form at least two adjacent rectilinear rows parallel to the container longitudinal axis L, each of which is locally aligned/facing a respective longitudinal gap 5.

[0034] With reference to Figure 3, in the shown example, in particular, the heat exchangers 4 are preferably arranged in a substantially specular position, on opposite

sides of the mid-plane M of the longitudinal recess or indentation 7 wirh a substantially W-shaped cross section, inclined by a predetermined angle α with respect to the mid-plane M. Preferably, the value of inclination angle α furthermore ranges between 15° and 90° and is optionally equal to about 60°.

[0035] The air-outlet openings 6 of box-like container 2, on the other hand, are preferably arranged so as to form two rectilinear rows adjacent and parallel to the container longitudinal axis L, which are arranged on the bottom wall 9 of the longitudinal recess or indentation 7 with a substantially W-shaped cross-section in a substantially specular position on opposite sides of the mid-plane M of the longitudinal recess or indentation 7, preferably each at a respective substantially S-shaped longitudinal fold 9c of bottom wall 9.

[0036] Preferably, the/each heat exchanger 4 is moreover a finned pack heat exchanger.

[0037] With reference to Figures 2 and 3, the air-conditioning unit 1 finally comprises, for at least one and preferably all the air-outlet openings 6 of the box-like container 2, also a respective converging nozzle 10, preferably having a horn- or funnel-shaped profile, that joins to the air-outlet opening 6 so as to reduce the pressure drops of the air leaving the box-like container 2 through the same air-outlet opening 6.

[0038] More in detail, each converging nozzle 10 is shaped so as to reduce the pressure drops of the air leaving the air-outlet opening 6, consequently increasing the speed of the air jet g that penetrates into the gap 5 lapping the face of the heat exchanger 4.

[0039] Preferably, the/each converging nozzle 10 is furthermore arranged inside the box-like container 2, in abutment against the wall of the box-like container 2 where the corresponding air-outlet opening 6 is located.

[0040] Moreover, the/each converging nozzle 10 preferably extends substantially coaxial to a reference axis A that is locally substantially perpendicular to the laying plane of the corresponding air-outlet opening 6.

[0041] With particular reference to Figures 2 and 3, preferably the converging nozzles 10 are furthermore incorporated in at least one longitudinal bar 11, which is preferably made of plastic material and is arranged in abutment against the wall of the box-like container 2, immediately over at least one section or a corresponding row of air-outlet openings 6, so that each converging nozzle 10 is aligned with a respective air-outlet opening 6 of said section of the row of openings.

[0042] More in detail, the air-conditioning unit 1 is preferably provided with at least one longitudinal bar 11 that incorporates a plurality of converging nozzles 10, extends inside the box-like container 2 parallel to the container longitudinal axis L, and is arranged in abutment against the wall of the box-like container 2 so as to cover at least one section of a corresponding row of air-outlet openings 6, and so that each converging nozzle 10 is aligned with a respective air-outlet opening 6 of the same section of the row of openings.

[0043] In other words, the converging nozzles 10 are spaced on the longitudinal bar 11 so that each converging nozzle 10 is aligned with a respective air-outlet opening 6 of the underlying row of openings.

[0044] Preferably, the longitudinal bar 11 is further dimensioned so as to extend above the entire row of air-outlet opening 6 and incorporates a number of converging nozzles 10 equal to the number of air-outlet openings 6 forming the same row of openings.

[0045] With reference to Figures 2 and 3, in the shown example, in particular, the air-conditioning unit 1 is preferably provided with two longitudinal bars 11, which extend inside the box-like component 2 parallel to the container longitudinal axis L and are each arranged in abutment against a respective substantially S-shaped longitudinal fold 9c of the bottom wall 9 of the longitudinal recess or indentation 7, immediately above a corresponding row of air-outlet openings 6.

[0046] Preferably, each longitudinal bar 11 is furthermore dimensioned so as to cover the entire row of air-outlet openings 6, and is moreover provided with a series of converging nozzles 10 that are spaced so that each converging nozzle 10 is aligned with a respective air-outlet opening 6 of the underlying row of openings. Finally, the/each longitudinal bar 11 is preferably longitudinally divided into a plurality of modular segments.

[0047] Operation of air-conditioning unit 1 is easily inferable from the above, and therefore does not require further explanations.

[0048] The advantages connected to the presence of the converging nozzles 10 are considerable.

[0049] Experimental tests have shown that the presence of converging nozzles 10 significantly reduces the pressure drops at the air-outlet openings 6, considerably increasing the speed of the air jets g leaving the box-like container 2.

[0050] The higher speed of the air jets g produces an additional convective motion that is much stronger and more turbulent, and drives a greater quantity of ambient air through the heat exchanger 4, thus increasing the heat exchange with the environment and, thus, the overall energy efficiency of the air-conditioning unit 1.

[0051] Moreover, the particular shape of the longitudinal recess or indentation 7 and the arrangement of the heat exchangers 4 inside the same longitudinal recess or indentation 7 increase the convective motion around the heat exchanger 4, further increasing the energy efficiency of the air-conditioning unit 1.

[0052] It is finally clear that modifications and variations can be made to the air-conditioning unit 1 described above without however departing from the scope of the present invention.

[0053] For example, the converging nozzles 10 can be made by moulding, directly on the metal sheet forming the wall of the box-like container 2.

Claims

1. Air-conditioning unit (1) comprising: a box-like container (2) adapted to receive at inlet an air flow (f) from an external aeraulic source; and at least one heat exchanger (4) which is adapted to be crossed by a heat-transfer fluid and which extends adjacent to said box-like container (2) so as to form/delimit, on a side of the box-like container (2), a corresponding gap (5);
the box-like container (2) being additionally provided with a series of air-outlet openings (6) adapted to direct, inside said gap (5), corresponding air jets (g) adapted to create an additional convective motion that drives the ambient air through the heat exchanger (4);
said air-conditioning unit (1) being **characterized by** additionally comprising one or more converging nozzles (10), each of which joins with a respective air-outlet opening (6) to reduce the pressure drop of the air flowing out from the box-like container (2) through the same air-outlet opening (6).

2. Air-conditioning unit according to claim 1, wherein the converging nozzle (10) has a horn- or funnel-shaped profile.

3. Air-conditioning unit according to claim 1 or 2, wherein the converging nozzle (10) is arranged inside the box-like container (2), in abutment against the wall of the box-like container (2) in which the corresponding air-outlet opening (6) is located.

4. Air-conditioning unit according to any one of the preceding claims, wherein the converging nozzle (10) extends substantially coaxial to a reference axis (A) locally substantially perpendicular to the laying plane of the corresponding air-outlet opening (6).

5. Air-conditioning unit according to any one of the preceding claims, wherein the box-like container (2) is oblong in shape, and the heat exchanger or exchangers (4) extend beside the box-like container (2) remaining locally substantially parallel to the box-like container (2).

6. Air-conditioning unit according to claim 5, wherein the air-outlet openings (6) are realized on the wall of the box-like container (2) spaced one after the other, so as to form at least one row of openings that extends next to the gap (5).

7. Air-conditioning unit according to claim 6, wherein the converging nozzles (10) are incorporated in at least one longitudinal bar (11) arranged in abutment against the wall of the box-like container (2), immediately above at least one section of said row of openings, so that each converging nozzle (10) is aligned with a respective air-outlet opening (6) of said section of the row of openings.

8. Air-conditioning unit according to any one of the preceding claims, wherein said unit has a converging nozzle (10) at each air-outlet opening (6).

9. Air-conditioning unit according to any one of the preceding claims, wherein the box-like container (2) extends parallel to a given longitudinal axis (L).

10. Air-conditioning unit according to any one of the preceding claims, wherein the box-like container (2) has a longitudinal recess or indentation (7) designed to accommodate the heat exchanger(s) (4).

11. Air-conditioning unit according to claim 10, wherein said longitudinal recess or indentation (7) has a substantially W-shaped cross-section.

12. Air-conditioning unit according to claim 10 or 11, wherein said unit is provided with two oblong heat exchangers (4) with a plate-like structure, which extend side by side and are accommodated/contained inside said longitudinal recess or indentation (7).

13. Air-conditioning unit according to claim 12, wherein the two heat exchangers (4) are arranged so as to form an upside-down V, and extend inside the longitudinal recess or indentation (7) with a substantially W-shaped cross section, each locally substantially skimmed over a respective flat lateral portion of the bottom wall (9) of the longitudinal recess or indentation (7).

14. Air-conditioning unit according to claim 13, wherein the air-outlet openings (6) are arranged on the bottom wall (9) of the longitudinal recess or indentation (7).

15. Air-conditioning unit according to claim 14, wherein the bottom wall (9) has a central flat strip (9a) and two lateral flat strips (9b) that are inclined with respect to the central flat strip (9a) and are connected to the central flat strip by two substantially S-shaped longitudinal folds (9c); the air-outlet openings (6) being placed at the two longitudinal folds (9c).

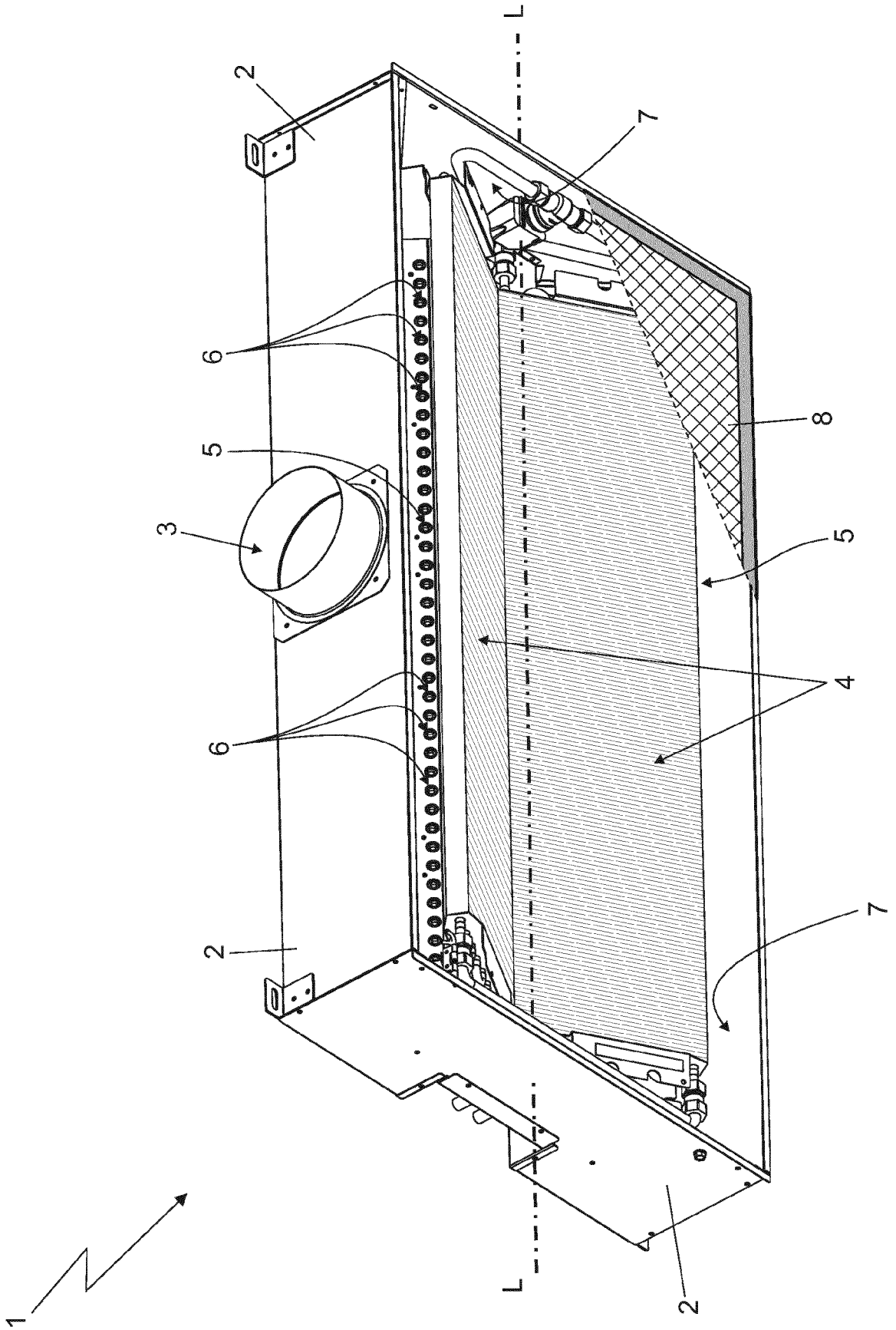

Fig. 1

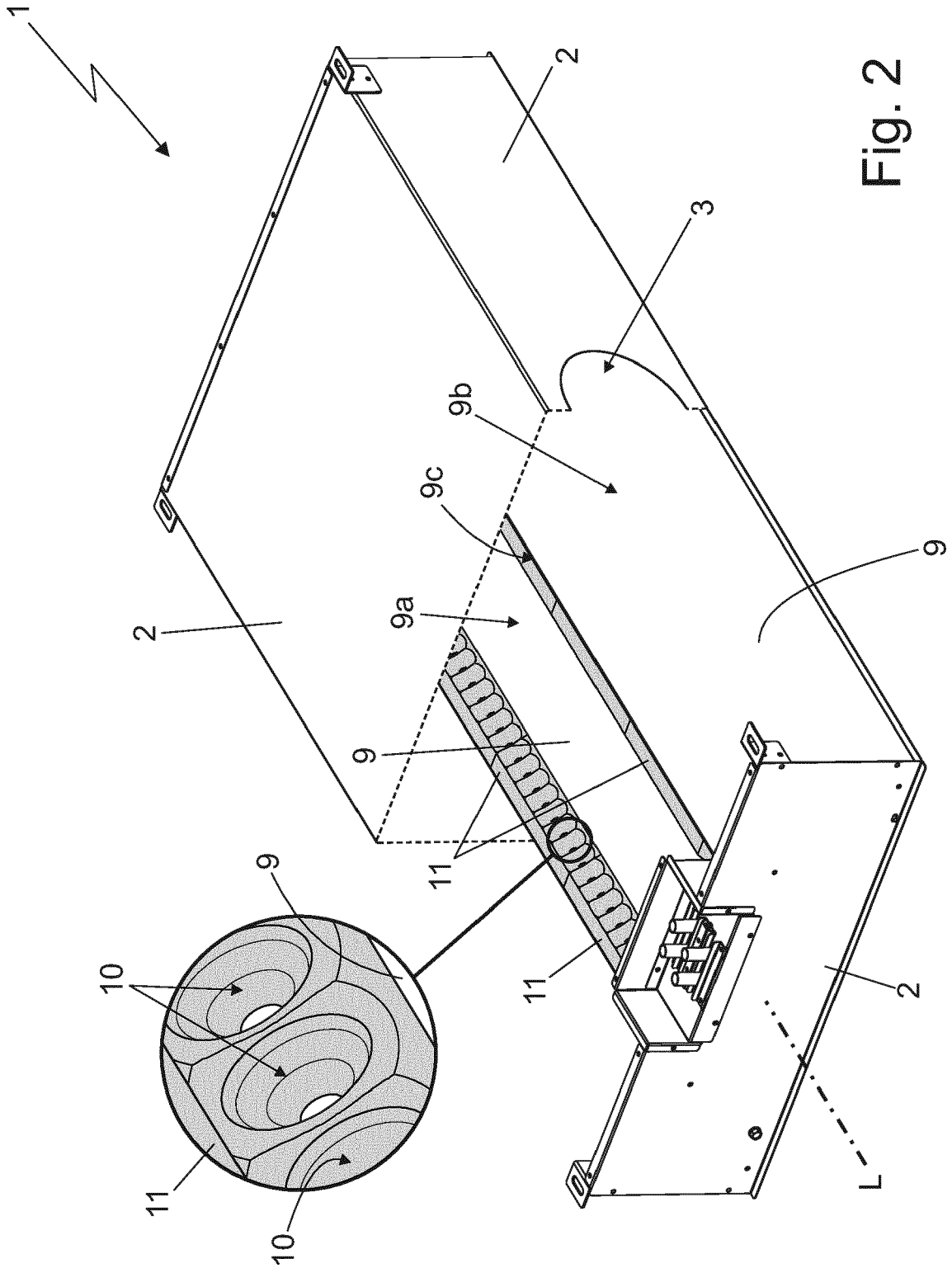

Fig. 2

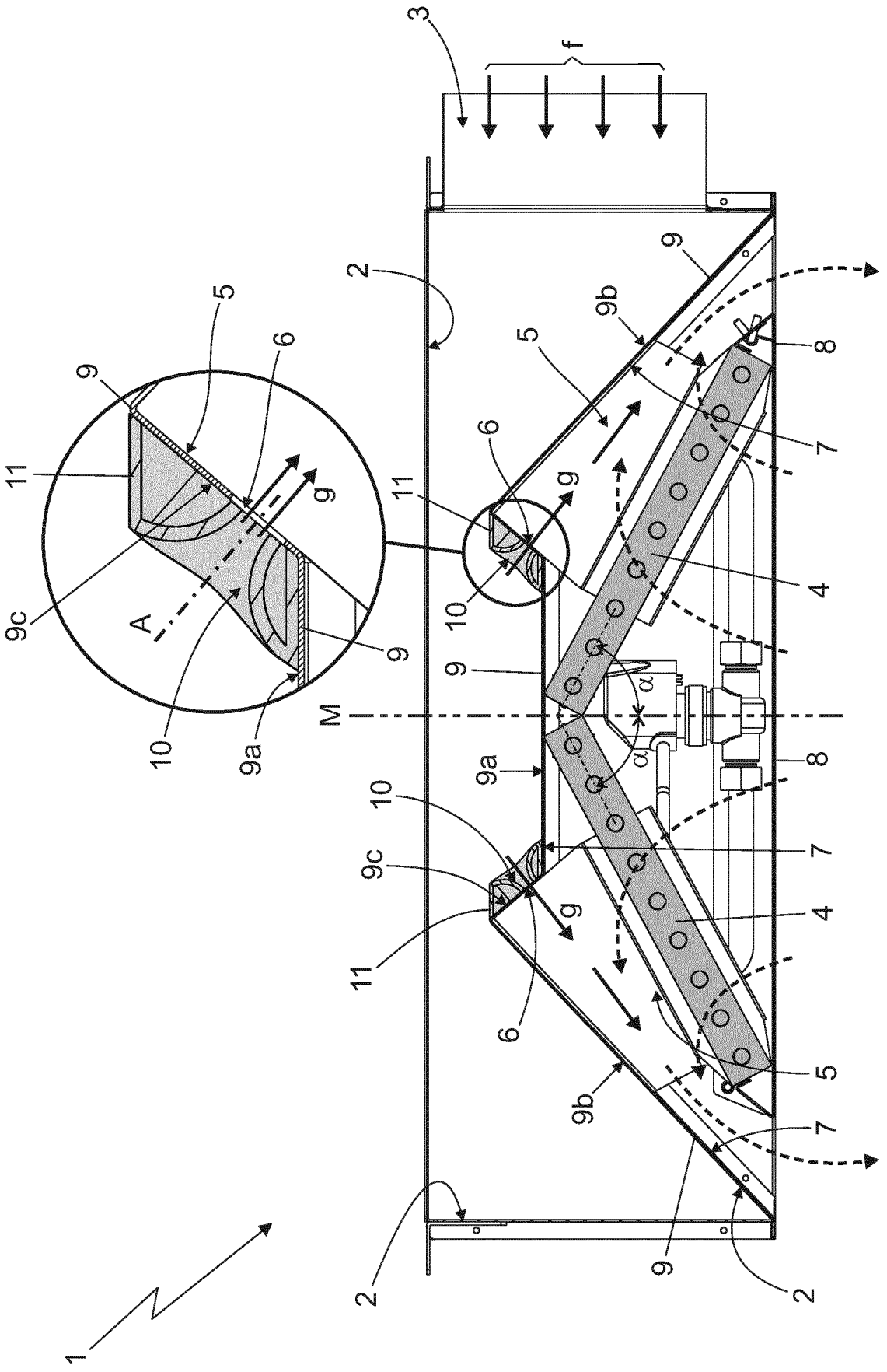

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 19 16 1427

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/140363 A1 (HIRSCH JOACHIM [US] ET AL) 10 June 2010 (2010-06-10) * paragraph [0025] - paragraph [0025]; figures 6-9 * * paragraph [0030] - paragraph [0033] * * paragraph [0043] - paragraph [0048] *	1-15	INV. F24F13/26 F24F1/01 F24F5/00 F24F1/0007 F24F1/0047
X	US 2002/062948 A1 (HORTTANAINEN PEKKA [FI] ET AL) 30 May 2002 (2002-05-30) * paragraph [0021] - paragraph [0027]; figures 1-5 *	1-15	ADD. F24F1/00
X	WO 2015/107550 A2 (DESICCANT ROTORS INTERNAT PRIVATE LTD [IN]; PAHWA DEEPAK [IN]; PAHWA V) 23 July 2015 (2015-07-23) * page 7 - page 9; figures 1,9 *	1-15	
X	EP 0 967 443 A2 (STIFAB FAREX AB [SE]) 29 December 1999 (1999-12-29) * paragraph [0010] - paragraph [0012]; figure 1 *	1-15	TECHNICAL FIELDS SEARCHED (IPC)
X	AU 67616 81 A (ENVIRON MECHANICAL SERVICES PT) 3 September 1981 (1981-09-03) * page 2 - page 2; figures 1,2 *	1-15	F24F
X	DE 33 21 612 A1 (HOWALDTSWERKE DEUTSCHE WERFT [DE]) 20 December 1984 (1984-12-20) * page 6 - page 7; figure 1 *	1-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 June 2019	Anconetani, Mirco

CATEGORY OF CITED DOCUMENTS

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27-06-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010140363 A1	10-06-2010	CA 2685977 A1	05-06-2010
		US 2010140363 A1	10-06-2010
US 2002062948 A1	30-05-2002	BE 1014487 A5	04-11-2003
		DE 10157408 A1	29-05-2002
		FI 20002589 A	25-05-2002
		FR 2817329 A1	31-05-2002
		GB 2371357 A	24-07-2002
		NL 1019384 C2	27-05-2002
		US 2002062948 A1	30-05-2002
WO 2015107550 A2	23-07-2015	AU 2015207691 A1	01-09-2016
		CA 2963620 A1	23-07-2015
		CN 106574790 A	19-04-2017
		EP 3094926 A2	23-11-2016
		JP 2017503999 A	02-02-2017
		US 2016334117 A1	17-11-2016
		WO 2015107550 A2	23-07-2015
EP 0967443 A2	29-12-1999	DE 69912030 T2	22-07-2004
		EP 0967443 A2	29-12-1999
		NO 318402 B1	14-03-2005
AU 6761681 A	03-09-1981	NONE	
DE 3321612 A1	20-12-1984	NONE	

EPO FORM P0459

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- IT 102018000003335 **[0001]**