(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 726 890 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.11.2006 Bulletin 2006/48

(51) Int Cl.:
F24F 1/00 *(2006.01)* ***F24F 13/20*** *(2006.01)*

(21) Application number: **06380106.2**

(22) Date of filing: **09.05.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **10.05.2005 ES 200501112**

(71) Applicant: **Universitat Politecnica de Catalunya**
08028 Barcelona (ES)

(72) Inventor: **Nacenta Anmella, Jose Maria**
08028 Barcelona (ES)

(74) Representative: **SUGRANES - VERDONCES - FERREGÜELA**
304 Calle Provenza
08008 Barcelona (ES)

(54) Indoor unit of an air conditioner

(57) Indoor unit of an air conditioner of the type that consists of a hollow casing with vents for the inlet and outlet of air, respectively, being housed therein at least one heat exchanger and a centrifugal fan that inhales air, through the inlet vent, from the comfort area of a room to the surfaces of the heat exchanger and returns it, through the outlet vent, to said comfort area, the indoor unit comprising a separator that divides the casing into two transversal cavities, one inlet cavity and one outlet cavity, with an opening for the air to pass from one cavity to the other, the fan being positioned in said opening with its axis of rotation essentially perpendicular to the largest faces of the casing, the opening constituting the entrance to the fan's air intake.

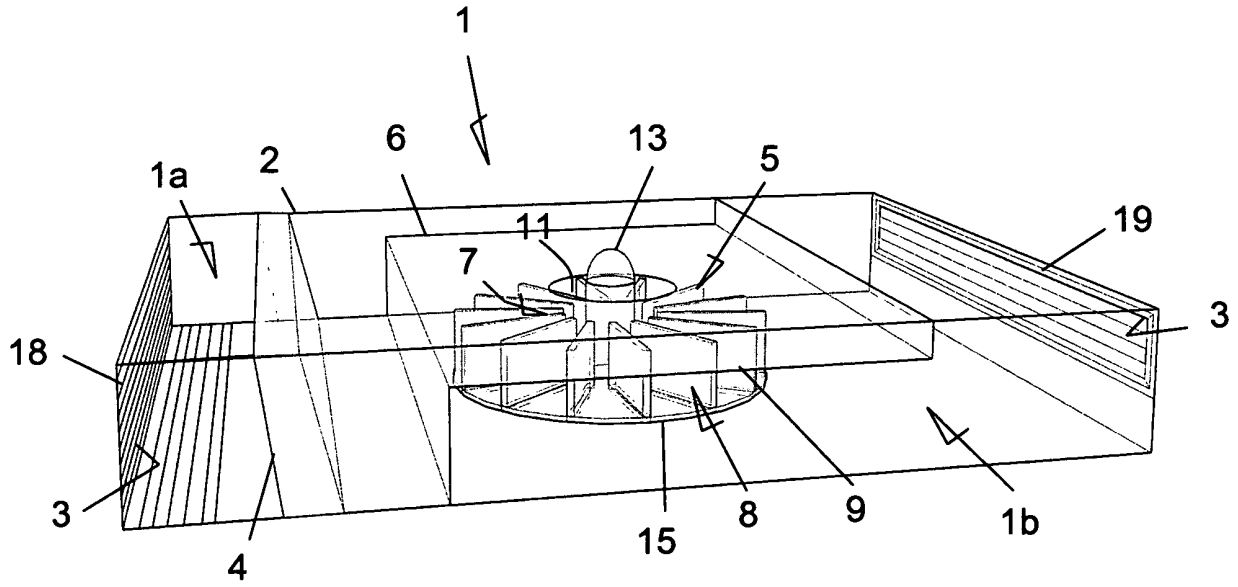

Fig. 3

EP 1 726 890 A1

Description

Technical field of the invention

[0001] The invention relates to an indoor unit of an air conditioner of the type that consists of a hollow casing with vents for the inlet and outlet of air, respectively, being housed therein at least one heat exchanger and a fan that inhales air, through the inlet vent, from the comfort area of a room to the surfaces of the heat exchanger and returns it, through the outlet vent, to said comfort area.

Background of the invention

[0002] The known indoor units of air conditioners consist of an outer casing, in the form of a cabinet, with an air inlet grille or orifice situated preferably, in apparatus to be installed in a horizontal or vertical position, on the lower part and an air outlet grille or orifice situated on the front part of the casing. Said units also comprise a heat exchanger generally consisting, in cooling apparatus, of an evaporator that cools the air that enters the casing through the inlet grille using the evaporation heat of a refrigerant. A fan housed inside the casing is responsible for inhaling the air from the room, directing it towards the heat exchanger of the indoor unit and expelling it towards the outside through the outlet grille or through tubes.

[0003] An example of an indoor unit of an air conditioner is disclosed in document WO 3033965. The casing of the unit has a front orifice or a grille that extends horizontally, behind which a tangential fan is positioned, inside the casing, which inhales and expels the air in a tangential direction in relation to its axis of rotation. Until now, this type of fan, with an axis of rotation parallel to the inlet grille or orifice, has been used because the fan motor can be housed inside the casing at one of the ends of the fan, thus increasing the length of the casing to a greater or lesser extent whilst avoiding having to increase the thickness thereof. In this type of unit the thickness of the casing is determined by the diameter of the fan wheel, which, to achieve an optimum airflow, must have a minimum size. As has been mentioned above, this minimum size conditions the thickness of the casing; the greater the airflow, the thicker the casing.

[0004] The use of centrifugal fans, positioned inside the casing in such a way that their axis of rotation is perpendicular to the largest faces of said casing, partly solves the aforementioned problems. Despite the fact that the diameter of the fan wheel does not condition the thickness of the casing, the size of the drive motor of said fans does condition said thickness. This type of fan is often used in units to be installed horizontally on the ceilings of rooms requiring air conditioning. In this type of installations the thickness of the unit is not particularly relevant as the unit is usually built into the false ceiling of the room and the formwork of the floor above.

[0005] There is therefore a need for an indoor air-conditioning unit that is thinner than known units, without this entailing a reduction in the flow of inhaled air, ensuring an optimum cooling capacity of the air conditioner.

Explanation of the invention

[0006] The indoor unit of an air conditioner that is the object of the invention overcomes the aforementioned problems. Said unit consists of an essentially parallelepipedic straight rectangular hollow casing with vents for the inlet and outlet of air, respectively, being housed therein at least one filter element, at least one heat exchanger and a centrifugal fan that inhales air, through the inlet vent, from the comfort area of a room to the surfaces of the heat exchanger and returns it, through the outlet vent, to said comfort area.

[0007] The unit is essentially characterised in that it comprises a separator that divides the casing into two transversal cavities, one inlet cavity and one outlet cavity, with an opening for the air to pass from one cavity to the other, the fan being positioned in said opening of the separator, in such a way that its axis of rotation is essentially perpendicular to the largest faces of the casing, said opening constituting the entrance to the air intake of the fan, and in that the heat exchanger is situated on one side or other of the fan, always outside the projection, in an axial direction, of the air intake thereof.

[0008] According to another characteristic of the invention, the relationship between the diameter (D) of the fan wheel and the outlet height (h) of the fan blades follows the ratio: D/h = 5.5.

[0009] According to another characteristic of the invention, the unit is characterised in that the drive motor of the fan is housed therein, and in that the stator of said motor is housed inside a casing situated in the air intake of the fan, fastened to one of the largest faces of the hollow casing of the indoor unit.

[0010] According to another characteristic of the invention, the fan wheel comprises a flat annulus or flat circle that joins the blades of said wheel, which project from the air intake towards the ends of the fan, the annulus being joined to the rotor of the drive motor of the fan, which is an external rotor motor, and in that the stator of said motor is fastened, by supports, to the face of the casing adjacent to the annulus of the fan wheel.

Brief description of the drawings

[0011] In the attached drawings an embodiment of the indoor unit of an air conditioner according to the invention is illustrated by means of a non-limiting example. In said drawings:

Fig. 1 is a view of the longitudinal section of an indoor unit according to the invention;

Figs. 2a, 2b and 2b each show cross-section views of the separator and the fan corresponding to three variants of an indoor unit according to the invention; and

Fig. 3 shows a schematic perspective view of the indoor unit shown in Fig. 1.

Detailed description of the drawings

[0012] The indoor unit 1 of the air conditioner shown by way of an example in Fig. 1 is formed in a known way by a parallelepipedic straight rectangular hollow casing 2 with vents for the inlet 18 and outlet 19 of air, respectively, being housed therein two filter elements 3, that cover said air inlet and outlet vents; a heat exchanger 4; and a centrifugal fan 5 that inhales air, through the inlet vent 18, from the comfort area of a room to the surfaces of the heat exchanger 4 and returns it, through the outlet vent 19, to said comfort area.

[0013] As is shown in Figs. 1 and 3, the indoor unit 1 comprises a separator 6 that divides the casing into two transversal cavities, one inlet cavity 1 a and one outlet cavity 1 b. The separator has an opening 11 (see Fig. 3) for the air to pass from the inlet cavity 1 a to the outlet cavity 1b, always through the centrifugal fan 5 positioned for this purpose on one side of said opening in the separator, its axis of rotation being perpendicular to the largest faces 17 and 17' of the casing 2, said opening 11 constituting the fan's air intake 7. In the example shown in Figs. 1 and 3 the heat exchanger 4 is situated in the inlet cavity 1 a of the casing 2, outside the projection, in an axial direction, of the fan's air intake 7.

[0014] The air flow through the inside of the casing 2 follows an axial direction at the inlet of the fan 5 and flows perpendicular to the axis thereof at the outlet of the fan 5, the inlet direction and outlet direction of the air thus forming a right angle.

[0015] The fan 5 is preferably of the type fitted with blades 9 facing forwards (action) or backwards (reaction). Fans fitted with blades facing forwards have a larger number of blades but generate little noise. For the same speed of rotation, this type of fan achieves the same airflow with a smaller fan compared to other types of fan. Fans fitted with blades facing backwards offer better performance than the former type because the old flat blades can be replaced by the latest designs with an aerodynamic profile, making it possible to reach performances of between 75 and 80% although, for the same speed of rotation and number of blades, their mass flow rate and their pressure are lower than fans of the type that have blades facing forwards.

[0016] In general, by using this type of fans it is not necessary to reach high speeds of rotation to achieve sufficient flow and force of air. In this embodiment the fan works at few revolutions per minute; to be specific, with a motor with 6 or more poles it can work at up to 950 revolutions per minute.

[0017] In order to achieve the optimum flow with the minimum space in which to locate the drive motor of the fan 5, the relationship between the diameter D of the wheel 8 of the fan 5 and the outlet height h of the fan blades 9 follows the expression D/h = 5.5. It is thus possible to achieve, as can be seen in Fig. 3, a considerable reduction in the thickness of the casing 2 compared to the current thickness of known indoor units, keeping the same technical features as regards cooling capacity, airflow, available pressure, electrical consumption and noise level. This reduction is actually due to not only the dimensions of the fan 5 but also the innovative location of the drive motor 12 inside the air intake 7 of the fan 5. With these characteristics it is possible to reduce the maximum thickness of the casing of conventional indoor units of air conditioners by between 30 and 40%.

[0018] In effect, as can be observed in detail in Figs. 2 and 3, the stator 10 of the drive motor 12 is housed inside a casing 13 situated in the air intake 7 of the fan 5, fastened to one of the largest faces of the hollow casing 2 of the indoor unit. With the motor thus located, the thickness of the casing 2 adapts to measurements very similar to those of the drive motor 12, which in turn guarantees an airflow of the proportions between the diameter and the outlet height of the blades of the fan described above.

[0019] As can be observed in Figs. 2a and 2b the wheel 8 of the fan 5 comprises a flat annulus 15 that joins the blades 9 of said wheel, which project from the annulus towards the air intake 7, said annulus 15 being joined to the rotor 14 of the drive motor 12 of the fan 5. In the example in Fig. 2b, the drive motor 12 is an internal rotor motor, and the stator 10 of said motor is fastened, by corresponding supports 16', to the face 17' opposite the face 17 of the casing 2 that is adjacent to the annulus 15 of the fan wheel.

[0020] By way of an alternative, in the example shown in Fig. 2a the drive motor 12 is an external rotor motor, and the stator 10 of said motor is fastened, by supports 16, to the face 17 of the casing 2 adjacent to the annulus 15 of the wheel 8 of the fan 5. This has an advantage over the previous variant, in that the supports 16 do not have to be adapted to the thickness of the casing 2.

[0021] Fig. 2c shows another variant of an indoor unit of an air conditioner according to the invention, and more specifically of the separator 6 and the area in which the wheel 8 is located. In said variant it can be observed that the face 17 of the casing 2 is not flat and that, unlike the variants in Figs. 2a and 2b, it has a recess 20 that determines a housing wherein the drive motor 12 of the fan 5 is located. Said motor 12 is firmly attached to the casing by means of supports 16' and it also has a second set of wall fastening supports 21 for the attachment thereof to the walls of the room, preferably to the wall adjacent to the ceiling.

[0022] In the example shown in Fig. 2c, the recess 20 takes the form of an inverted dome and has a hole through which the axis of rotation of the fan 5, driven by the rotor 14 of the drive motor 12 is inserted into the casing 2 to thereby transmit the rotational movement to the wheel 8 of the fan 5. Advantageously, according to this constructive variant it is not necessary to dismantle the casing 2 to perform any maintenance or repair work on the drive motor 12.

[0023] Unlike known indoor units, wherein the fan 5 has its own casing that encloses the fan wheel and forms the fan's air intake, in the indoor unit according to the invention it is the separator 6 that performs said function. As can be observed in Fig. 1, the opening 11 in the separator 6 has a section, like a funnel, that widens in the direction of the airflow. In said figure, the walls that constitute the air intake of the fan 5, which form part of the separator 6, are of a concave generatrix whilst the upper profile of the blade 9 is straight. Although not shown in the drawings, it should be understood that the upper profile of the blades 9 can be curved and that the walls that constitute the air intake of the fan 5 can have a straight generatrix or can have a curvature that is complementary to that of the upper profile of the blades 9.

[0024] In Figs. 2a and 2b, by way of an alternative, the opening 11 in the separator 6 does not have a collar to accompany the air inhaled by the fan 5 towards the blades 9.

[0025] On the outlet side, the separator 6 can have a rounded form to aid the flow of air as it leaves the fan 5, towards the outlet vent 19, similar to spiral-shaped casings.

[0026] Naturally, the air inlet 18 and outlet 19 vents can be situated on the lateral faces or on the front face of the casing 2. As regards the heat exchanger 4, it is disposed at an angle to the largest faces 17 and 17' of the casing 2 of the indoor unit 1, thus maximising the surface area for contact with the air.

[0027] With these characteristics, the indoor unit 1 of the air conditioner that is the object of the invention can either be installed in a horizontal position, suspended from the ceiling of the room to be air conditioned, or in a vertical position, resting against one of the walls of said room, occupying a minimum space thanks to the reduction in the thickness of the casing 2.

Claims

1. Indoor unit (1) of an air conditioner of the type that consist of an essentially parallelepipedic straight rectangular hollow casing (2) with vents for the inlet (18) and outlet (19) of air, respectively, being housed therein at least one filter element (3), at least one heat exchanger (4) and a centrifugal fan (5) that inhales air, through the inlet vent, from the comfort area of a room to the surfaces of the heat exchanger and returns it, through the outlet vent, to said comfort area, **characterised in that** it comprises a separator (6) that divides the casing into two transversal cavities, one inlet cavity (1a) and one outlet cavity (1 b), with an opening (11) for the air to pass from one cavity to the other, the fan being positioned in said opening of the separator, in such a way that its axis of rotation is essentially perpendicular to the largest faces of the casing, said opening constituting the air intake (7) of the fan, and **in that** the heat exchanger is situated on one side or other of the fan, always outside the projection, in an axial direction, of the air intake thereof.

2. Indoor unit (1) according to claim 1, **characterised in that** the relationship between the diameter (D) of the fan wheel (8) and the outlet height (h) of the fan blades (9) follows the ratio:

$$D/h = 5.5$$

3. Indoor unit (1) according to the previous claims, **characterised in that** the drive motor (12) of the fan (5) is housed therein, and **in that** the stator (10) of said motor is housed inside a casing (13) situated in the air intake (7) of the fan and is fastened to one of the largest faces of the hollow casing (2) of the indoor unit.

4. Indoor unit (1) according to claim 3, **characterised in that** the fan wheel (8) comprises a flat annulus (15) that joins the blades (9) of said wheel, which project from the air intake towards the ends of the fan (7), the annulus being joined to the rotor (14) of the drive motor (12) of the fan (5), which is an external rotor motor, and **in that** the stator (10) of said motor is fastened to the face (17) of the casing (2) adjacent to the annulus of the fan wheel by supports (16).

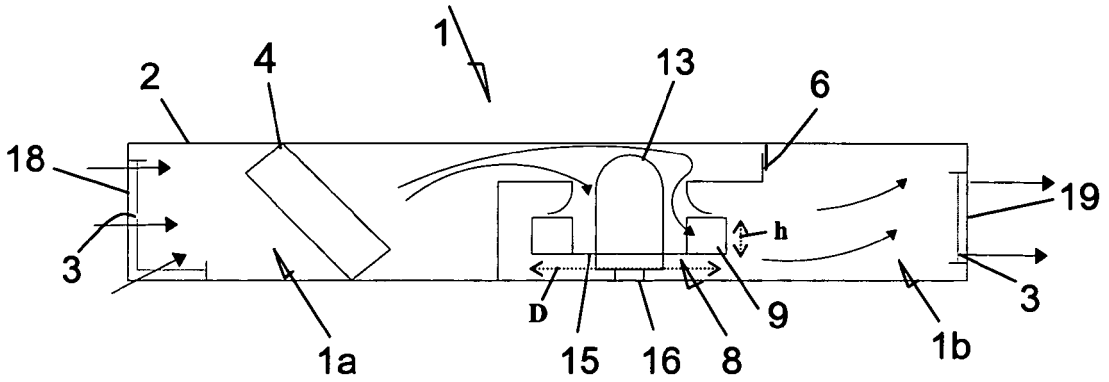

Fig. 1

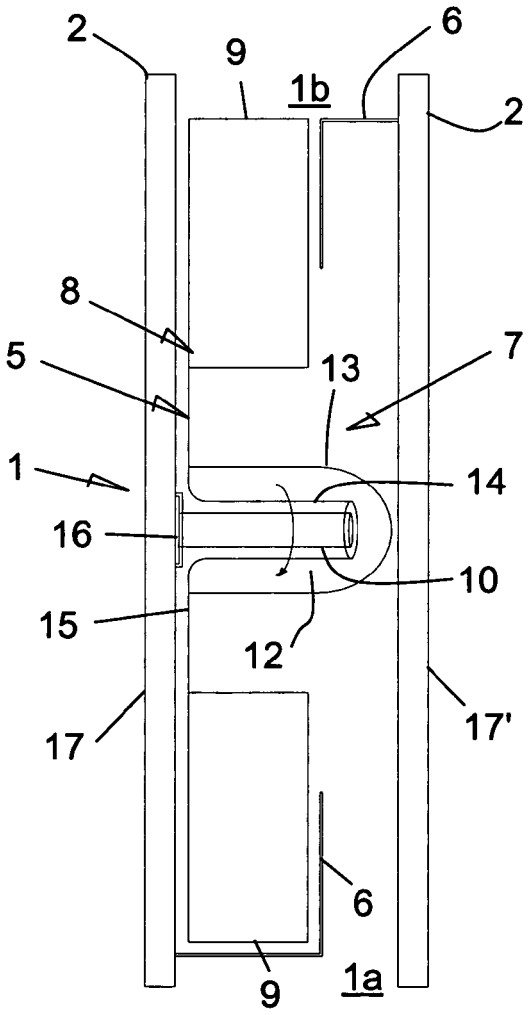

Fig. 2a

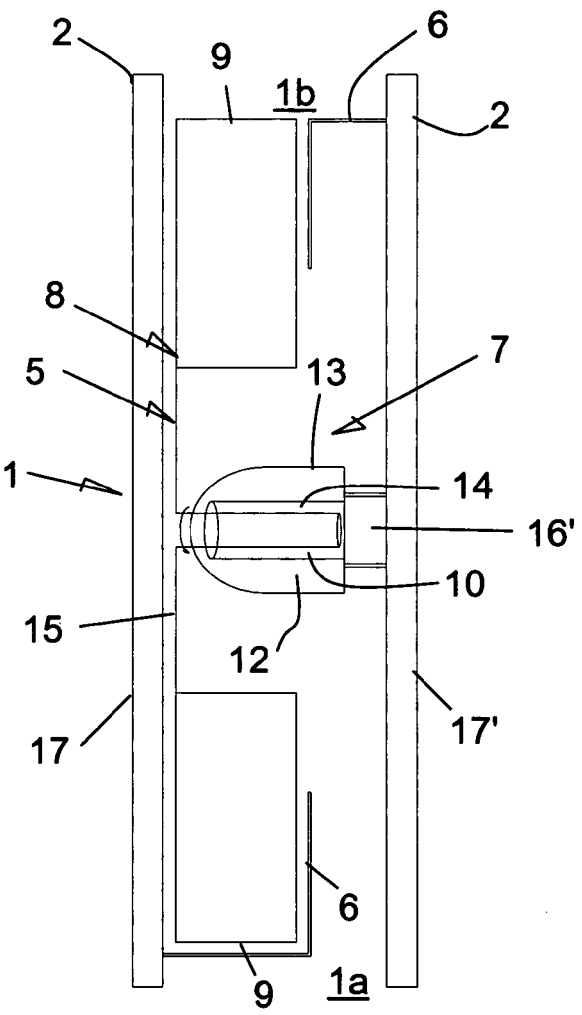

Fig. 2b

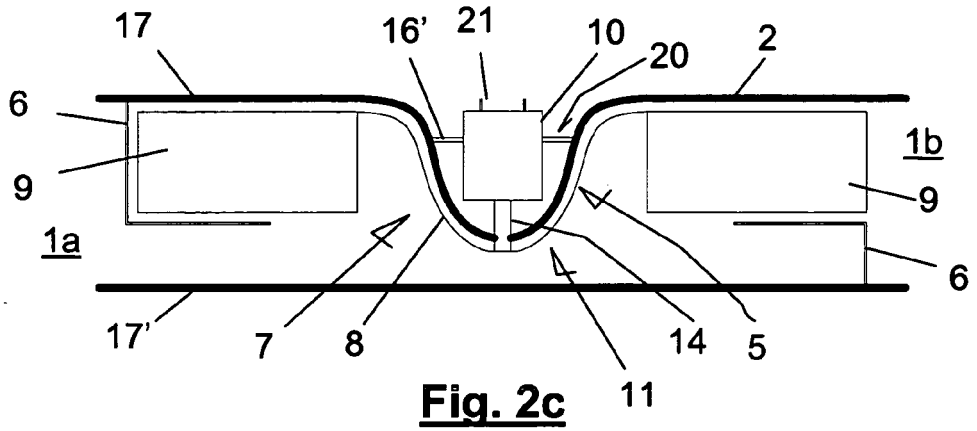
17
16'
21
10
20
2
6
1b
9
9
1a
6
17'
7
8
14
5
11

Fig. 2c

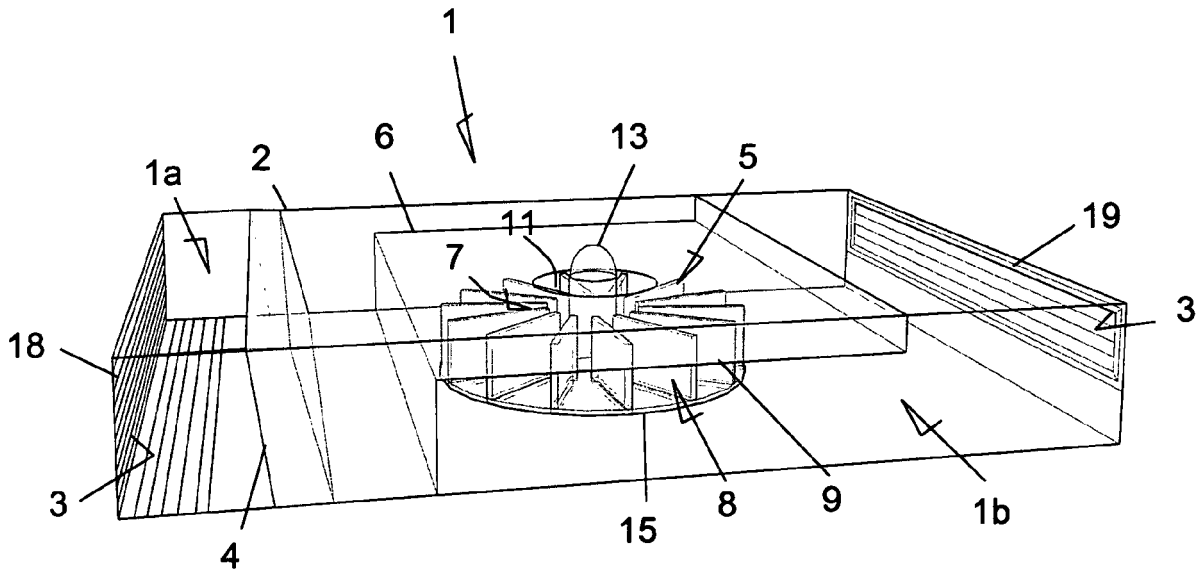
1
6
13
5
1a
2
11
19
7
3
18
3
4
15
8
9
1b

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 38 0106

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 5 823 002 A (JEONG ET AL) 20 October 1998 (1998-10-20) * the whole document * -----	1-4	INV. F24F1/00 F24F13/20
X	US 5 769 709 A (KIM ET AL) 23 June 1998 (1998-06-23) * the whole document * -----	1-4	
E	EP 1 686 324 A (LG ELECTRONICS INC) 2 August 2006 (2006-08-02) * abstract * -----	1-4	
Y	US 4 367 636 A (SAKUMA ET AL) 11 January 1983 (1983-01-11) * the whole document * -----	1-4	
Y	PATENT ABSTRACTS OF JAPAN vol. 007, no. 159 (M-228), 13 July 1983 (1983-07-13) & JP 58 066737 A (HITACHI SEISAKUSHO KK), 21 April 1983 (1983-04-21) * abstract * -----	1-4	

TECHNICAL FIELDS SEARCHED (IPC)

F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 August 2006	Valenza, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

4

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 38 0106

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-08-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5823002 A	20-10-1998	CN 1161434 A	08-10-1997
		JP 2895813 B2	24-05-1999
		JP 9178253 A	11-07-1997
		KR 187226 B1	01-05-1999
US 5769709 A	23-06-1998	CN 1165273 A	19-11-1997
		ID 16277 A	18-09-1997
		JP 2849582 B2	20-01-1999
		JP 10026394 A	27-01-1998
		KR 210084 B1	15-07-1999
EP 1686324 A	02-08-2006	WO 2006071067 A2	06-07-2006
US 4367636 A	11-01-1983	AU 543392 B2	18-04-1985
		AU 7435581 A	01-04-1982
		PH 20141 A	08-10-1986
JP 58066737 A	21-04-1983	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 3033965 A **[0003]**