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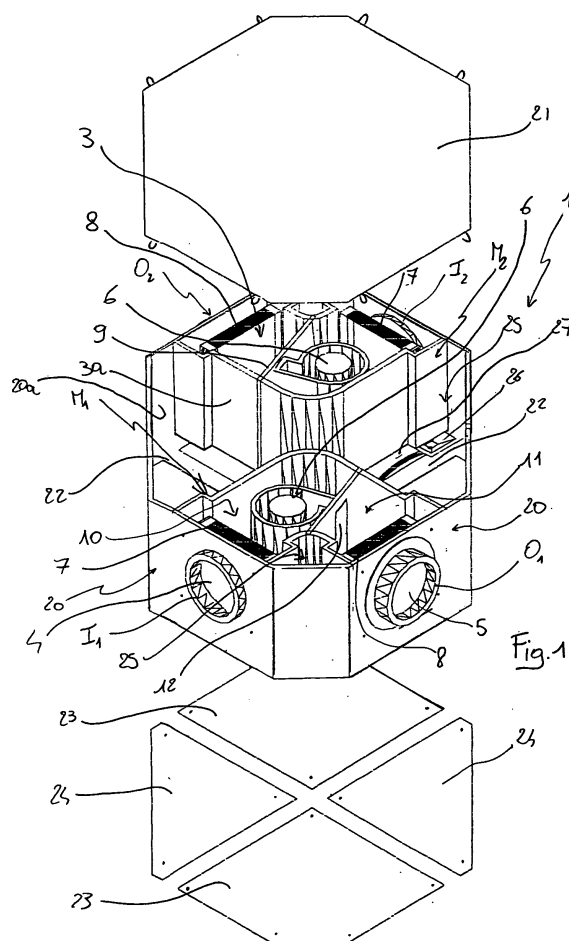
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(54) **Modular air-conditioning unit**

(57) An air-conditioning unit (1) comprises a case (2) with air intake mouths (In) and air delivery mouths (On), ventilation means to admit air via the air intake mouths (In) and to expel air from the air delivery mouths (On), and heat exchange means. The unit (1) comprises air-conditioning modules (M_j) which are housed in the case (2), each module (M_j) comprising a closed air conveyor element (3) which has an air intake opening (4) in fluid communication with a corresponding air intake mouth of said air intake mouths (In) and an air delivery opening (5) in fluid communication with a corresponding air delivery mouth of said air delivery mouths (On). The ventilation means comprise a ventilation element (6) which is housed in each module of said air-conditioning modules (M_j). The heat exchange means comprise a first heat exchange element (7) which is housed in each module of said air-conditioning modules (M_j) at the corresponding air intake opening (4).



Description

[0001] The present invention relates to an air-conditioning unit according to the preamble of claim 1.

[0002] In particular, the air-conditioning unit according to the present application can be applied in systems for centralised conditioning of one or several environments.

[0003] Air-conditioning units for several environments are known for water-based conditioning systems, for example with a water cooler and a boiler heating system, as well as for direct-expansion systems, for example with internal evaporating units and an external motorised condenser.

[0004] In the case of water-based air-conditioning units, a water supplier provides hot or cold water, depending on whether the season is winter or summer respectively, for the supply of a heat exchange battery which is installed inside the air-conditioning unit. This unit typically consists of a case which has air intake mouths to receive the air to be conditioned from the environments, and air delivery mouths to supply conditioned air to the environments.

[0005] Inside the case are housed a plurality of ventilation elements, which admit air from the various environments via the air intake mouths, and take in the air admitted, into the interior of the unit, where the air obtained from the various environments is processed by the heat exchange battery. The air thus processed by the heat exchange battery is finally expelled from the ventilation elements via the delivery mouths for the various environments.

[0006] This solution is inadequate if the various environments require different regulations of the temperature and/or humidity. For example, in the case of buildings in which there are environments present which are used for different purposes, it is often necessary to regulate differently the temperature and humidity of the various environments, according to the different purposes to which they are allocated (laboratories, offices, stores, storage areas for micro-organisms, high-purity environments). In some of these cases, it is also essential for there to be no mixing of the air extracted from different environments.

[0007] In order to solve this problem, it has been proposed to use air-conditioning units which have a direct-expansion internal evaporating unit/convector fan, and an external motorised condenser/cooler. The evaporating units/convectors fans are installed in the individual environments to be conditioned, and make it possible to condition the corresponding environments in a manner which is differentiated in terms both of humidity and quality of the air.

[0008] However, these evaporating units/convectors fans are not adequate, not only because of the presence of elements which are on view inside the environments, but also because of the lack of systems to replace the air. In order to meet this requirement, conditioning units have been proposed which are designed to be connected

to additional ventilation elements which are outside the unit, are not normally supplied with the unit, and are intended to admit into the unit itself the external air which has not been processed and is admitted by means of corresponding ducts. Nevertheless, these evaporating units/ convectors fans cannot be considered as a valid and satisfactory alternative to the centralised air-conditioning units, since they do not eliminate the problem of the elements on view within the environments, and in particular do not permit an adequate exchange of air, since only approximately 10% of the air flow of the evaporating unit/convectors fan can consist of external air.

[0009] The foregoing information therefore shows the need to have a conditioning unit which can condition different environments by regulating both the temperature and humidity in a differentiated manner.

[0010] A further requirement consists of making it possible to have an air-conditioning unit which, when required, can guarantee an adequate exchange of air of the air-conditioned environments.

[0011] The object of the present invention is thus to propose an air-conditioning unit which has functional and structural characteristics such as to meet the aforementioned requirements, and simultaneously to eliminate the disadvantages encountered in the systems described with reference to the known art.

[0012] This object is achieved by an air-conditioning unit according to claim 1.

[0013] Further characteristics and the advantages of the air-conditioning unit according to the present invention will become apparent from the following description of a preferred embodiment of it, provided by way of non-limiting indication, with reference to the attached figures, in which:

- figure 1 shows an exploded perspective view of an air-conditioning unit according to a first embodiment of the present invention;
- figure 2 shows an exploded perspective view of an air-conditioning unit according to a second embodiment of the present invention;
- figure 3 shows an exploded perspective view of an air-conditioning unit according to a third embodiment of the present invention;
- figure 4 shows an exploded perspective view of a detail of the unit in figure 3; and
- figures 5 to 7 show perspective views of details of the air-conditioning module installed in the units in figures 1 to 3.

[0014] With reference to the attached figures, 1 indicates as a whole an air-conditioning unit according to the present invention. The unit 1 can be inserted in direct-expansion and water air-conditioning systems.

[0015] In particular, the unit 1 as described hereinafter can be installed in the false ceiling. However, the unit 1 according to the invention can also be installed in a different location, for example in an environment which is

correspondingly dedicated to it within a building. The unit 1 comprises a case 2 which has a plurality N of air intake mouths I_n and a corresponding plurality N of air delivery mouths O_n , where $n=1...N$.

[0016] A plurality of air-conditioning modules M_j , where $j=1...J$, are housed inside the case 2 of the unit 1. The number J of conditioning modules M_j is $\leq$ the number N of air intake and delivery mouths. In particular, some intake and delivery mouths can be destined for a different use, as will be described hereinafter in the present description. Each conditioning module M_j comprises an air conveyor element 3 which has an air intake opening 4 in fluid communication with a respective air intake mouth I_n of the support structure 2, and an air delivery opening 5 in fluid communication with a respective air delivery mouth O_n of the support structure 2.

[0017] The conveyor element 3 can be made of thermally insulated metal plate, or of polyurethane.

[0018] In the examples shown in the attached figures, the case 2 of the unit 1 comprises a surrounding frame 20, an upper panel 21 which can be secured by being closed onto the top of the frame 20, a pair of crossed ribs 22 provided in the lower part of the frame 20, and a plurality of lower panels 23, 24 which are appropriately shaped, such as to be closed onto the bottom of the frame 20, and in particular onto the ribs 22 of the frame 20.

[0019] The upper panel 21 has a form which is suitable for closing the frame 20 at the top, it can be made of metal plate, and it is advantageously thermally insulated.

[0020] As can be seen from figures 1 to 6, the shape of the frame 20 varies according to the number of conditioning modules M_j which must be housed in its interior.

[0021] Advantageously, the frame 20 is shaped such that, once the conditioning modules M_j are housed, empty areas 25 remain inside the frame 20 itself. These empty areas 25 form air boxes between the outer structure of the conditioning modules M_j , i.e. the wall 3a of the conveyor element 3 in the example given, and the inner wall 20a of the frame 20.

[0022] The conveyor element 3 is closed at the top by a portion of the panel 21 and at the bottom by a removable panel, for example the panel 27, the function of which will become apparent from the remainder of the present description, such as to define a closed conveyor element with only two openings, in this specific case the air intake opening 4 and the air delivery opening 5.

[0023] Alternatively the closed conveyor element can be produced with a different structure, whilst however retaining the two air intake and delivery openings 4 and 5.

[0024] Preferably, the conditioning modules M_j are positioned inside the support structure of the unit 1, such that the intake mouths I_n and delivery mouths O_n of the unit 1 correspond to the respective air intake openings 4 and air delivery openings 5 of each module M_j .

[0025] The conveyor element 3 can be secured to the frame 20 by securing means which are known, and are therefore not described further. Each module M_j can also comprise air filters and other elements which in them-

selves are known to persons skilled in the art, and will therefore not be described in further detail.

[0026] The unit 1 comprises ventilation means for the intake of air by the air intake mouths I_n and to expel air from the air delivery mouths O_n , and means for heat exchange.

[0027] In particular, the ventilation means comprise a ventilation element 6 which is housed in each conditioning module M_j , and the heat exchange means comprise a first heat exchange element 7 which is housed in each air conditioning module M_j at the respective air intake opening 4.

[0028] Substantially, the air which flows to each air intake mouth I_n is taken in and conveyed inside each module M_j by the respective ventilation element 6 via the respective air intake opening 4 which is provided in the air conveyor element 3.

[0029] The air admitted is intercepted by the heat exchange element 7 which is housed in each conditioning module M_j at the respective air intake opening 4, and is thus conditioned by the heat exchange element 7.

[0030] The air which is conditioned by the heat exchange element 7 is then conveyed by the ventilation element 6 to the delivery opening 5 of each module M_j , and is expelled from the corresponding air delivery mouth O_n of the unit 1.

[0031] By this means, each conditioning module M_j processes the air admitted by the corresponding air intake mouth I_n independently from the other modules M_j . In particular, the presence of a heat exchange module, i.e. the element 7, inside each conditioning module M_j makes it possible to condition the air independently from the other modules M_j .

[0032] The ventilation element 6 can for example be a ventilating unit with a variable-speed and adjustable electric motor. The ventilating unit can for example be a fan of the high-performance centrifugal type.

[0033] Preferably, the first heat exchange element 7 comprises an air heating/cooling element which can heat/cool the air admitted by the respective ventilation element 6 via the respective air intake opening 4.

[0034] The heating/cooling battery 7 can be a battery which is supplied with water, or a direct-expansion battery in the case of coolant fluid supplied by means of a heat pump/motorised condenser. In both cases, the battery 7 has two attachments for connection of the delivery pipes to and from a fluid supply unit.

[0035] The battery 7 can for example be a battery with copper pipes and aluminium fins.

[0036] In order to collect the condensation from the battery 7, each conditioning module M_j is provided with a condensation collection tray 26. Preferably, the collection tray 26 is integrated in the lower closure panel 27 which closes the conveyor element 3 at the bottom. The closure panel 27 can be of the metal plate type, and shaped suitably for being secured to the base of the conveyor element 3.

[0037] In order to collect the condensation obtained

from the batteries 7 of the various conditioning modules M_j , a condensation discharge device 28 is provided, which, by means of rubber tubes, is connected to the collection trays 26 of the corresponding conditioning modules M_j . The device 28 can also comprise a discharge pump and all the typical hydraulic elements necessary for its installation and functioning.

[0038] The heat exchange means can advantageously comprise a second heat exchange element 8 which is housed in at least one of the conditioning modules M_j , downstream from the ventilation element 6 or at the delivery to the ventilation element 6.

[0039] This second heat exchange element 8 makes it possible to regulate further the temperature, and, when it is used for summer post-heating, makes it possible to regulate the humidity of the air expelled from the air-conditioning module M_j in which it is housed.

[0040] Preferably, this second heat exchange element 8 comprises an air heating battery which can heat the air to be expelled from the corresponding air delivery opening 5 via the corresponding ventilation element 6. The air heating battery 8 can be a coolant gas or water battery or an electric battery.

[0041] In the case of a water battery or a direct-expansion battery, the battery is positioned at the respective air delivery opening 5.

[0042] In the case of an electric battery 8, the battery is positioned on the delivery mouth 6a of the ventilation element 6, such as to make the best possible use of the calorific power supplied by the electric battery itself. The electric battery is provided in a known manner with a safety thermostat and with the necessary wiring to be installed on the delivery mouth 6a of the ventilation element 6.

[0043] The use of the additional battery 8 is particularly advantageous in conditioning systems with 4 pipes. Examples are given hereinafter of application of the additional post-heating battery 8 in the unit 1.

[0044] I) The air-conditioning unit 1 is used in a conditioning system in which the heating system, for example of the hot water type, is physically separated from the cooling system, for example by a water cooler. In this case, the 2 pipes for delivery to, and return from, the first heat exchange element 7 positioned at the intake are connected to the delivery and return pipes of one of the two systems, for example to the water cooler of the cooling system to be used in the summer period, whereas the 2 delivery and return pipes of the heating system to be used in the winter period are connected to the delivery and return pipes of the second heat exchange element 8 which is positioned at the delivery.

[0045] II) The second heat exchange element 8 is used as summer post-heating in order to increase the temperature and to reduce the percentage of relative humidity of the air processed by the first heat exchange element 7. In fact, it may happen that the cooling battery 7 produces cold air at a temperature which is suitable for some environments but is too cold in certain climatic conditions.

In this case, the second exchange element 8 fulfils completely the function of summer post-heating, and at the same time makes it possible to regulate the percentage of humidity in the air which is emitted into the environment connected to the air conditioning module in which it is housed.

[0046] III) The air-conditioning unit 1 is used in a conditioning system with 4 pipes, in which the two fluids, i.e. hot and cold, are available and usable simultaneously by means of a three-way valve.

[0047] In the direct-expansion version with a battery 7 supplied with coolant gas, any additional hot-water or electric battery 8 can be used both in the summer conditioning and in the winter conditioning with a heat pump. In this last case, the additional battery 8 supplements or replaces the battery 7 which is supplied with a heat pump, depending on the temperature of the external air to be processed.

[0048] It should be pointed out that some air-conditioning modules M_j can have a water battery 7 for connection to a water system, and others can have a coolant gas battery 7 for connection to a direct expansion system, if the two systems are present simultaneously.

[0049] It is apparent from the foregoing description that the unit 1 makes it possible not only to select the number of heat exchange batteries to be inserted in each conditioning module M_j , but also to select the type of battery, such as to make the best possible use of the heating and cooling resources of the conditioning system in which the unit is installed, thus making an improvement on the limits of the two systems taken individually.

[0050] If the additional battery 8 is not necessary, the space which is designed to accommodate it inside the conditioning module M_j can be used to insert an acoustic attenuator which guarantees better acoustic insulation of the unit 1.

[0051] Preferably, the ventilation element 6 and the heat exchange batteries 7,8 of each conditioning module M_j are secured to the upper panel 20, whereas the accessibility to the modules M_j for their maintenance takes place from the lower part of the frame 20, by removing the lower shaped metal plate panels 23 which are secured to the crossed ribs 22, and dismantling in succession the lower closure panels 27 of the individual conditioning modules M_j .

[0052] The frame 20 thus makes it possible to access easily the components of each conditioning module M_j , i.e. the ventilation element 6, the first heat exchange battery 7, and, if it is present, the second heat exchange battery 8, in order to carry out the necessary operations of maintenance and/or replacement.

[0053] The hydraulic connections for the batteries 7,8 are positioned outside the conditioning module M_j , for example on the frame 20 of the case 2. It is also necessary to provide a three-way valve of the ON-OFF type for each air-conditioning module M_j , both for application of the unit 1 to systems with 2 pipes, and for application to systems with 4 pipes.

[0054] Figures 11 and 12 show examples of hydraulic connections of the unit 1 in the case respectively of conditioning systems with 2 and 4 pipes.

[0055] In the example shown in the attached figures, each air-conditioning unit module M_j comprises a dividing element 9 which is housed in the air conveyor element 3, in order to provide an air intake area 10 in which the air intake opening 4 is present, and an air delivery area 11 in which the air delivery opening 5 is present.

[0056] An opening 12 is provided in the dividing element 9 in order to put into communication the air intake area 10 and the air delivery area 11. In particular, the ventilation element 6 is housed in the air intake area 10 such that its delivery mouth 6a is at the opening 12 in the dividing element 9.

[0057] The dividing element 9 makes it possible to separate physically the area 10 in which the air is processed by the first heat exchange element 7, from the area 11 in which the air is processed by the second heat exchange element 8, when the latter is present.

[0058] Finally, in a known manner, the unit 1 comprises electronic control means (not shown in the figures) for control of the functioning of the individual conditioning modules M_j .

[0059] The unit 1 can be allocated to the conditioning of several environments. In this case, the air intake mouths I_n and air delivery mouths O_n for each conditioning module M_j are designed to be connected to different environments to be conditioned.

[0060] The unit 1 can also comprise at least one air-ventilation module F_k , where $k=1\dots K$, housed in the case 2, such that $N=J+K$, i.e. the number N of air intake mouths and air delivery mouths I_n , O_n is equal to the number J of air-conditioning modules M_j added to the number of air-ventilation modules F_k . In the example, it is assumed that a single air-ventilation module F is present. Each air-ventilation module F has the same elements as the above-described air-conditioning module M_j , apart from the heat exchange elements 7,8. In other words, the air-ventilation module F comprises an air conveyor element 3 which has an air intake opening 4 in fluid communication with a corresponding air intake mouth I_n and an air delivery opening 5 in fluid communication with a corresponding air delivery mouth O_n and an air ventilation element 6 which is housed in the ventilation module F .

[0061] The presence of the ventilation element F makes it possible to use the unit 1 to condition a single environment. In this case, the air intake mouths I_n and air delivery mouths O_n for at least part of the conditioning modules M_j are designed to be connected to the single environment to be conditioned, in order to carry out a function of conditioning with air recirculation, and the air intake mouths I_n and air delivery mouths O_n for the air-ventilation module are designed to be connected respectively to the single environment to be conditioned and to the exterior of this single environment to be conditioned, in order to carry out a function of extraction of air from the environment. In fact, the air extraction does not re-

quire conditioning of the air, and therefore it does not require the use of the heat exchange elements 7,8.

[0062] Advantageously, the air intake mouths I_n and air delivery mouths O_n for the other part of the air-conditioning modules M_j are designed to be connected respectively to the exterior of the single environment to be conditioned and to the environment to be conditioned in order to carry out a function of emission of conditioned air into the environment, or renewal or replacement of air.

[0063] It should also be pointed out that when several ventilation modules F are used in combination with several air-conditioning modules M_j , the unit 1 can be used to condition different environments, and at the same time to perform several functions (recirculation, extraction and replacement of air) in one or more of the environments, according to the connections of the intake and delivery mouths, and according to the type of modules to be connected.

[0064] As can be appreciated from the foregoing description, the air-conditioning unit according to the present invention makes it possible to satisfy the requirements and overcome the disadvantages referred to in the introductory part of the present description, with reference to the known art.

[0065] As demonstrated, the air-conditioning unit according to the present invention permits independent control of different environments, but with a centralised installation and with centralisation of the maintenance activities. In fact, the unit makes it possible to condition several environments which have delivery and intake in line, to and from each environment, and prevents mixing of the different flows of air obtained from the different environments.

[0066] It will be appreciated that, in order to meet contingent and specific requirements, a person skilled in the art may apply numerous modifications and variations to the air-conditioning unit according to the above-described invention, all of which are however included in the scope of the invention as defined by the following claims.

Claims

1. Air-conditioning unit (1) comprising a case (2) with a plurality (N) of air intake mouths (I_n) and a corresponding plurality (N) of air delivery mouths (O_n), ventilation means to admit air via said air intake mouths (I_n) and to expel air from said air delivery mouths (O_n) and heat exchange means,

characterised in that

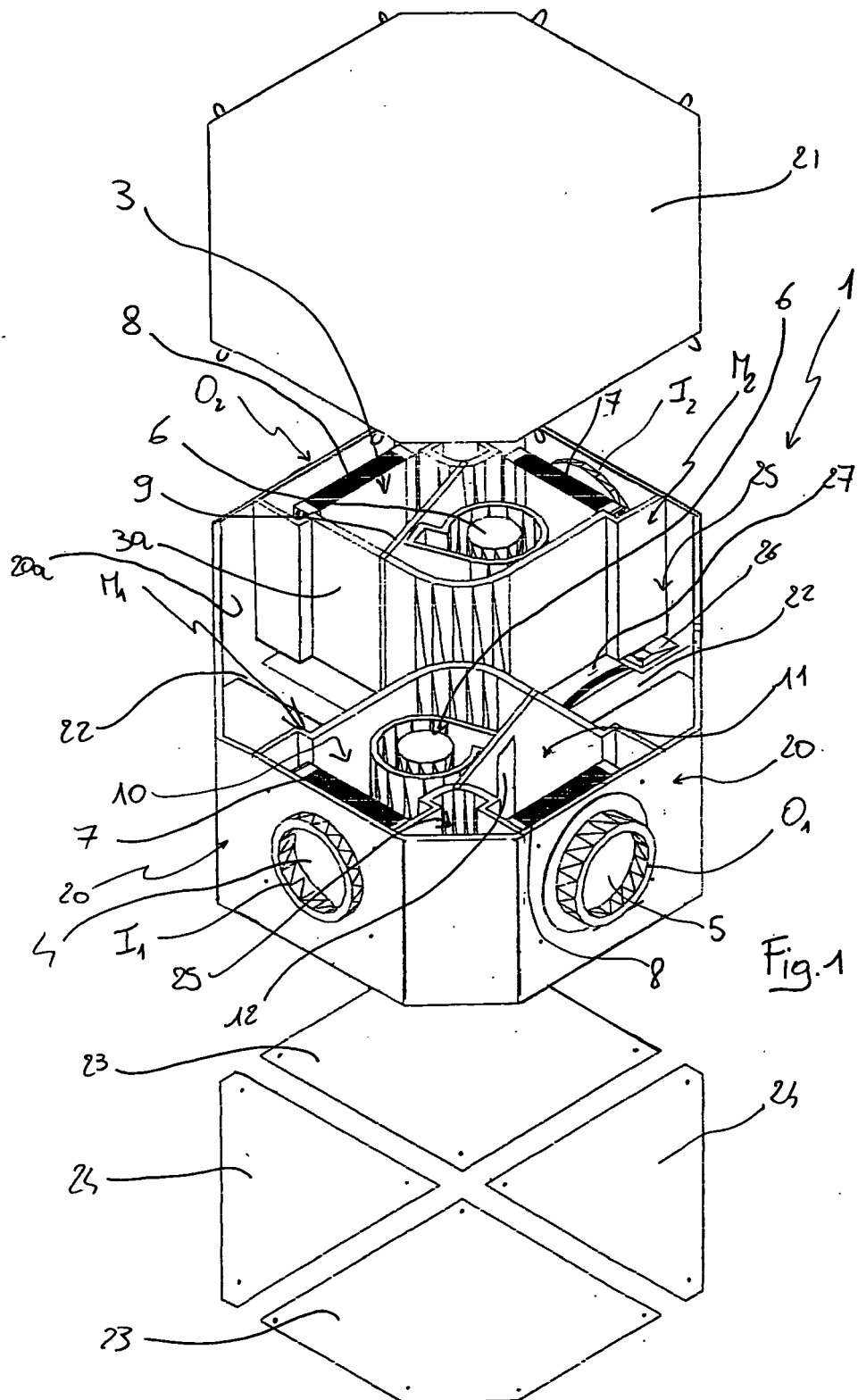
the air-conditioning unit (1) comprises a plurality (J) of air-conditioning modules (M_j) which are housed in said case (2), each air-conditioning module (M_j) comprising a closed air conveyor element (3) which has an air intake opening (4) in fluid communication with a corresponding air intake mouth of said air intake mouths (I_n) and an air delivery opening (5) in fluid

communication with a corresponding air delivery mouth of said air delivery mouths (O_n),
 said ventilation means comprising a ventilation element (6) which is housed in each module of said air-conditioning modules (M_j),
 said heat exchange means comprising at least a first heat exchange element (7) which is housed in each module of said air-conditioning modules (M_j) at the corresponding air intake opening (4).

2. Air-conditioning unit (1) according to claim 1, wherein said first heat exchange element (7) comprises an air cooling/heating battery for cooling/heating the air admitted by the corresponding ventilation element (6) via the corresponding air intake opening (4). 5
3. Air-conditioning unit (1) according to claim 1 or claim 2, wherein said heat exchange means comprise a second heat exchange element (8) which is housed in at least one module of said air-conditioning modules (M_j) at the delivery of the ventilation element (6). 10
4. Air-conditioning unit (1) according to claim 3, wherein said second heat exchange element (8) comprises an air heating battery for heating the air to be expelled from the corresponding air delivery opening (5) via the corresponding ventilation element (6). 15
5. Air-conditioning unit (1) according to any one of claims 1 to 4, wherein the air intake mouths (I_n) and air delivery mouths (O_n) for each air conditioning module are intended to be connected to different environments to be conditioned. 20
6. Air-conditioning unit (1) according to any one of claims 1 to 4, also comprising at least one air ventilation module (F_k) which is housed in said case (2), each air ventilation module (F_k) comprising an air conveyer element (3) which has an air intake opening (4) in fluid communication with a corresponding air intake mouth of said air intake mouths (I_n) and an air delivery opening (5) in fluid communication with a corresponding air delivery mouth of said air delivery mouths (O_n) and an air ventilation element (6) which is housed in said ventilation module (F_k). 25
7. Air-conditioning unit (1) according to claim 6, wherein the air intake mouths (I_n) and air delivery mouths (O_n) for at least part of the air conditioning modules (M_j) are intended to be connected to a single environment to be conditioned, to perform a function of conditioning with air recirculation in said environment, and the air intake mouths (I_n) and air delivery mouths (O_n) for each air-ventilation module (F_k) are intended to be connected respectively to said single environment to be conditioned, and on the exterior of said single environment to be conditioned in order to perform a function of extraction of air from said 30

environment.

8. Air-conditioning unit (1) according to claim 7, wherein the air intake mouths (I_n) and air delivery mouths (O_n) for the other part of the air-conditioning modules are intended to be connected respectively to the exterior of said single environment to be conditioned and to said single environment to be conditioned, to perform a function of emission of conditioned air into said environment. 35
9. Air-conditioning unit (1) according to any one of claims 1 to 8, wherein each module of said air-conditioning modules (M_j) comprises a dividing element (9) which is housed in said closed air conveyer element (3) for identifying an air intake area (10) which is provided with the air intake opening (4) and an air delivery area (11) which is provided with the air delivery opening (5), an opening (12) being provided in said dividing element (9) in order to put into communication said air intake (10) and air delivery areas (11). 40



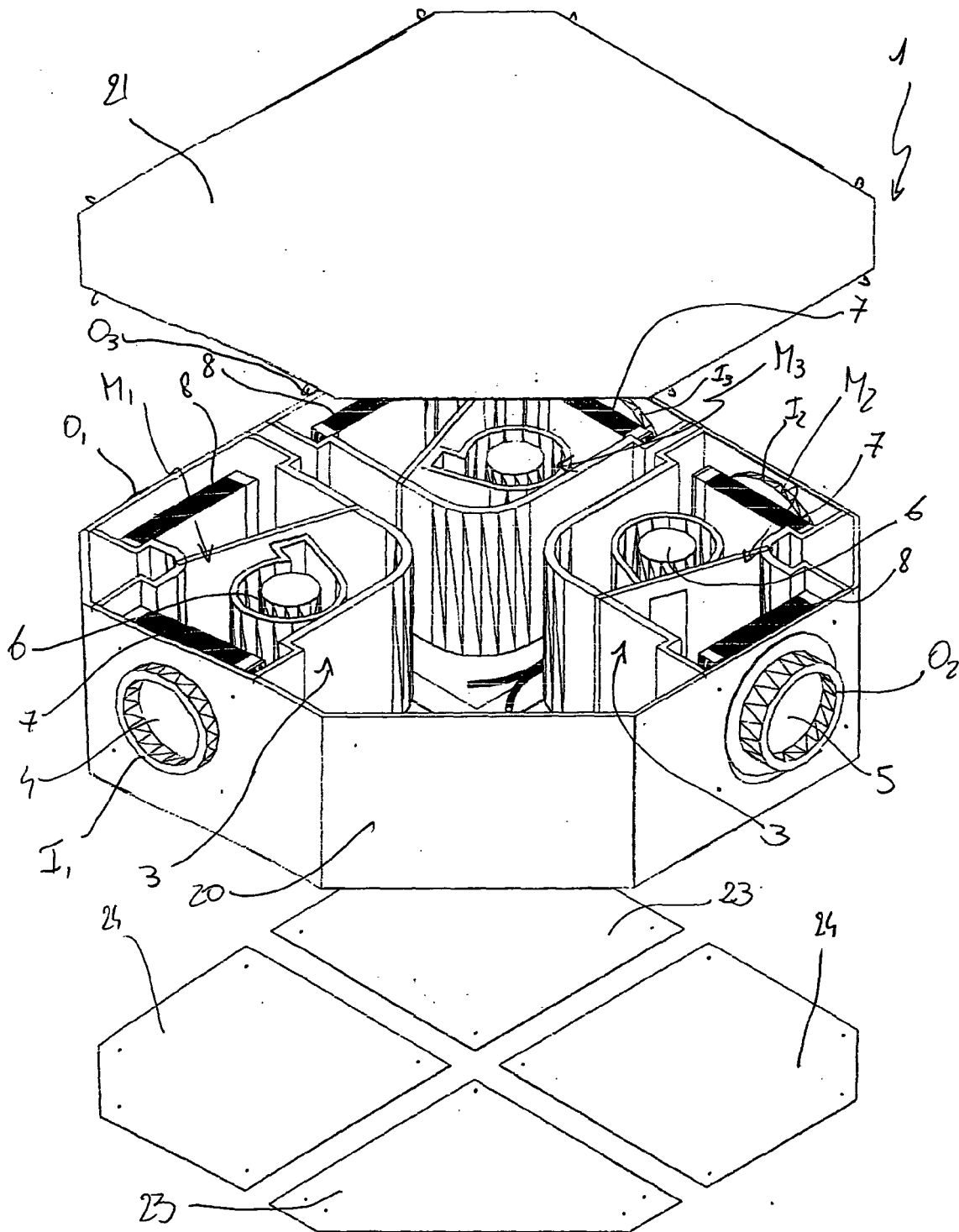


Fig. 2

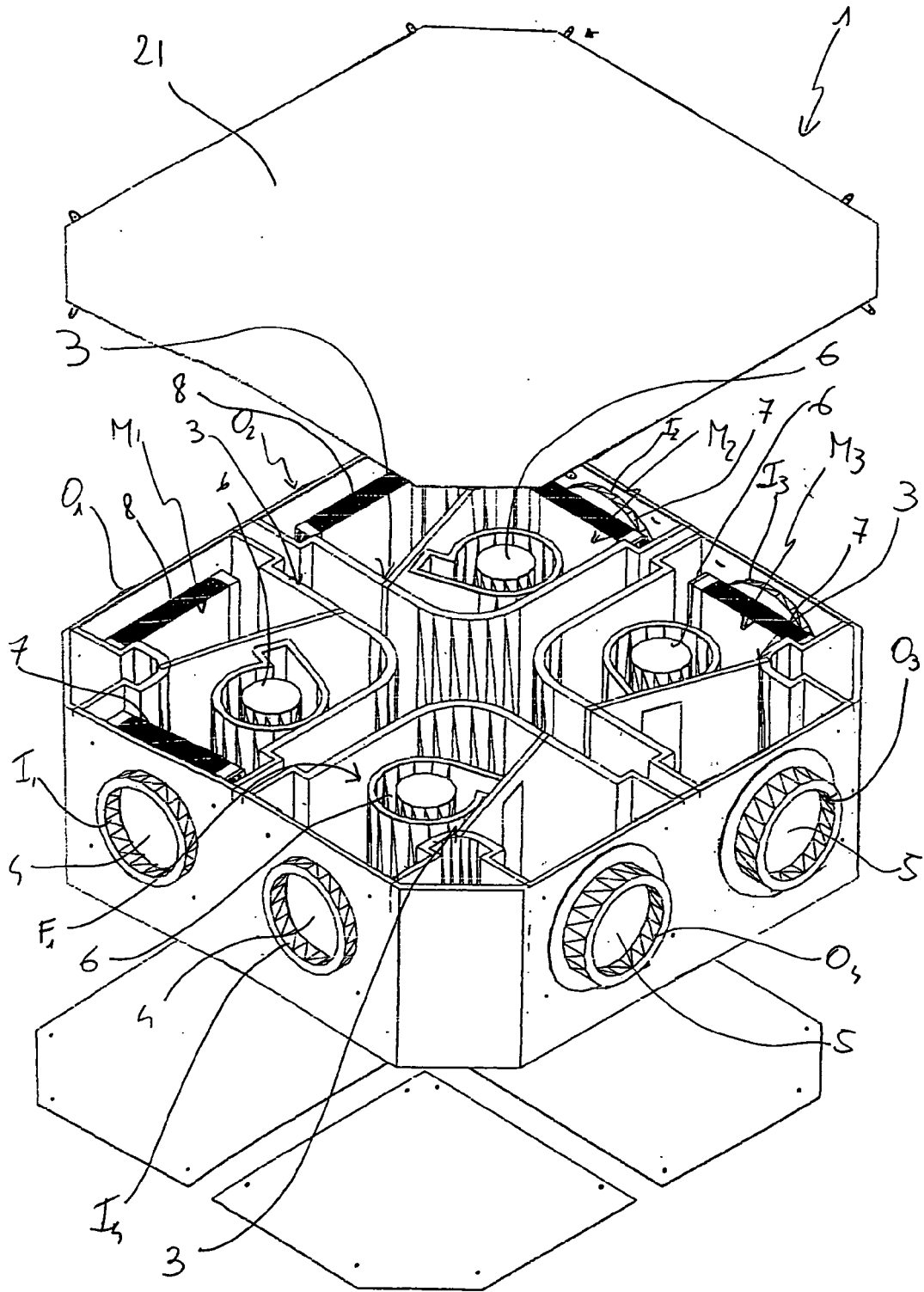
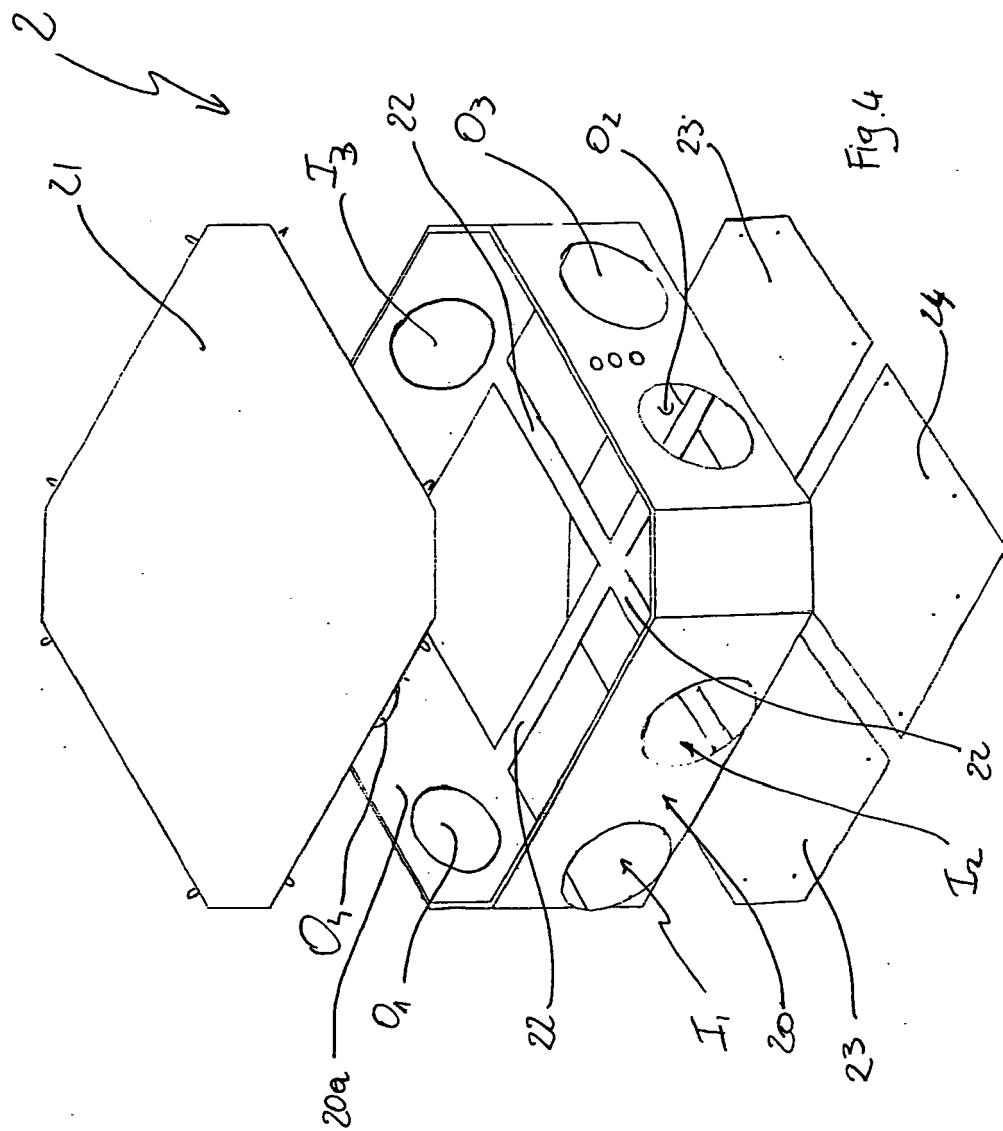
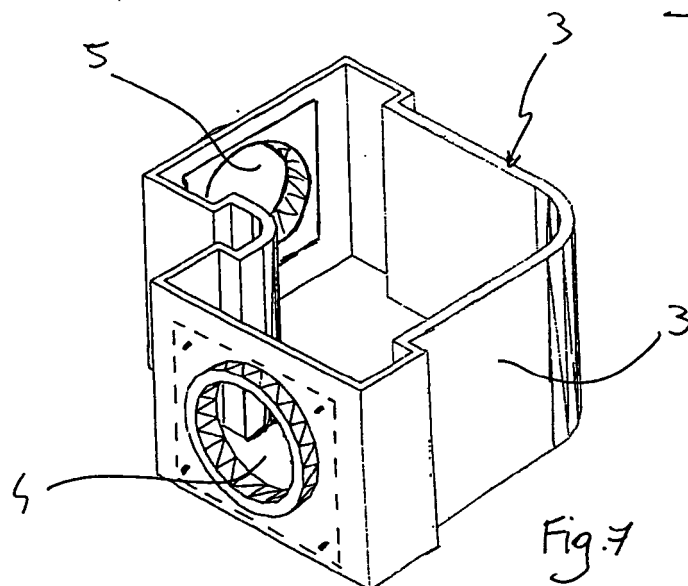
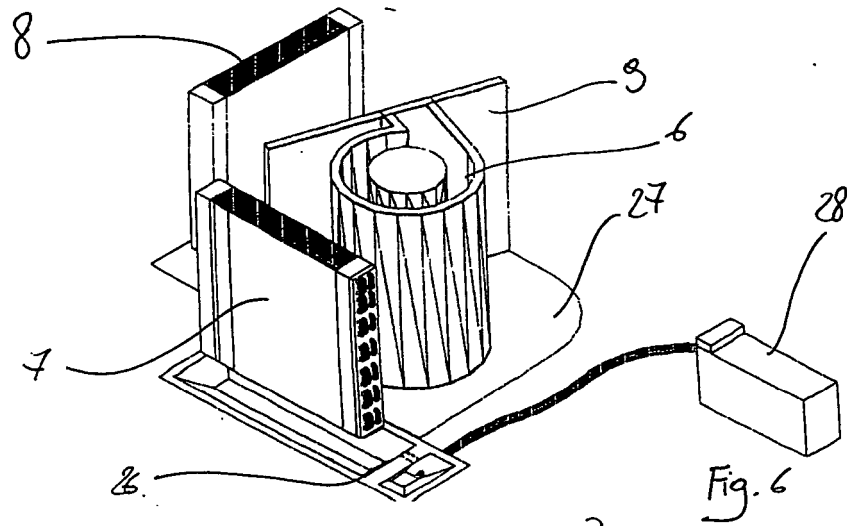
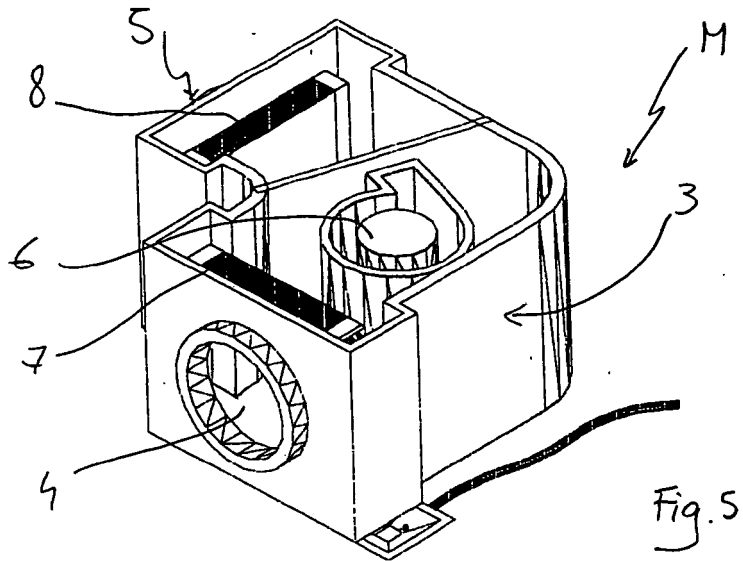


Fig. 3







European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 05 42 5893

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			F24F
Place of search		Date of completion of the search	Examiner
Munich		18 May 2006	Valenza, D
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 42 5893

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