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CA 2594499 A1 2006/08/10

(21) 2 594 499

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2006/01/05
(87) Date publication PCT/PCT Publication Date: 2006/08/10
(85) Entrée phase nationale/National Entry: 2007/07/09
(86) N° demande PCT/PCT Application No.: EP 2006/000063
(87) N° publication PCT/PCT Publication No.: 2006/081909
(30) Priorité/Priority: 2005/02/07 (DE10 2005 005 588.5)

(51) Cl.Int./Int.Cl. *H05K 5/02* (2006.01),
H02B 1/56 (2006.01)

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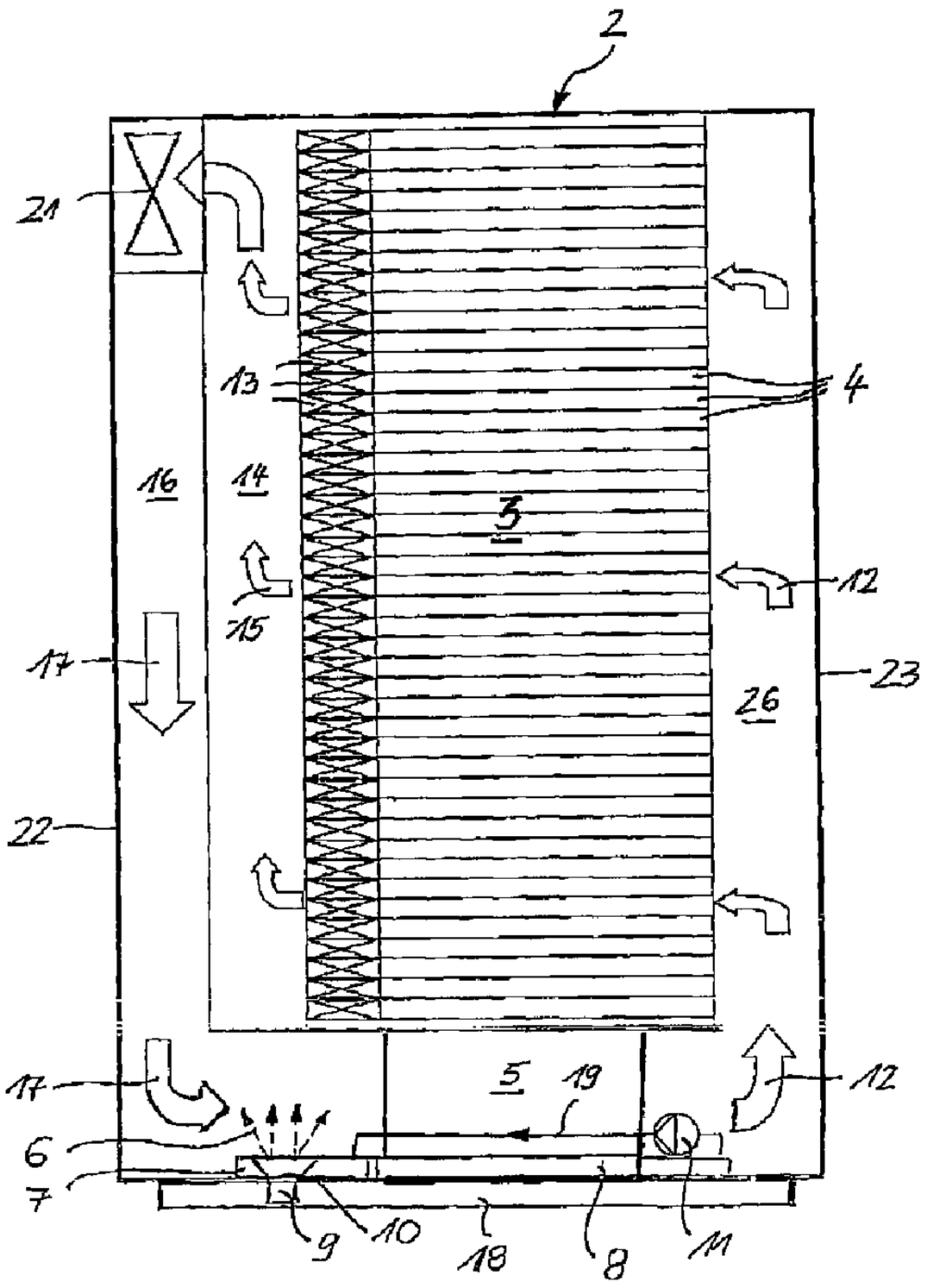
(54) Titre : ARMOIRE DE COMMANDE
(54) Title: SWITCH CABINET



(57) Abrégé/Abstract:
The invention relates to a switch cabinet, comprising a closed cooling air circuit and a heat exchanger for removal of the lost heat from electronic modular units arranged within a chamber. According to the invention, at least one atomisation device is provided

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(57) Abrégé(suite)/Abstract(continued):
which transforms the condensed water into an aerosol in order to avoid draining of the condensation water appearing in the heat exchanger into the environment of the switch cabinet. The condensation water aerosol is immediately introduced into the cooling air circuit, preferably the warm and dry exhaust air flow which also guarantees an advantageous air humidity stabilization in the switch cabinet.

ABSTRACT

The invention relates to a switch cabinet with a closed cooling air circuit and a heat exchanger for dissipating the heat loss from electronic modular units located in an inner area.

For efficient cooling and to avoid the removal to the switch cabinet environment of condensate produced in the heat exchanger, at least one atomizing device is provided and transforms the condensate into aerosols. The condensate aerosols are immediately resupplied to the cooling air circuit, preferably the hot, dry exhaust air flow, so that simultaneously an advantageous atmospheric humidity stabilization in the switch cabinet is ensured.

SWITCH CABINET

The invention relates to a switch cabinet according to the preamble of claim 1.

The invention is also suitable for equipment and network cabinets, in which a cooling air flow is led in rotation and cooled with the aid of a cooling device. A preferred field of application is constituted by server cabinets.

DE 20 2004 006 552.5 discloses a cooling system for equipment and network cabinets. Electronic modular units, e.g. servers are located in a sealed inner area, and a closed cooling air circuit has an air-water heat exchanger for cooling the exhaust air subject to the heat loss of the electronic modular units. The air-water heat exchanger is positioned in a lower area of the cabinet and there is an air guidance with air paths of equal length and therefore identical air resistances for the individual modular units, so that to the individual modular units is supplied cold fresh air with an almost uniform fresh air temperature.

For dissipating the significant heat losses of high power processors and servers of the cabinet and whilst taking account of the fact that generally there are relatively large numbers of such cabinets in a room or area, the air-water heat exchanger is connected to the building cold water supply. As a result the entire heat loss of the cabinets can be dissipated through the building cold water system and a heat transfer between the installation area and the cabinets is avoided in a highly cost-saving manner.

As switch cabinets generally have an airtight construction, an air exchange between the cabinet interior and the installation area is avoided. Within the heat exchanger there can be local drops below the dew point and on using cooling water with a temperature below 12°C and/or a high atmospheric humidity in the installation area condensate is formed within the heat exchanger. This leads to a drop in the absolute atmospheric

humidity within the switch cabinet, which can lead to damage to the installed modular units and systems.

It has been proposed (DE 10 2004 049 487.8) to keep stable the atmospheric humidity within the cabinet or the cooling air flow by a clearly defined external air supply. As a function of the ambient conditions and the target values in the cabinet leaks or interruptions are formed in the cabinet housing, which ensure a clearly defined external air supply to the cabinet interior, particularly in the vicinity of a fan intake side. Through such an atmospheric humidity stabilization it is possible to avoid the disadvantages of condensate formation and dehumidification below a preset value and in particular damage to the equipment and systems within the cabinet. However, devices are required for removing the condensate formed.

DE 298 23 784 U1 discloses a cooling device for a switch cabinet having a condensate removal unit. The condensate is collected in a condensate collector and on reaching a presettable fill level activation takes place of a detector with a float switch. By means of a drain in the condensate tank and an outlet line condensate is removed from the cooling device and switch cabinet.

WO 01/63713 A1 describes a switch cabinet with an air conditioning device having a refrigeration circuit system with an evaporator and a condenser. The evaporator together with a fan is integrated into an evaporator unit and is placed on the switch cabinet, whereas the condenser with a fan is integrated into the condenser unit and is arranged in spatially separated manner from the evaporator unit and switch cabinet, particularly outside the switch cabinet installation area. This is intended to reduce the introduction of heat and the noise level in the switch cabinet installation area, whilst leading to an improved cooling of the cabinet interior and components located therein. The evaporator unit has a condensate collector and a condensate evaporating device and the condensate produced on the evaporator is evaporated and removed to the outside with a fan.

In the case of the cooling device described in DE 198 17 247 A1 the devices for leading off the condensate into the switch cabinet environment are avoided in that the condensate collected in a collecting device below the cooling device is evaporated with the aid of a collecting container and a heating element located therein.

The water vapour produced is transported away via the air flow in the cooling device and nothing is stated concerning a possible dehumidification of the cooling air flow. The known condensate evaporation is linked with a thermal energy supply, so that an increased air-heat exchanger cooling capacity is necessary.

The object of the invention is to provide a switch cabinet with a heat exchanger which, whilst avoiding condensate removal into the environment, ensures an extremely efficient cooling and atmospheric humidity stabilization in the switch cabinet.

According to the invention this object is achieved by the features of claim 1. Advantageous and appropriate developments appear in the subclaims and the description relative to the drawings.

It is a fundamental idea of the invention to collect condensate produced in a heat exchanger in a collecting device and transform it into aerosols with the aid of an atomizing device which is positioned upstream of the heat exchanger in the switch cabinet, relative to the flow direction of the air conveyed in a closed circuit and said aerosols are immediately resupplied to the recycled cooling air.

As the condensate produced, at least in a predeterminable quantity, is atomized to an ultrafine mist, particularly with an aerosol size <0.001 mm, there is no need to remove to the exterior of the switch cabinet. At the same time a largely stable atmospheric humidity in the switch cabinet is ensured because the condensate formed is supplied to the atomizing device, atomized into condensate aerosols and immediately resupplied to the cooling air flow.

According to the invention the atomizing device is positioned upstream of the heat exchanger, relative to the cooling air flow direction. The condensate aerosols then pass into the hot, dry exhaust air flow subject to the heat loss of the electronic modular units. As a result of the high specific surface the condensate aerosols are immediately absorbed by said hot, dry exhaust air flow and evaporate. As a result of the evaporation there is an adiabatic cooling of the air flow. Thus, less energy is required during the subsequent cooling of the exhaust air flow in the heat exchanger.

It is advantageous to provide as the atomizing device one or more ultrasonic vibrators or ultrasonic atomizers, which have no heat evolution and which are characterized by a limited size, pressureless atomization and a low energy demand.

It is particularly advantageous to use ultrasonic vibrators with a variable atomizing capacity, so as to be able to ensure a predeterminable atmospheric humidity in the switch cabinet.

Appropriately the ultrasonic vibrators are located in a vibrating tank and are particularly fixed to the bottom of said tank. In order to maintain a predeterminable liquid level over said bottom, a sensor, e.g. a float switch can be provided.

The supply of condensate from the collecting device to the vibrating tank can take place with the aid of a condensate line using a pump. It is also possible to provide the collecting device with a bevel in the direction of the vibrating tank and to equip the latter with a corresponding supply opening.

The ultrasonic vibrators can e.g. be piezoceramic vibrators, which have a frequency >20,000 Hz, or magnetostrictive vibrators with a frequency up to 200 Hz. Use can also be made of commercial ultrasonic atomizers with a piezoceramic element, an amplifier for the mechanical vibrations produced and an atomizer plate on which a condensate film of limited thickness is excited to capillary waves and very fine droplets are centrifuged away in a corresponding trajectory. The liquid film is advantageously formed by a condensate quantity supplied in pressureless manner.

It is alternatively possible to provide a high pressure pump, particularly with a pressure of >50 bar for supplying the condensate produced to at least one high pressure nozzle, in which the condensate is atomized to a very fine mist. At least the high pressure nozzle is again located in the area upstream of the heat exchanger, so that the fine condensate mist is immediately absorbed by the dry, hot exhaust air and can rapidly evaporate. It is possible to use as high pressure nozzles e.g. those types known in connection with air humidification. Particularly small, rapidly evaporating condensate aerosols can be formed by an advantageous pulsating of the condensate flow.

The invention is described in greater detail hereinafter relative to the attached drawings, wherein show:

Fig. 1 A highly diagrammatic representation of a switch cabinet with an ultrasonic vibrator as the atomizing device.

Fig. 2 A highly diagrammatic representation of a switch cabinet with a high pressure nozzle as the atomizing device.

The equipment cabinet 2 according to figs. 1 and 2 has an inner area 3 with vertically superimposed, electronic modular units 4. In the present example the electronic modular units 4 are servers, which are in each case received in a housing with not shown air inlets and outlets and a fan 13.

The equipment cabinet 2 has a largely airtight construction and the heat loss of the electronic modular units 4 is dissipated with the aid of a heat exchanger 5, which is advantageously constructed as an air-water heat exchanger with connection of the cooling water to the building cold water supply.

The bottom of the heat exchanger 5 is located in switch cabinet 2 and supply air 12 cooled therein is supplied to the individual modular units 4 by means of a supply air duct 26 in the vicinity of a front door 23. The exhaust air flows of the individual electronic modular units pass into an upwardly directed exhaust air flow 15 within a first exhaust air duct 14 and with the aid of at least one fan 21 positioned in the vicinity of a back door 22 are deflected into a second exhaust air duct 16. The downwardly directed exhaust air flow 17 is supplied to heat exchanger 5.

Below heat exchanger 5 is positioned a condensate collecting tank 8, which in the embodiment according to fig. 1 is connected by a condensate line 19 to a vibrating tank 7.

With respect to the closed cooling air circuit, the vibrating tank 7 is positioned upstream of the heat exchanger 5, e.g. with approximately the same level as the condensate collecting tank 8, and is provided with at least one ultrasonic vibrator 10 as the atomizing device. The ultrasonic vibrator 10 has a high frequency generator 9, which extends into the area of a cabinet base 18.

When using a piezoceramic ultrasonic vibrator 10 located on the bottom of vibrating tank 7, the condensate above the same is vibrated by high frequency a.c. voltage and the propagating ultrasonic waves bring about the atomization of the condensate, i.e. the release of very small liquid droplets or condensate aerosols.

Through the provision of the atomizing device 10 with the ultrasonic vibrating tank 7 in the vicinity of the supply of the hot, dry exhaust air flow 17 to heat exchanger 5, the

condensate aerosols are absorbed and evaporate adiabatically. Associated with this a cooling takes place and has an advantageous action on the necessary cooling capacity of heat exchanger 5. Simultaneously as a result of the condensate atomization the necessary atmospheric humidity of the air flow in switch cabinet 2 is ensured and damage associated with dehumidification to the installed modular units is avoided.

Fig. 2 shows an alternative atomizing device 20, which is once again positioned in the vicinity of the hot, dry exhaust air flow 17 supplied to heat exchanger 5. The further features of switch cabinet 2 are identical and consequently carry the same reference numerals.

A high pressure nozzle 20 is provided as the atomizing device 20 for the condensate collected in the condensate collecting tank 8. The condensate from the collecting tank 8 is supplied to high pressure nozzle 20 with the aid of a high pressure pump 25.

It falls within the scope of the invention to provide several high pressure nozzles 20.

In addition, the invention is not restricted to a switch, equipment or network cabinet with a heat exchanger at the bottom and instead covers further cooling devices with condensate production independently of the positioning thereof. It is e.g. possible to provide cooling devices having a refrigeration circuit equipped with an evaporator, a condenser and a compressor, with an atomizing device according to the invention.

NEW CLAIMS 1 TO 12

1. Switch cabinet
having an inner area (3) for receiving electronic modular units (4),
a closed cooling air circuit, which has a heat exchanger (5) for dissipating the heat loss of the electronic modular units (4), and
with a collecting device (8) for the condensate produced in heat exchanger (5),
characterized in that
an atomizing device (10, 20) for the condensate is provided which transforms the condensate into aerosols (9),
the condensate aerosols (9) can be supplied to the cooling air circuit for stabilizing the atmospheric humidity in the switch cabinet (2) and
the atomizing device (10, 20), relative to the flow direction of the cooling air circuit, is positioned upstream of the heat exchanger (5) and the condensate aerosols (9) can be received by hot, dry exhaust air flow (17) subject to the heat loss of the electronic modular units (4) and can be transformed into water vapour accompanied by an adiabatic cooling of the exhaust air flow (17).

2. Switch cabinet according to claim 1,
characterized in that
at least one ultrasonic vibrator (10) is provided as atomizing device.

3. Switch cabinet according to claim 1,
characterized in that
at least one high pressure nozzle (20) is provided as atomizing device.

4. Switch cabinet according to one of the preceding claims,
characterized in that
as collecting device (8) for the condensate a condensate collecting tank is placed below the heat exchanger (5) and a pump (11) and a condensate line (19) are pro-

vided, which supply a predeterminable condensate quantity to atomizing device (10, 20).

5. Switch cabinet according to one of the preceding claims,
characterized in that
a vibrating tank (7) is provided for an ultrasonic vibrator as the atomizing device (10) and into which the condensate can be introduced from the collecting device (8).

6. Switch cabinet according to claim 5,
characterized in that
the condensate can be supplied to the vibrating tank (7) with the aid of a bevel, e.g. a bevelled bottom of collecting device (8).

7. Switch cabinet according to one of the preceding claims,
characterized in that
a piezoceramic ultrasonic vibrator with a frequency >20,000 Hz or a magnetostrictive ultrasonic vibrator with a frequency up to 200 Hz is used as atomizing device (10).

8. Switch cabinet according to one of the preceding claims,
characterized in that
a high pressure pump (25) is provided, which supplies condensate at a pressure >50 bar to a high pressure nozzle as atomizing device (20).

9. Switch cabinet according to one of the preceding claims,
characterized in that
the atomizing device (10) can be regulated as a function of the atmospheric humidity in the supply air flow (12).

10. Switch cabinet according to one of the preceding claims,
characterized in that
an overflow device is provided in the collecting device (8).

11. Switch cabinet according to one of the preceding claims,
characterized in that
as heat exchanger (5) is provided an air-water heat exchanger in the bottom area of the switch cabinet (2).

12. Cooling device for a switch cabinet with a closed cooling air circuit having a collecting device (8) for the condensate produced,
characterized in that
an atomizing device (10, 20) is provided for the condensate which transforms the latter into aerosols,
the condensate aerosols formed can be resupplied to the cooling air circuit for stabilizing the atmospheric humidity in the switch cabinet and
the atomizing device (10, 20) is positioned upstream of the cooling device, relative to the flow direction of the cooling air circuit and
the condensate aerosols (9) can be received by a hot, dry exhaust air flow (17) subject to the heat loss of the electronic modular units (4) and can be transformed into water vapour accompanied by an adiabatic cooling of the exhaust air flow (17).

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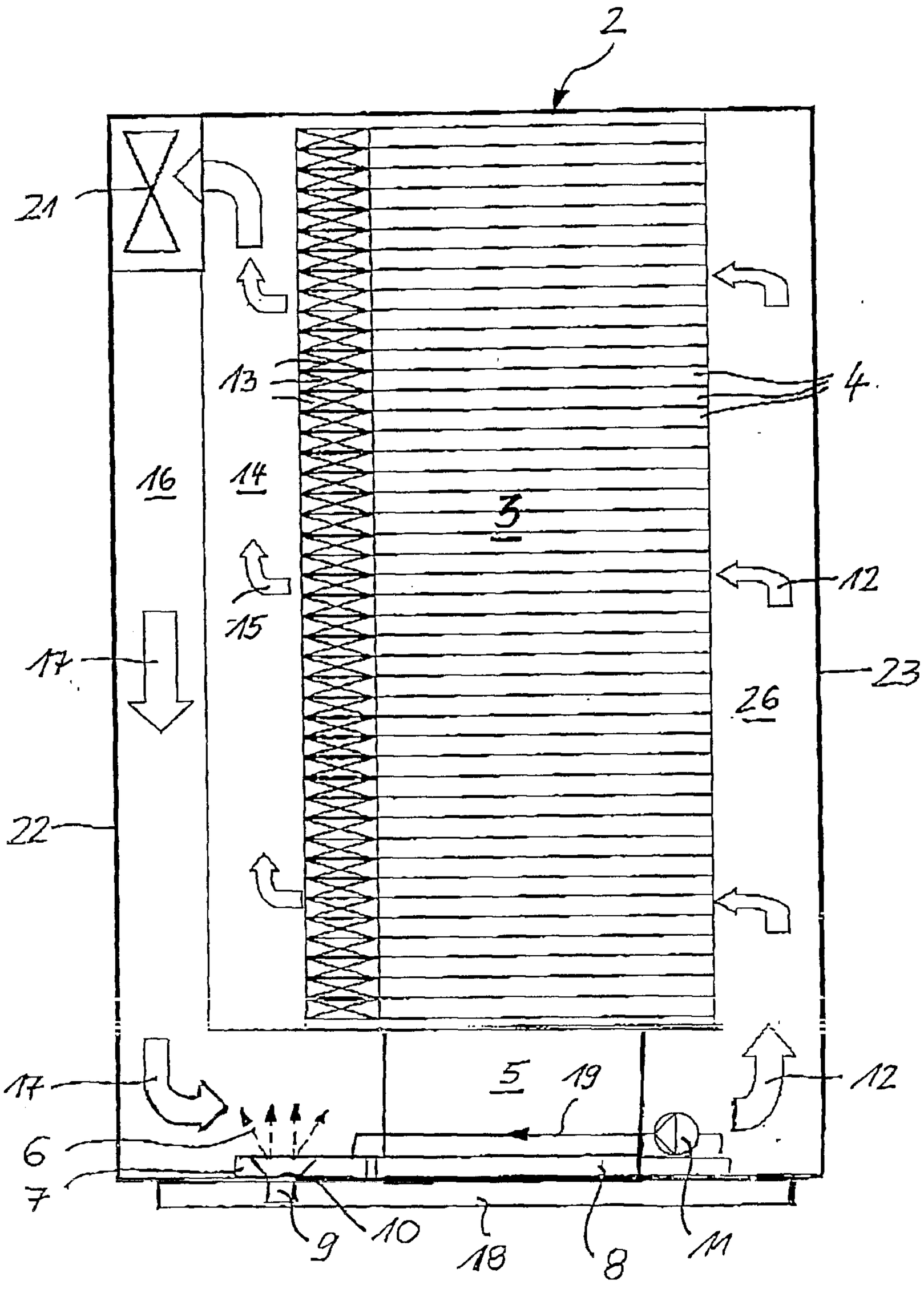


Fig. 1

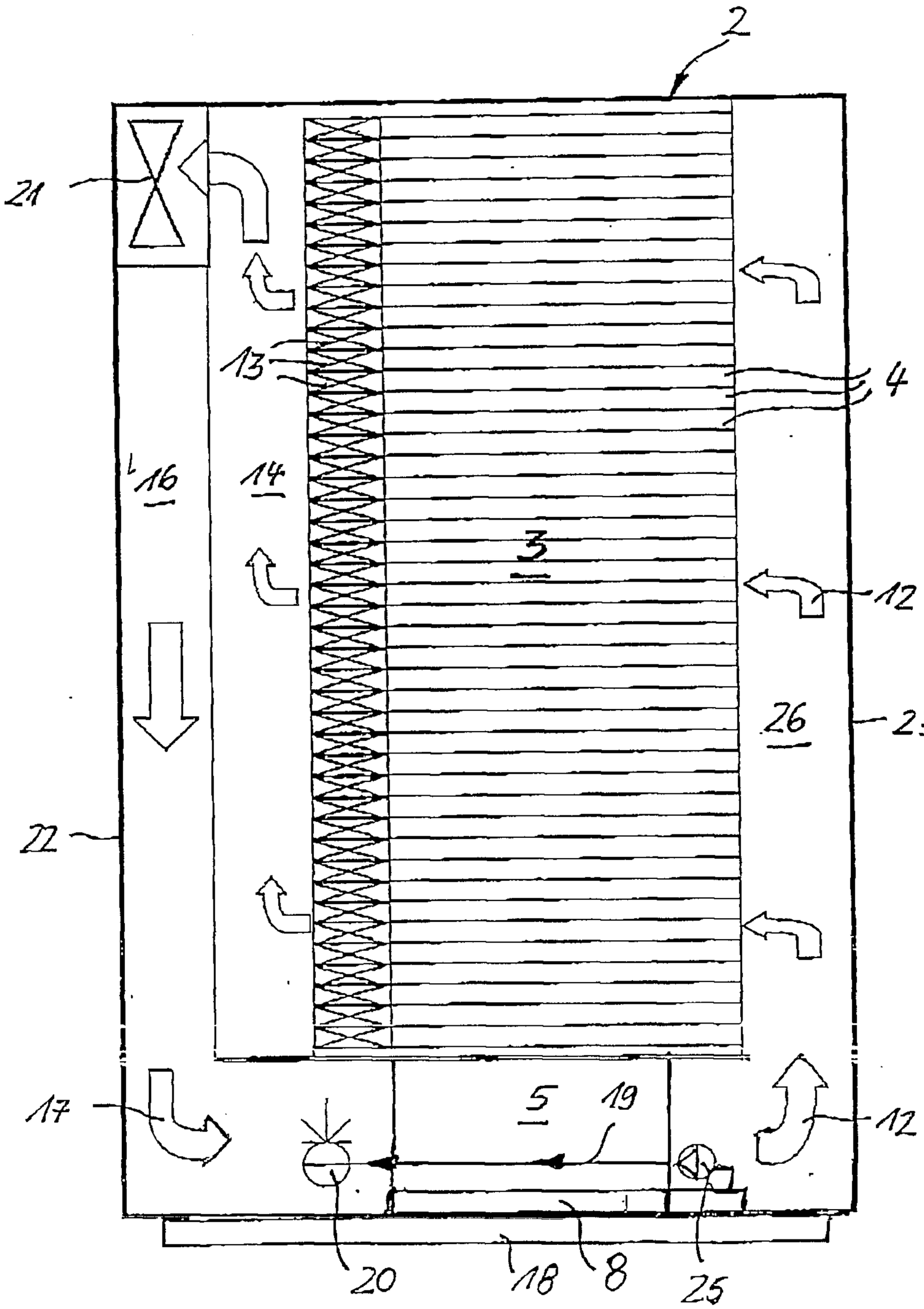
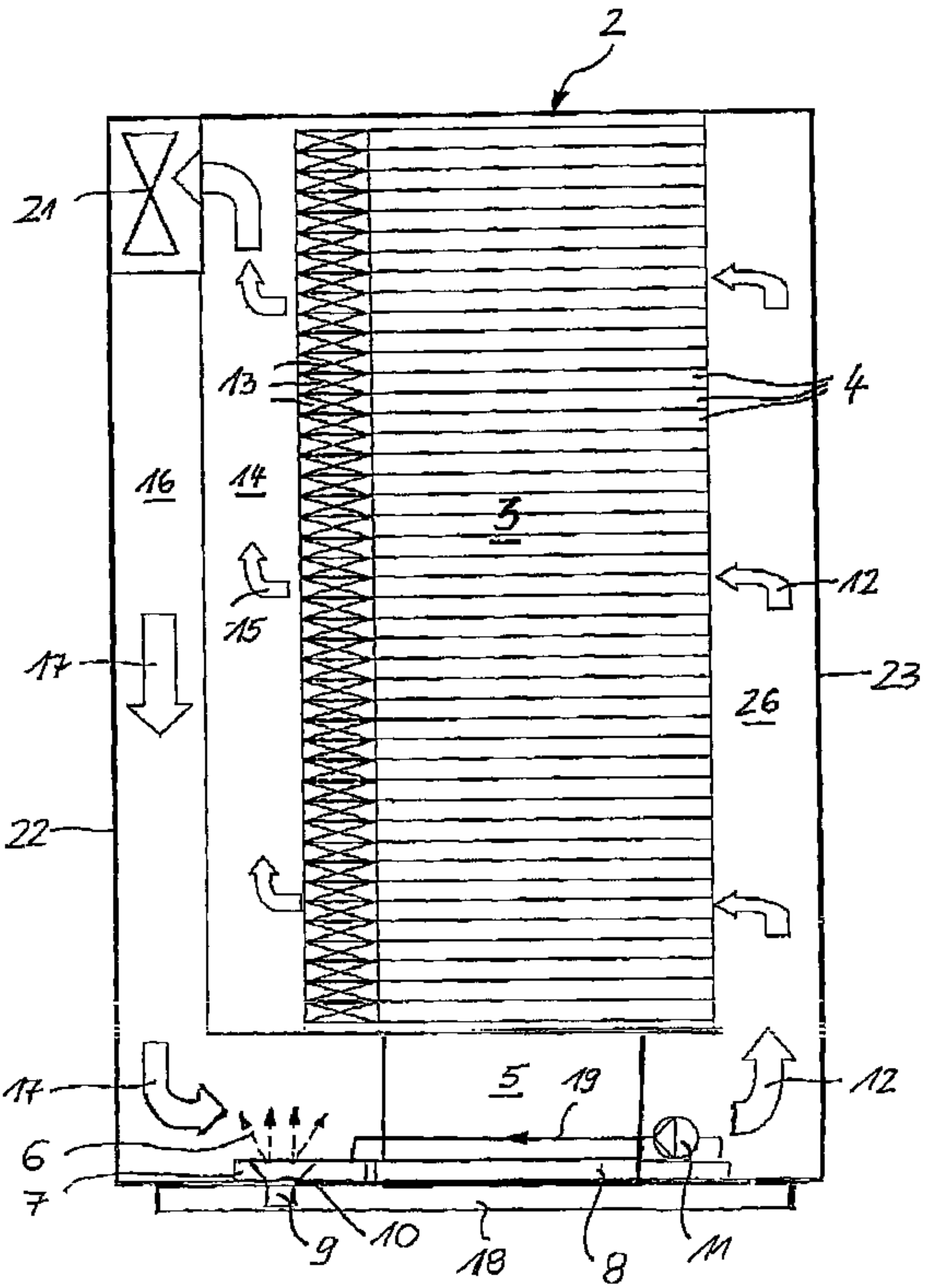


Fig. 2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