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(54) Benevnelse **VENTILATION DEVICE FOR FILTERING AIR AND FOR SEPARATING WATER AEROSOLS FROM AIR**

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VENTILATION DEVICE FOR FILTERING AIR AND FOR SEPARATING WATER AEROSOLS FROM AIR

The invention relates to a ventilation apparatus for filtering air and separating water aerosols from air according to the preamble of claim 1.

Ventilation apparatuses for filtering air and separating water aerosols from air are already known from the prior art and are used, for example, in wind turbines. Depending on the location of the wind turbine, the air drawn in from outside must be cleaned and dehydrated in order to protect electronic or electrical components inside the wind turbine. For this purpose, fans suck the air into the wind turbine through filter elements in which the sucked-in air is cleaned and drained. Depending on the design of the wind turbine, the ventilation apparatus must also be adapted. This usually involves high costs and a great deal of effort. US2011/154991A1 discloses a ventilation apparatus comprising a plurality of filter elements and a flow adapter.

It is therefore the task of the invention to provide an improved or at least alternative embodiment for a ventilation apparatus of the type described, in which the disadvantages described are overcome.

This task is solved according to the invention by the object of independent claim 1. Advantageous embodiments are the subject of the dependent claims.

The present invention is based on the general idea of constructing a ventilation apparatus for filtering air and separating water aerosols from air in a modular manner. The ventilation apparatus according to the present invention comprises a plurality of filter elements, a plurality of housings, a plurality of fans and at least one flow adapter. In the at least one housing, the at least one filter element is fixed so that air can flow through it in a flow direction from an inlet opening to an outlet opening of the at least one housing. The at least one fan is fixed at the outlet opening downstream of the at least one housing in the flow direction and the at least one flow adapter is fixed at the inlet opening upstream of the at least one housing in the flow direction. According to the invention, the filter element, the housing and the fan each form a ventilation module with a flow area. Furthermore, a plurality of identical ventilation modules are detachably stacked against one another to form the ventilation apparatus in such a way that a total flow area of the ventilation apparatus corresponds to a multiple of the flow area of the individual ventilation module. Advantageously, the ventilation apparatus can

be built up in a modular way and can be extended with further ventilation modules depending on the requirements. Furthermore, the individual identically designed ventilation modules are interchangeable, so that the assembly and maintenance of the ventilation apparatus is simplified.

In the ventilation apparatus, the at least one flow adapter, the respective housing with the respective filter element and the respective fan are connected one after the other in the flow direction, so that the air can flow through the at least one flow adapter to the inlet opening of the respective housing and further through the respective filter element. The fan can suck in the air from the outside and guide it through the at least one flow adapter further into the respective housing with the respective filter element. The housing can advantageously be made of plastic - for example rotationally moulded. The flow adapter can advantageously be flow-optimised and the geometry of the flow adapter can be adapted to the respective application. The respective filter element expediently has a clean side and a raw side and is formed from a filter material. The filter material can, for example, be hydrophobic and separate the water in the intake air in a filtration zone. The water separated in the filter element can then settle on the raw side of the filter element under the effect of gravity into a drainage zone of the filter element. The drainage zone adjoins the filtration zone of the filter element and is expediently arranged offset transversely to the flow direction below the filtration zone of the filter element. The filter element's filtering zone corresponds to a filtering region and the drainage zone corresponds to a drip region of the housing. The filtering region and the drip region of the housing are adjacent to each other.

Advantageously, it can be provided that at least two of the ventilation modules adjacent in the ventilation apparatus each have on their housings a cable part indentation extending in the flow direction. In this case, the respective cable part indentations on the housings of the adjacent ventilation modules abut one another in the flow direction and form a cable opening. The cable part indentations can be identical in shape, so that a cross-sectional area of the cable opening corresponds to twice the cross-sectional area of the individual cable part indentation. The cable lines can be routed through the cable opening in the flow direction between the respective ventilation modules, so that electrical components of the ventilation apparatus can be electrically connected to each other in the flow direction upstream and downstream of the respective ventilation module without requiring additional space.

In order to be able to stack the individual ventilation modules detachably against one another, one of the ventilation modules adjacent in the ventilation apparatus can advantageously have at least one recess extending in the flow direction on its housing and another of the ventilation modules adjacent in the ventilation apparatus can have at least one formation extending in the flow direction on its housing. The at least one recess and the at least one formation are in engagement transversely to the flow direction and form a so-called tongue-and-groove connection. In this way, the at least one recess and the at least one formation detachably fix the adjacent ventilation modules to each other. In order to form the respective ventilation modules identically, the at least one recess and the at least one formation can be formed on the respective housing. These are expediently formed on opposite sides of the housing, so that the ventilation modules stacked on top of one another or next to one another can be detachably fixed to one another.

In a preferred embodiment of the ventilation apparatus, it is provided that the ventilation apparatus has four ventilation modules and a flow adapter. The ventilation modules are detachably fixed to one another to form a 2x2 stacking block and are fixed in an air conducting manner to the flow adapter by means of a coupling frame. The respective ventilation modules are identical in design and each have a cuboid housing with a cuboid filter element and a fan. The flow adapter is fixed to the respective ventilation modules by the coupling frame.

A coupling frame has a module support frame enclosing the respective ventilation modules transversely to the flow direction and an adapter support frame supporting the at least one flow adapter.

The module support frame and the adapter support frame can be hinged or displaceably mounted to each other by a hinge device and can be fixed to each other by a closure unit. With this advantageous design of the ventilation apparatus, the coupling frame can be opened and, for example, the filter element in the respective ventilation module can be replaced in a simplified manner. A drain channel arrangement for draining off the water separated in the respective filter element can then be formed in the adapter support frame, for example. A passage arrangement for the inlet opening of the respective housing transverse to the flow direction can advantageously be fixed to the coupling frame. The passage arrangement - preferably a louvre arrangement - is

thereby provided for controlling the air flow rate through the respective ventilation module.

In a further development of the ventilation apparatus according to the invention, it is advantageously provided that the respective filter element has a circumferential sealing rim. In this case, the sealing rim bears on one side against a sealing surface of the housing enclosing the inlet opening and on the other side against the coupling frame and seals the respective housing around the inlet opening to the coupling frame transversely to the flow direction. The sealing rim seals a pressure space of the ventilation apparatus and is formed on the filter element, so that when the respective filter element is inserted or replaced in the ventilation apparatus, the sealing rim can also be inserted or replaced. In particular, the sealing of the pressure chamber of the ventilation apparatus by means of the sealing rim can be carried out without the use of tools, thereby reducing the time and effort required for the initial and renewed sealing of the ventilation apparatus. The sealing surface on the respective housing can thereby be formed by a housing frame enclosing the inlet opening, which forms a radially inwardly projecting inlet step in the respective housing. In this advantageous way, the air flow can be directed to the filter element in the respective housing without losses. For sealing, an elastic seal can be fixed to a side surface of the sealing rim facing the housing and/or the coupling frame. The elastic seal can be fixed to the side surfaces of the sealing rim by a material bond - for example by gluing - or by a force fit - for example by engaging in a profile groove.

In an advantageous further development of the ventilation apparatus according to the invention, it is provided that the at least one flow adapter is in one piece and preferably made of plastic. The at least one flow adapter is thus robustly shaped so that the air drawn in from the outside by the at least one fan is already distributed in the at least one flow adapter and can flow uniformly over the respective filter element. In particular, this allows the respective filter element to be protected and used for a longer period of time. Furthermore, the at least one flow adapter made of plastic only slightly increases the dead weight of the aeration system. The at least one flow adapter can have a collecting region and a flow region which are connected to each other. The flow region of the flow adapter corresponds in an air-conducting manner to the inlet opening of the respective housing and the collecting region is arranged offset transversely to the

flow direction below the flow region. Furthermore, the collecting region is located outside a main air flow in the at least one flow adapter.

Advantageously, it may be provided that a drain channel arrangement fluidically connects the collecting region of the at least one flow adapter and a drip region of the respective housing. Through the drain channel arrangement, the water separated in the filter element can be guided from the respective housing into the collecting region of the at least one flow adapter against the flow direction. The collecting region of the flow adapter is located outside the main air flow in the at least one flow adapter, so that the water separated in the filter element does not encounter any flow resistance when flowing in the collecting region of the at least one flow adapter. For discharging the water separated in the filter element from the collecting region, the at least one flow adapter can have an adapter outlet opening leading out of the collecting region, which is fluidically connected to the drain channel arrangement. Consequently, the water separated in the respective filter element can be guided out of the respective housing into the collecting region of the at least one flow adapter against the flow direction without any or with a low flow resistance under the effect of gravity. Within the flow adapter, the water separated in the filter element can then be guided to the adapter outlet opening and further to the outside without any or with a low flow resistance under the effect of gravity. In this advantageous way, discharging of the water separated in the filter element can be ensured at any operating point of the ventilation apparatus without any additional force being applied. In particular, additional pipes and pumps for discharging the water separated in the filter element can thus be dispensed with.

In a further development of the ventilation apparatus according to the invention, it is advantageously provided that the drain channel arrangement is formed in a coupling frame which is fixed in an airtight manner between the respective housing and the at least one flow adapter transversely to the flow direction. The coupling frame thus connects the respective housing to the at least one flow adapter in an air-conducting manner in the flow direction and in an air-tight manner transversely to the flow direction. In particular, this allows the pressure space of the ventilation apparatus to be sealed and maintained. The coupling frame can also assume a load-bearing function and stabilise the ventilation apparatus against deformation. The drain channel arrangement is formed in the coupling frame so that the water separated in the filter element can be directed from the drip region of the respective housing via the coupling frame into the

collecting region of the at least one flow adapter. Subsequently, the water separated in the filter element can be conducted from the collecting region of the at least one flow adapter to the outside through the adapter outlet opening. The drain channel arrangement can thereby fluidically connect the drip regions of the plurality of housings with the collecting region of the one flow adapter or, however, the drip regions of the plurality of housings with the collecting regions of the plurality of flow adapters.

Advantageously, the drain channel arrangement may have at least one horizontal gutter channel fluidly connected to a drip region of at least one of the housings. In the operating condition, the gutter channel is oriented horizontally with a deviation of up to 10° from the ground to allow the water separated in the filter element to be directed horizontally in the ventilation apparatus under the action of gravity. In this regard, the single gutter channel can fluidically connect the drip regions of the plurality of housings arranged side by side with the corresponding filter elements. Advantageously, the drain channel arrangement may comprise at least two superimposed drain channels fluidically connected to each other by at least one vertical drain channel. The gutter channels arranged one above the other connect the drip regions of the respective housings in a horizontal row in each case, and the at least one vertical drainage channel fluidically connects the gutter channels vertically to one another. In the operating state of the ventilation apparatus, the vertical drainage channel is aligned vertically with a deviation of up to 10° to the floor, so that the water separated in the filter element can be guided under the effect of gravity from a channel upper to the floor into the channel lower to the floor. Advantageously, in the drain channel arrangement, discharging of the water separated in the filter element can thus be ensured at any operating point of the ventilation apparatus without any additional force being exerted solely under the effect of gravity. The water separated in the filter elements can then be led out of the drain channel arrangement into the collecting region of the at least one flow adapter and further to the outside. For this purpose, the channel lowest to the ground can be fluidically connected at its lowest point through a drain opening with the collecting region of the at least one flow adapter - for example via a drain pipe. In this advantageous way, the plurality of housings and the plurality of filter elements are fluidically connected to each other via the drain channel arrangement in the coupling frame and the water separated in the plurality of filter elements can be discharged from the ventilation apparatus in a simplified manner. Preferably, the at least one gutter

channel is formed from a U-shaped metallic profile and the at least one drain duct is formed from a U-shaped or L-shaped metallic profile.

In an advantageous further development of the ventilation apparatus according to the invention, it is provided that the respective fan is controlled by a control device. The control device has at least one measurement arrangement for detecting the air flow rate through the respective filter element. The at least one measurement arrangement thereby has a pressure measurement unit for detecting a static pressure, which is arranged within the ventilation apparatus. By means of the pressure measurement unit, the static pressure in the respective filter element can be detected and the air flow rate through the respective filter element can be determined therefrom. In particular, a direct and inaccurate measurement of the air flow rate in the respective filter housing is not required and the ventilation apparatus can be controlled more precisely.

Advantageously, the respective pressure measurement unit can be fluidically connected to a pressure measurement point or have such a pressure measurement point. The pressure measurement point is arranged within the respective housing in the region of the inlet opening and has a measurement opening there. The measurement opening can penetrate the respective housing so that the pressure measurement unit arranged outside the housing can detect the static pressure inside the housing and the filter element. The respective pressure measurement point or its measurement opening can advantageously be arranged in a drip region of the housing. The drip region of the housing corresponds to a drainage region of the filter element, which is provided for discharging the water separated in the filter element. The drainage zone of the filter element is connected to a filtration zone of the filter element and is arranged transversely to the flow direction below the filtration zone of the filter element. To protect the pressure measurement unit or its pressure measurement point from water and dirt, the pressure measurement point can be arranged on a clean side of the filter element in the respective housing. Advantageously, the respective pressure measurement point or its measurement opening can be integrated into or fixed in a flow-calmed zone of the drip region of the housing. The flow-calmed zone of the drip region of the housing can correspond to a flow-calmed zone of the drainage zone of the filter element. "Flow-calmed" in this context means that the air flow present at the pressure measurement point or its measurement opening is negligible for a

measurement of the static pressure or causes a measurement error of less than 5% in the measurement of the static pressure.

Advantageously, the housing can have a housing frame which encloses the inlet opening with a radially inwardly projecting inlet step. In order to increase the measuring accuracy when detecting the static pressure in the respective housing through which the flow passes, the pressure measurement point can be arranged on the inlet step. The measurement opening can be open in the flow direction and oriented essentially parallel – in this context with a deviation of up to 30° – to the flow direction. It is expedient that the measurement opening is arranged in the respective housing in such a way that there is no or only negligibly small air flow at the pressure measurement point or at the measurement opening. In particular, this allows the measured static pressure to be detected independently of the dynamic pressure prevailing in the respective housing.

In summary, the ventilation apparatus according to the invention can be constructed in a modular manner and the identically designed ventilation modules can be exchanged for one another in a simple manner. Advantageous further designs of the ventilation apparatus further enable the water separated in the respective filter element to be discharged from the ventilation apparatus in a simplified manner; to simplify sealing of the ventilation apparatus; to control the ventilation apparatus more precisely and to better distribute the air flow in the respective filter element.

Further important features and advantages of the invention will be apparent from the sub-claims, from the drawings and from the accompanying figure description with reference to the drawings.

It is understood that the above features and those to be explained below can be used not only in the combination indicated in each case, but also in other combinations or on their own, without departing from the scope of the present invention.

Preferred embodiments of the invention are shown in the drawings and will be explained in more detail in the following description, wherein identical reference signs refer to identical or similar or functionally identical components.

It is shown schematically

Fig. 1 a view of a ventilation apparatus according to the invention;

Fig. 2 a front view of the ventilation apparatus shown in Fig. 1;

Fig. 3 a rear view of the ventilation apparatus shown in Fig. 1;

Fig. 4 a side view of the ventilation apparatus shown in Fig. 1;

Fig. 5. a top view of the ventilation apparatus shown in Fig. 1;

Fig. 6 a sectional view of the ventilation apparatus shown in Fig. 1;

Fig. 7 a side view of a ventilation mode of the ventilation apparatus shown in Fig. 1;

Fig. 8 a top view of the ventilation mode of the ventilation apparatus shown in Fig. 1;

Fig. 9 a sectional view of the ventilation mode of the ventilation apparatus shown in Fig. 1;

Fig. 10 a view of a flow adapter of the ventilation apparatus shown in Fig. 1;

Fig. 11 a partial sectional view of the flow adapter of the ventilation apparatus shown in Fig. 1;

Fig. 12 a rear view of the flow adapter of the ventilation apparatus shown in Fig. 1;

Fig. 13 a top view of the flow adapter of the ventilation apparatus shown in Fig. 1;

Fig. 14 a sectional view of the ventilation apparatus shown in Fig. 1;

Fig. 15 a further sectional view of the ventilation apparatus shown in Fig. 1.

Fig. 1 shows a view of a ventilation apparatus 1 according to the invention for filtering air and separating water aerosols from air. The ventilation apparatus 1 is shown in Fig. 2 from the front; in Fig. 3 from the rear; in Fig. 4 from the side; in Fig. 5 from above and in Fig. 6 in section. The terms "front" and "rear" refer here and in the following to the air flowing through the ventilation apparatus 1, which flows through the built-in ventilation apparatus 1 from "front" to "rear" parallel or almost parallel to the floor in the operating state. The terms "top" and "bottom" refer accordingly to the orientation of the built-in ventilation apparatus 1 to the floor. The ventilation apparatus 1 has a total of four ventilation modules 2, the respective ventilation module 2 having a filter element 3, a housing 4 and a fan 5.

The ventilation modules 2 are identical and detachably stacked against each other to form a stacking block 19, so that a total flow area 6 of the ventilation apparatus 1 corresponds to a multiple of the flow area 7 of the individual ventilation module 2. In the respective ventilation module 2, the filter element 3 is arranged in the respective housing 4 and air can flow through from an inlet opening 8 to an outlet opening 9 of the

housing 4 in a flow direction 10. The respective fan 5 is fixed at the outlet opening 9 in the flow direction 10 behind the respective housing 4. The respective fan 5 is controlled by a control device 27 which has a measurement arrangement for detecting the air flow rate through the respective filter element 3. In Fig. 7 to Fig. 9 the structure of the ventilation module 2 is shown in detail.

Furthermore, the ventilation apparatus 1 has a flow adapter 11 which is fixed to the respective inlet opening 8 in the flow direction 10 in front of the respective housing 4. The flow adapter 11 thereby has two air inlets 12 and an air outlet 13, which fluidically corresponds with the respective inlet opening 8 of the respective housing 4. The flow adapter 11 is in one piece – for example made of plastic – and robust, so that the air drawn in from outside by the respective fans 5 is already distributed in the flow adapter 11. The air drawn in from outside then flows evenly over the respective filter elements 3 and these are protected. Fig. 10 to Fig. 13 show the structure of the flow adapter 11 in detail.

In the ventilation apparatus 1, the flow adapter 11, the respective housing 4 with the respective filter element 3 and the respective fan 5 are consequently connected one after the other in flow direction 10, so that the air can flow through the air inlets 12 of the flow adapter 11 via the air outlet 13 to the inlet opening 8 of the respective housing 4 and further through the respective filter element 3. The respective filter element 3 has – as shown in Fig. 6 – a clean side and a raw side and is formed from a filter material. The filter material is hydrophobic and the water in the sucked-in air is separated in a filtration zone 3a on the raw side. The water separated in the filter element 3 then settles into a drainage zone 3b of the filter element 3 under the action of gravity. The drainage zone 3b adjoins the filtration zone 3a of the filter element 3 and is arranged offset transversely to the flow direction 10 below the filtration zone 3a of the filter element 3.

The filtration zone 3a of the filter element 3 corresponds to a filtration region 4a and the drainage zone 3b corresponds to a drip region 4b of the housing 4. The filtration region 4a and the drip region 4b of the housing 4 thereby adjoin each other. Furthermore, the flow adapter 11 has a flow region 11a and a collecting region 11b which adjoin each other. The flow region 11a of the flow adapter 11 corresponds fluidically with the inlet openings 8 of the respective housings 4 and the collecting region 11b is arranged offset transversely to the flow direction 10 below the flow region 11a.

Furthermore, the collecting region 11b lies outside a main air flow of the flow adapter 11.

The ventilation modules 2 are detachably fixed to the flow adapter 11 by a coupling frame 14. For this purpose, the coupling frame 14 has a module support frame 14a enclosing the respective ventilation modules 2 transversely to the flow direction 10 and an adapter support frame 14b supporting the flow adapter 11. The module support frame 14a and the adapter support frame 14b are hinged to each other by a hinge device 15 and can be fixed to each other by a closure unit 16. In this way, the coupling frame 14 can be opened and, for example, the filter element 3 in the respective ventilation module 2 can be replaced in a simplified manner. Furthermore, a drain channel arrangement 17 is formed in the coupling frame 14 for draining off the water separated in the respective filter element 3. The drain channel arrangement 17 - as shown in Fig. 6 - has two horizontal gutter channels 17a arranged one above the other and a vertical drain channel 17b. The respective drain channel 17a connects the drip regions 4b of the adjacent housings 4 of the ventilation modules 2 with the drain channel arrangement 17 and the drain channel 17b fluidically connects the two drain channels 17a with each other. The drain channel arrangement 17 allows the water separated in the respective filter element 3 to be discharged to the outside through the drain channel arrangement 17 under the action of gravity. The structure of the drain channel arrangement 17 is shown in detail in Fig. 14 and Fig. 15. Furthermore, a passage arrangement 18 - here a louvre arrangement 18a - is fixed to the coupling frame 14 for the inlet opening 8 of the respective housing 4 transverse to the flow direction 10. The passage arrangement 18 is provided for controlling the air flow rate through the respective ventilation module 2.

Fig. 7 shows a side view of an individual ventilation module 2 in the ventilation apparatus 1. The ventilation module 2 is further shown in Fig. 8 from above and in Fig. 9 in section. In order to stack the individual ventilation modules 2 detachably against each other to form the stacking block 19, the respective ventilation module 2 in the ventilation apparatus 1 has on its housing 4 a recess 20a extending in the flow direction 10 and a formation 20b extending in the flow direction 10. The recess 20a and the formation 20b of the adjacent ventilation modules 2 are in engagement transversely to the flow direction 10 and form a so-called tongue-and-groove connection. In this way, the recess 20a and the formation 20b detachably fix the adjacent ventilation modules 2

to each other to form the stacking block 19. The recess 20a and the formation 20b are formed on the respective housing 4 on opposite housing sides 21a and 21c, as also shown in Fig. 1 to Fig. 6 and in Fig. 14 to Fig. 15.

Furthermore, the respective ventilation module 2 has two cable part indentations 22a extending in the flow direction 10 on its housing 4 on the opposite housing sides 21b and 21d respectively. In the stacking block 19, the respective cable part indentations 22a abut on the housings 4 of the adjacent ventilation modules 2 in the flow direction 10 and form a cable opening 22. The cable part indentations 22a are identically shaped so that a cross-sectional area of the cable opening 22 corresponds to twice the cross-sectional area of the individual cable part indentation 22a. The cable lines can be guided through the cable opening 22 in the flow direction 10 between the respective ventilation modules 2, so that electrical components of the ventilation apparatus 1 can be connected to one another in the flow direction 10 upstream and downstream of the respective ventilation module 2 without requiring any additional space. The cable openings 22 from the adjacent cable part indentations 22a are also shown in Fig. 1 to Fig. 6 and Fig. 14 to Fig. 15.

In order to fix the filter element 3 transversely to the flow direction 10 in the housing 4 in an airtight manner, the filter element 3 has a circumferential sealing rim 23 in the respective ventilation module 2. The sealing rim 23 rests on one side against a sealing surface 24 of the housing 4 enclosing the inlet opening 8 and on the other side against the coupling frame 14. The sealing rim 23 is formed on the filter element 3 so that when the respective filter element 3 is inserted or replaced in the ventilation apparatus 1, the sealing rim 23 is also inserted or replaced. The sealing surface 24 is formed by a housing frame 25 enclosing the inlet opening 8. For sealing purposes, an elastic seal 26a and 26b is fixed - for example glued - to a side surface 23a and 23b of the sealing rim 23 facing the housing 4 and the coupling frame 14 respectively.

Fig. 10 shows a view of the flow adapter 11. Furthermore, the flow adapter 11 is shown in Fig. 11 partially in section; in Fig. 12 from behind and in Fig. 13 from above. The flow adapter 11 has the air inlets 12 and the air outlet 13 fluidically corresponding to the respective inlet opening 8 of the respective housing 4. The flow adapter 11 is in one piece and preferably moulded from plastic. As a result, the flow adapter 11 is robust and the air drawn in from the outside by the respective fans 5 is already distributed in the flow adapter 11 and flows evenly over the respective filter elements 3. In this

respect, the flow adapter 11 has the flow region 11a and the collecting region 11b, which adjoin one another. The flow region 11a of the flow adapter 11 corresponds fluidically with the inlet openings 8 of the respective housings 4 and the collecting region 11b is arranged offset transversely to the flow direction 10 below the flow region 11a. Furthermore, the collecting region 11b lies outside a main air flow in the flow adapter 11.

As already explained in Fig. 1 to Fig. 6, the drain channel arrangement 17 is formed in the coupling frame 14. This fluidically connects the collecting region 11b of the flow adapter 11 and the drip regions 4b of the respective housings 4. The drain channel arrangement 17 allows the water separated in the filter element 3 to be guided from the respective housing 4 into the collecting region 17 of the flow adapter 11 against the flow direction 10. For this purpose, the collecting region 11b of the flow adapter 11 is fluidically connected to the drain channel arrangement 17 via a drain opening 28, the drain channel arrangement 17 being connected to the drain opening 28 at its lowest point in the lower channel 17a via a drain pipe - not shown here. The water separated in the filter elements 3 is led through the drain opening 28 into the flow adapter 11 and guided outwards in the collecting region 11b of the flow adapter 11 against the flow direction 10. The structure of the drain channel arrangement 17 is shown in detail in Fig. 6, Fig. 14 and Fig. 15.

Fig. 14 and Fig. 15 show sectional views of the ventilation apparatus 1. In the ventilation apparatus 1, the individual ventilation modules 2 are fixed to the stacking block 19 on one side of the coupling frame 14 and the flow adapter 11 on the other side. In the coupling frame 14 the drain channel arrangement 17 is formed, which has two horizontal gutter channels 17a arranged one above the other and a vertical drain channel 17b. The respective drain channel 17a is oriented horizontally with a deviation of up to 10° from the ground in the installed ventilation apparatus, in order to be able to guide the water separated in the filter element 3 horizontally in the drain channel arrangement 17 under the action of gravity. The respective gutter channel 17a thereby connects the drip regions 4b of the housings 4 of the ventilation modules 2 in the stacking block 19, which are adjacent in series, respectively. The two gutter channels 17a are fluidically connected vertically via the drain channel 17b. The vertical drain channel 17b is oriented vertically with a deviation of up to 10° from the ground in the installed ventilation apparatus 1, so that the water separated in the filter element 3 can

be directed from the upper channel 17a to the lower channel 17a under the action of gravity. The water separated in the filter elements 3 is then directed from the drain channel arrangement 17 to the collecting region 11b of the flow adapter 11 and further to the outside. For this purpose, the lower channel 17a is fluidically connected to the collecting region 11b of the flow adapter at its lowest point through the drain opening 28. In this advantageous manner, the plurality of housings 4 and the plurality of filter elements 3 are fluidically connected to each other via the drain channel arrangement 17 in the coupling frame 14 and the water separated in the plurality of filter elements 3 can be discharged from the ventilation apparatus 1 in a simplified manner.

In summary, the ventilation apparatus 1 according to the invention can be constructed in a modular manner and the identically designed ventilation modules 2 can be exchanged for one another in a simple manner; furthermore, the water separated in the respective filter element 3 can be discharged from the ventilation apparatus 1 in a simplified manner; sealing of the ventilation apparatus 1 can be simplified and the ventilation apparatus 1 can be controlled more precisely and the air flow in the respective filter element 3 can be better distributed.

PATENTKRAV

1. Ventilasjonsapparat (1) for å filtrere luft og separere vannaerosoler fra luft,

- hvor ventilasjonsapparatet (1) har et flertall filterelementer (3), et flertall hus (4), et flertall vifter (5) og minst én strømningsadapter (11),
- hvor det minst ene filterelementet (3) er festet i det minst ene huset (4) slik at luft kan strømme gjennom det fra en innløpsåpning (8) til en utløpsåpning (9) til det minst ene huset (4) i en strømningsretning (10), og
- hvor den minst ene viften (5) er festet til utløpsåpningen (9) nedstrøms for det minst ene huset (4) i strømningsretningen (10) og den minst ene strømningsadapteren (11) er festet til innløpsåpning (8) oppstrøms for det minst ene huset (4) i strømningsretningen (10),
- hvor det respektive filterelementet (3), det respektive huset (4) og den respektive viften (5) hver danner en ventilasjonsmodul (2) med et strømningsareal (7), og
- hvor et antall identiske ventilasjonsmoduler (2) er løsbart stablet mot hverandre for å danne ventilasjonsapparatet (1) på en slik måte at et totalt strømningsareal (6) av ventilasjonsapparatet (1) tilsvarer et multiplum av strømningsareal (7) til den individuelle ventilasjonsmodulen (2),

karakterisert ved at

- en koblingsramme (14) har en modulstøtteramme (14a) som omslutter de respektive ventilasjonsmodulene (2) på tvers av strømningsretningen (10), og en adapterstøtteramme (14b) som støtter den minst ene strømningsadapteren (11), som er montert sammenleggbare mot hverandre eller forskyvbare ved hjelp av en hengselanordning (15) og kan festes mot hverandre ved hjelp av en lukkeenhet (16).

2. Ventilasjonsapparat ifølge krav 1,
karakterisert ved at
minst to av de tilstøtende ventilasjonsmodulene (2) i ventilasjonsapparatet (1) har hver på sine hus (4) en kabelfordypning (22a) som strekker seg i strømningsretningen (10), hvor de respektive kabelfordypninger (22a) på husene (4) til de tilstøtende ventilasjonsmodulene (2) ligger an mot hverandre i strømningsretningen (10) og danner en kabelfordypning (22).

3. Ventilasjonsapparat ifølge krav 1 eller 2,
karakterisert ved at
en av de tilstøtende ventilasjonsmodulene (2) i ventilasjonsapparatet (1) har på huset (4) en utsparing (20a) som strekker seg i strømningsretningen (10) og en annen av de tilstøtende ventilasjonsmodulene (2) i ventilasjonsapparatet (1) har på huset (4) en formasjon (20b) som strekker seg i strømningsretningen (10), hvor den respektive utsparingen (20a) og den respektive formasjonen (20b) er i inngrep på tvers av strømningsretningen (10) og fester de tilstøtende ventilasjonsmodulene (2) løsbart til hverandre.

4. Ventilasjonsapparat ifølge et hvilket som helst av de foregående kravene,
karakterisert ved at
ventilasjonsapparatet (1) har fire ventilasjonsmoduler (2) og en enkeltstrømsadapter (11), hvor ventilasjonsmodulene (2) er løsbart festet til hverandre og utgjør en 2x2 stableblokk (19) og er festet i en luft - ledende måte til strømningsadapteren (11) ved hjelp av en koblingsramme (14).

5. Ventilasjonsapparat ifølge hvilket som helst av kravene 1 til 4,
karakterisert ved at

et avløpskanalarrangement (17) er utformet i adapterstøtterammen (14b).

6. Ventilasjonsapparat ifølge et hvilket som helst av de foregående kravene,
karakterisert ved at
et gjennomløpsarrangement (18), fortrinnsvis et lamellarrangement (18a), for regulering av luftstrømmen gjennom den respektive ventilasjonsmodulen (2) på tvers av strømningsretningen (10) er i hvert tilfelle festet til en koblingsramme (14) for innløpsåpningen (8) til det respektive huset (4).

7. Ventilasjonsapparat ifølge et hvilket som helst av de foregående kravene,
karakterisert ved at
det respektive filterelementet (3) har en periferisk tetningskant (23), hvor tetningskanten (23) ligger an mot en tetningsflate (24) av huset (4) som omslutter innløpsåpningen (8) og på andre siden mot koblingsrammen (14) og tetter det respektive huset (4) rundt innløpsåpningen (8) til en koblingsramme (14) på tvers av strømningsretningen (10).

8. Ventilasjonsapparat ifølge krav 7,
karakterisert ved at
en elastisk tetning (26a, 26b) er festet til en sideflate (23a, 23b) av tetningskanten (23) som vender mot det respektive hus (4) og/eller koblingsrammen (14).

9. Ventilasjonsapparat ifølge et hvilket som helst av de foregående kravene,
karakterisert ved at

den minst ene strømningsadapteren (11) er i ett stykke og fortrinnsvis laget av plast.

10. Ventilasjonsapparat ifølge et hvilket som helst av de foregående kravene,
karakterisert ved at
den minst ene strømningsadapteren (11) har et oppsamlingsområde (11b) og et strømningsområde (11a), hvor strømningsområdet (11a) til den minst ene strømningsadapteren (11) på en luftledende måte tilsvarer innløpsåpningen (8) til det minst ene huset (4) og oppsamlingsområdet (11b) er anordnet forskjøvet i forhold til strømningsretningen (10) under strømningsområdet (11a) og utenfor en hovedluftstrøm av den i det minste én strømningsadapter (11).

11. Ventilasjonsapparat ifølge krav 10,
karakterisert ved at
et dreneringskanalarrangement (17) forbinder fluidisk oppsamlingsområdet (11b) til den minst ene strømningsadapteren (11) og et dryppområde (4b) til det minst ene huset (4), hvilket dryppområde fluidisk tilsvarer en drenerings-sone (3b) til filterelementet (3) for å tømme vannet som separeres i det minst ene filterelementet (3).

12. Ventilasjonsapparat ifølge krav 11,
karakterisert ved at
den minst ene strømningsadapteren (11) har en adapterutløpsåpning som leder ut av oppsamlingsområdet (11b) og er forbundet på en fluidledende måte til dreneringskanalarrangementet (11).

13. Ventilasjonsapparat ifølge krav 11 eller 12,
karakterisert ved at

avløpskanalarrangementet (17) er utformet i en koblingsramme (14) som er festet på en lufttett måte mellom det minst ene huset (4) og det minst ene strømningsadapteret (11) på tvers av strømningsretningen (10).

14. Ventilasjonsapparat ifølge krav 13,
karakterisert ved at
avløpskanalarrangementet (17) har minst en horisontal rennekanal (17a), fortrinnsvis laget av en U-formet metallprofil, som er fluidisk forbundet med et dryppområde (4b) til det minst ene huset (4).

15. Ventilasjonsapparat ifølge krav 14,
karakterisert ved at
avløpskanalarrangementet (17) har minst to rennekanaler (17a) som er anordnet over hverandre og er fluidisk forbundet med hverandre med minst én vertikal avløpskanal (17b) fortrinnsvis laget av en U-formet eller L- formet metallisk profil.

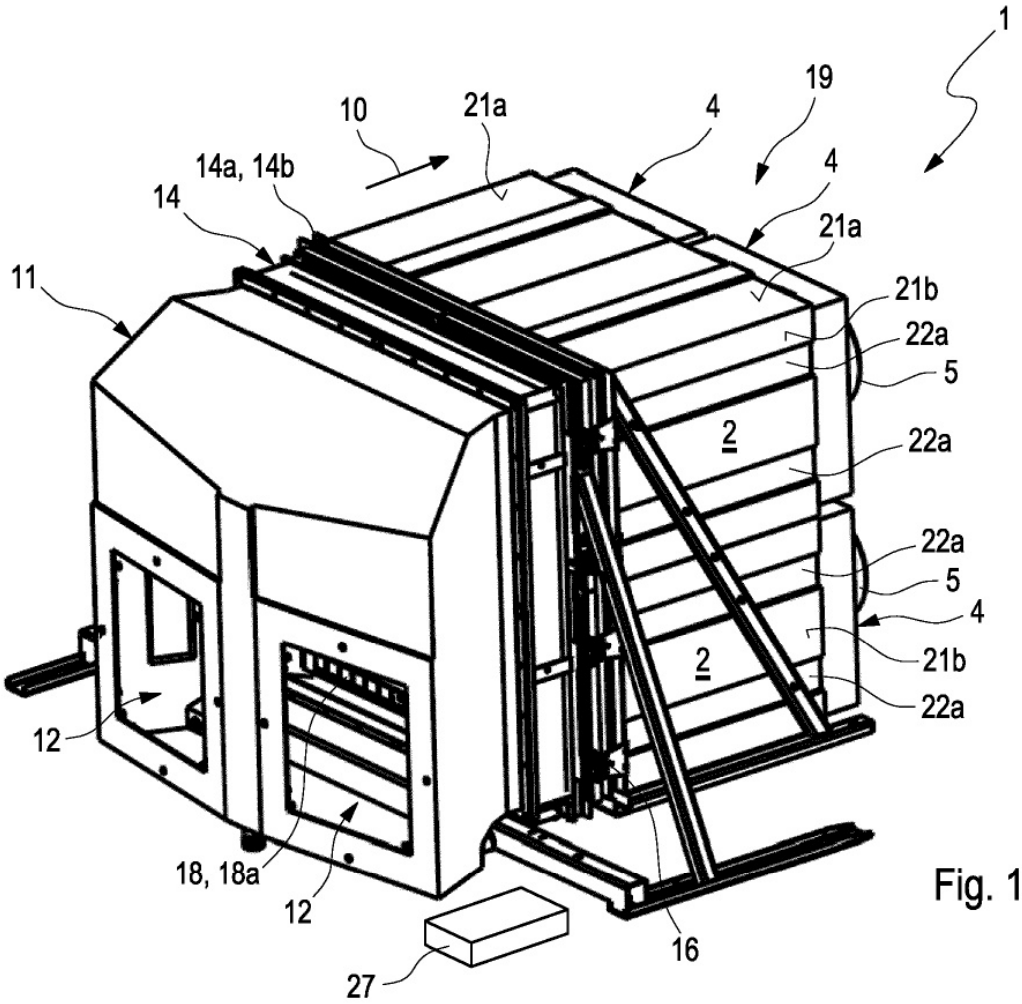
16. Ventilasjonsapparat ifølge et hvilket som helst av de foregående kravene,
karakterisert ved at
- den respektive viften (5) styres av en kontrollanordning (27) som har minst ett målearrangement for å detektere luftstrømhastigheten gjennom det respektive filterelementet (3), og
- det minst ene målearrangementet har en trykkmåleenhet for å detektere et statisk trykk, hvilken trykkmåleenhet er anordnet inne i ventilasjonsapparatet (1).

17. Ventilasjonsapparat ifølge krav 16,
karakterisert ved at
den respektive trykkmåleenheten er fluidisk forbundet med et trykkmålepunkt eller har et slikt trykkmålepunkt, hvor

trykkmålepunktet er anordnet inne i det minst ene huset (4) i området for innløpsåpningen (8) og har en måleåpning der.

18. Ventilasjonsapparat ifølge krav 17,
karakterisert ved at
det respektive trykkmålepunktet eller dets måleåpning er anordnet i et dryppområde (4b) av huset (4).

19. Ventilasjonsapparat ifølge krav 17 eller 18,
karakterisert ved at
- huset (4) har en husramme (25) som omslutter innløpsåpningen (8) og danner et radialt innad-stikkende innløpstrinn, og
- trykkmålepunktet er anordnet på innløpstrinnet, hvor måleåpningen er åpen i strømningsretningen (10) og er orientert hovedsakelig parallelt med strømningsretningen (10).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22a
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21b
22a
12
18, 18a
12
16
27

Fig. 1

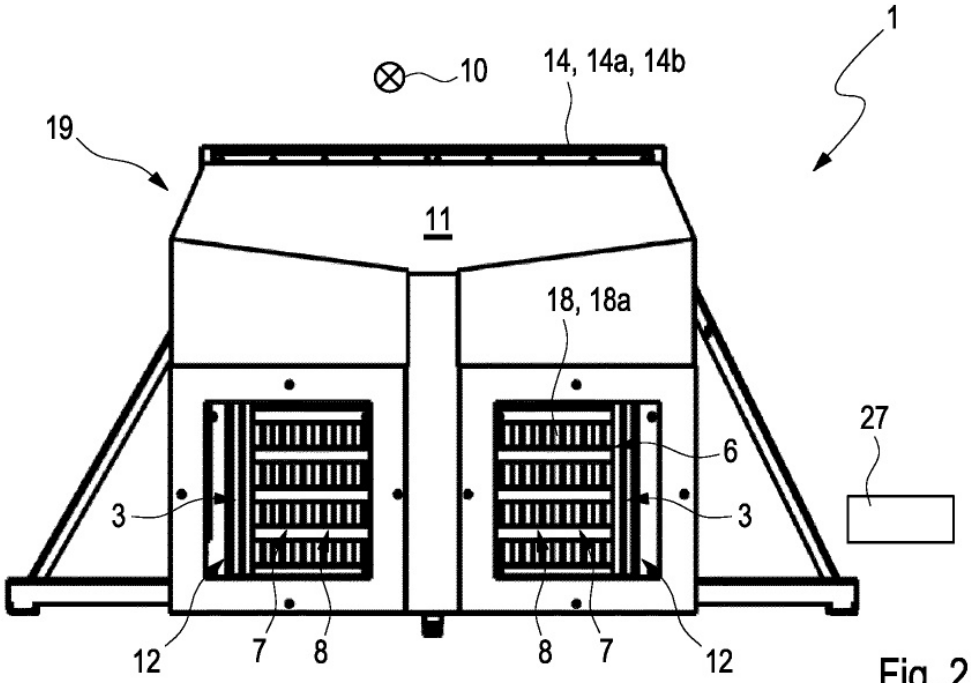
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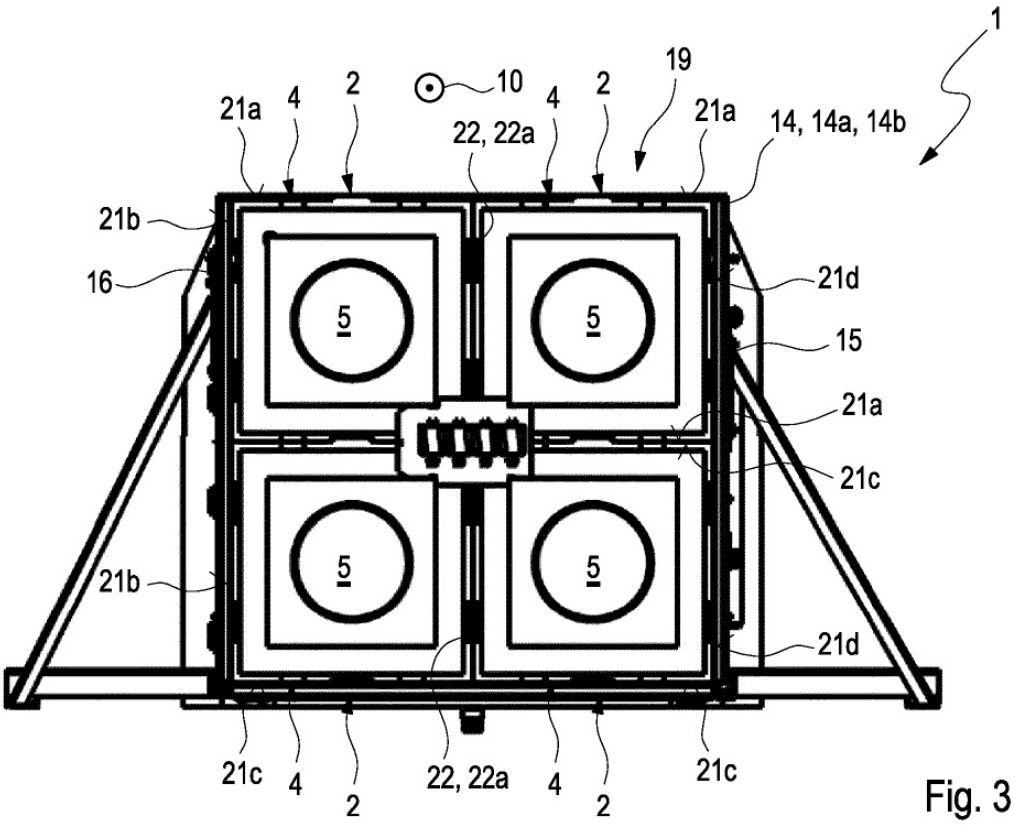
Fig. 2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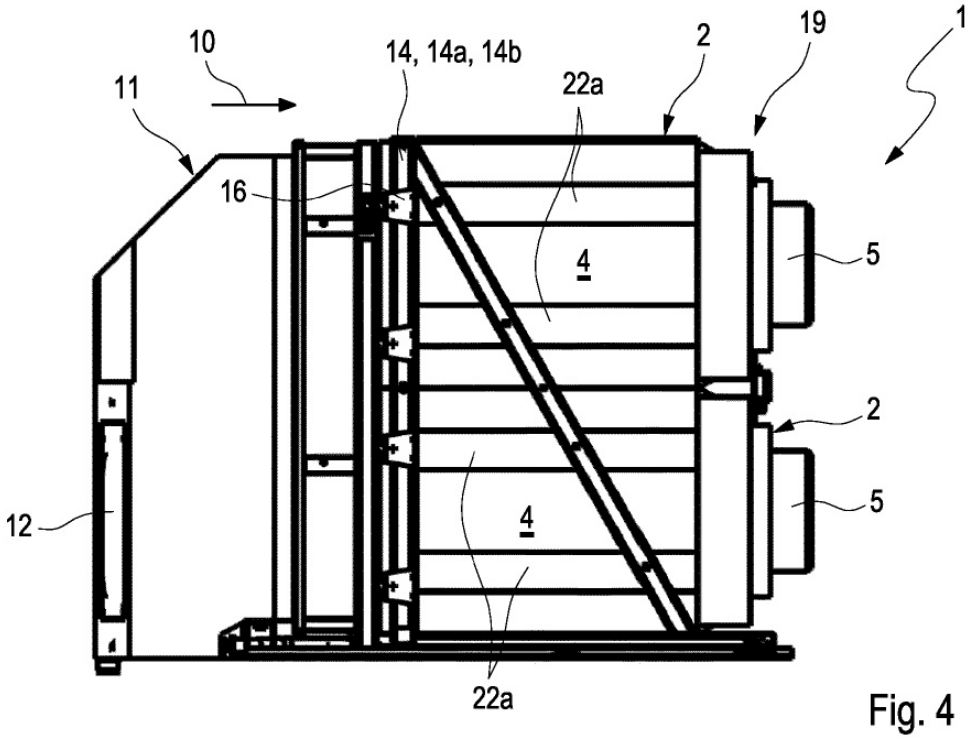
21c
21c
22, 22a

Fig. 3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22a

Fig. 4

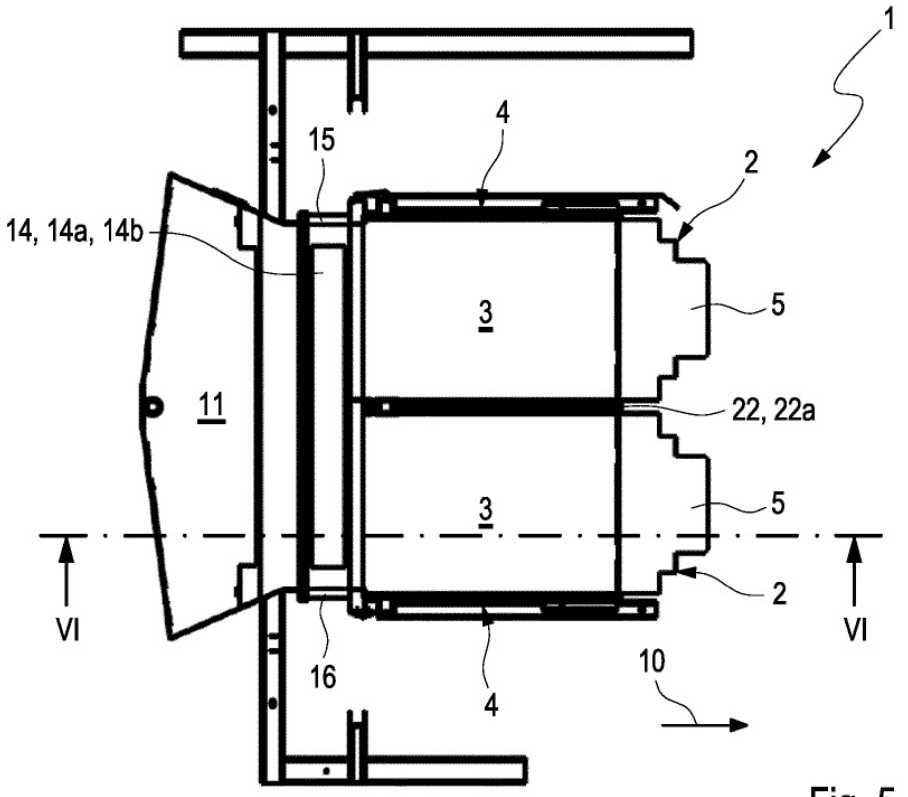
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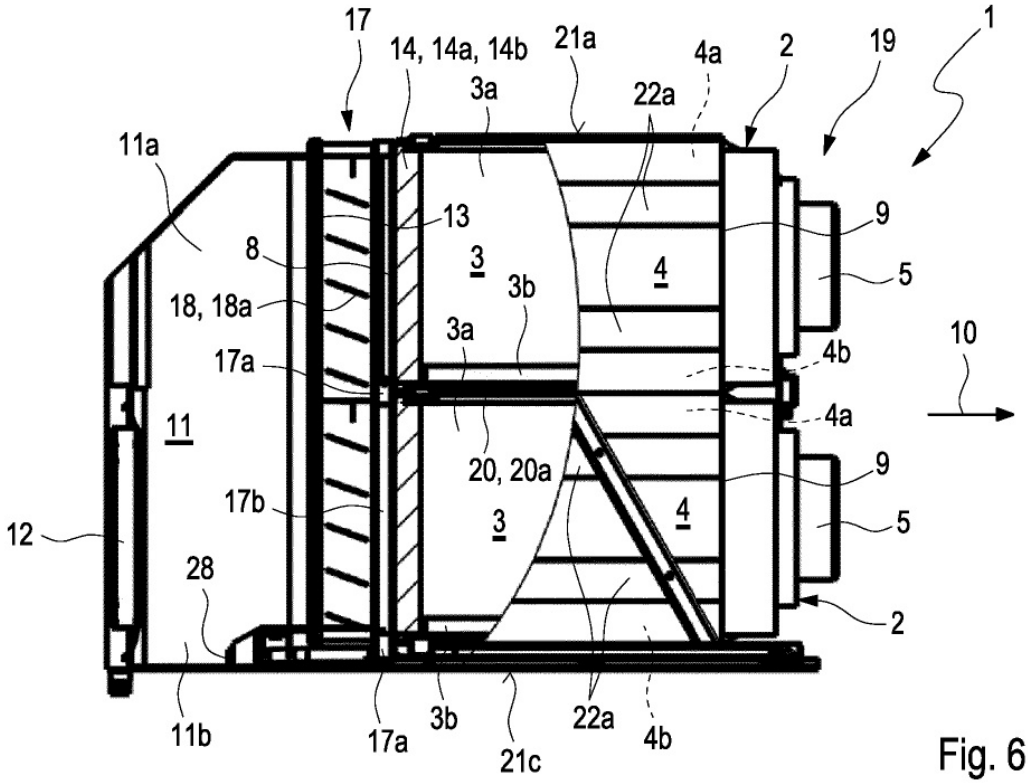
Fig. 5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3b
3a
10
4b
17a
4a
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17a
3b
22a
4b
21c

Fig. 6

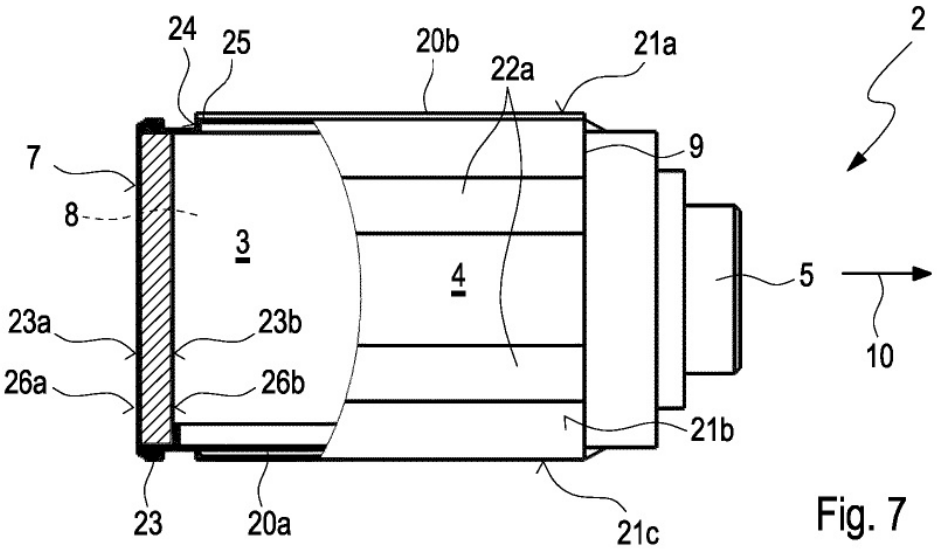

Fig. 7

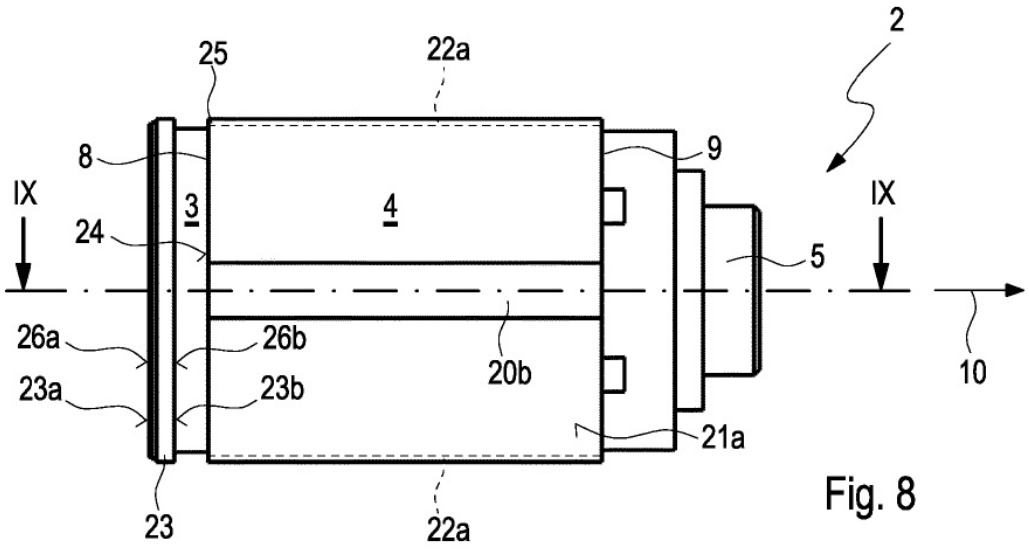

Fig. 8

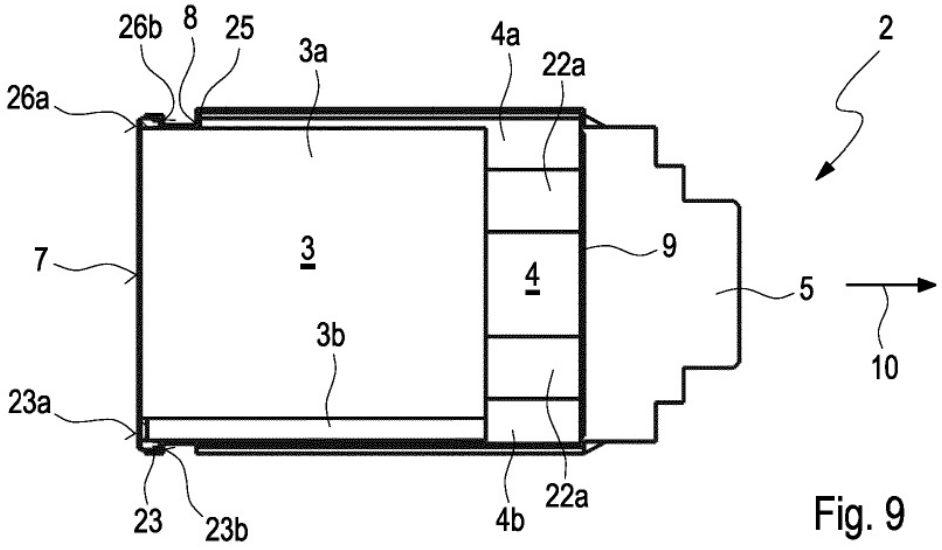

Fig. 9

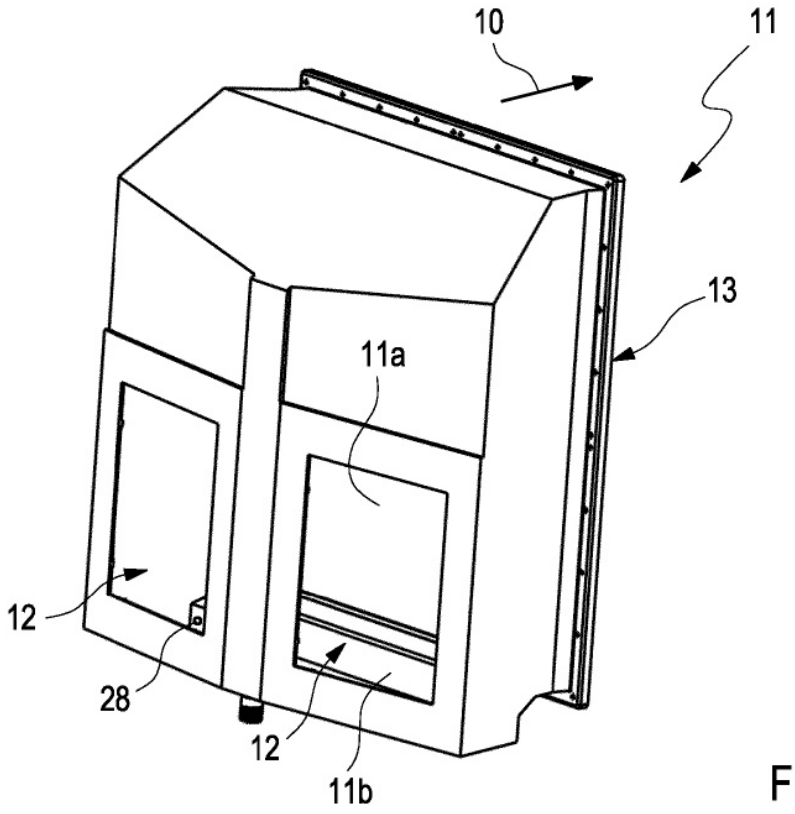

Fig. 10

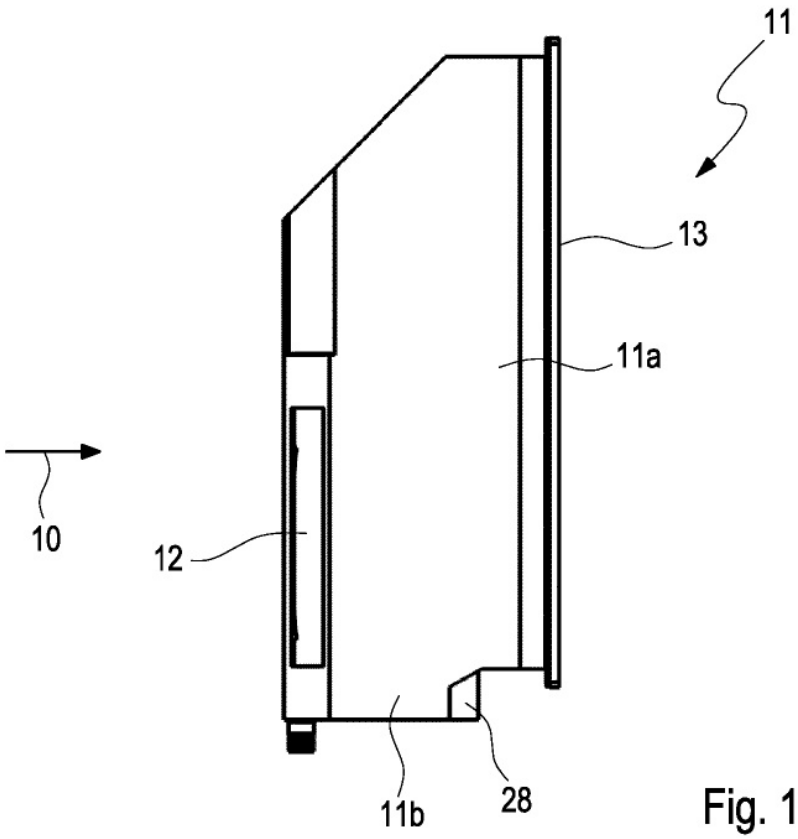

Fig. 11

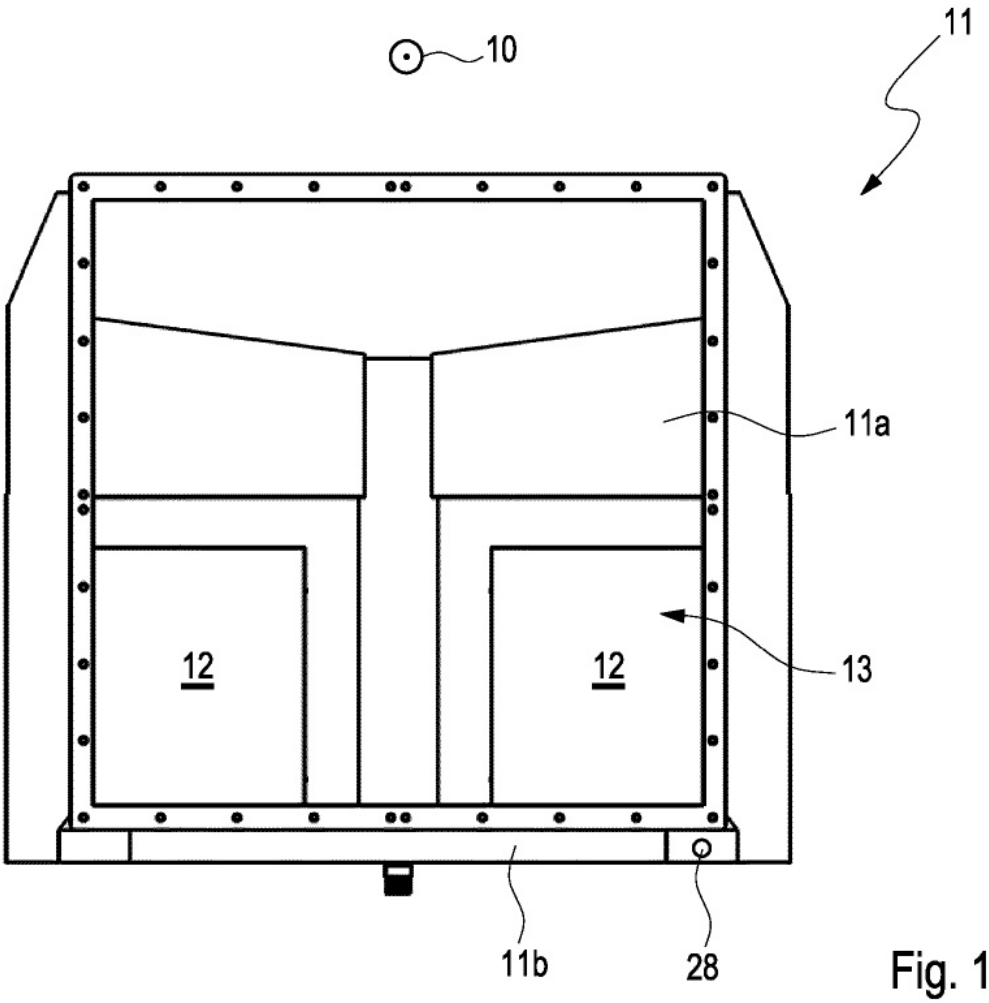

Fig. 12

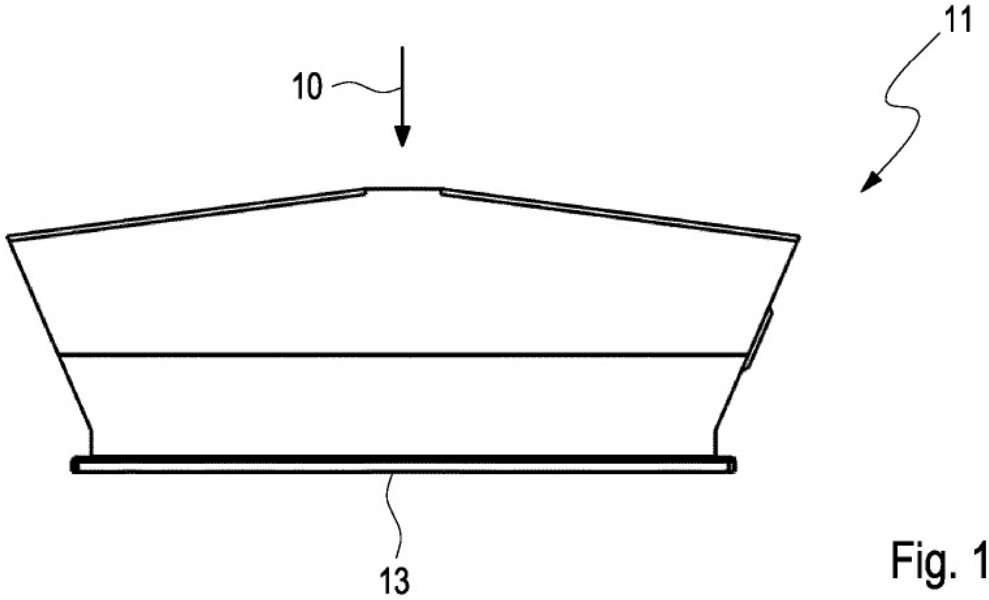

Fig. 13

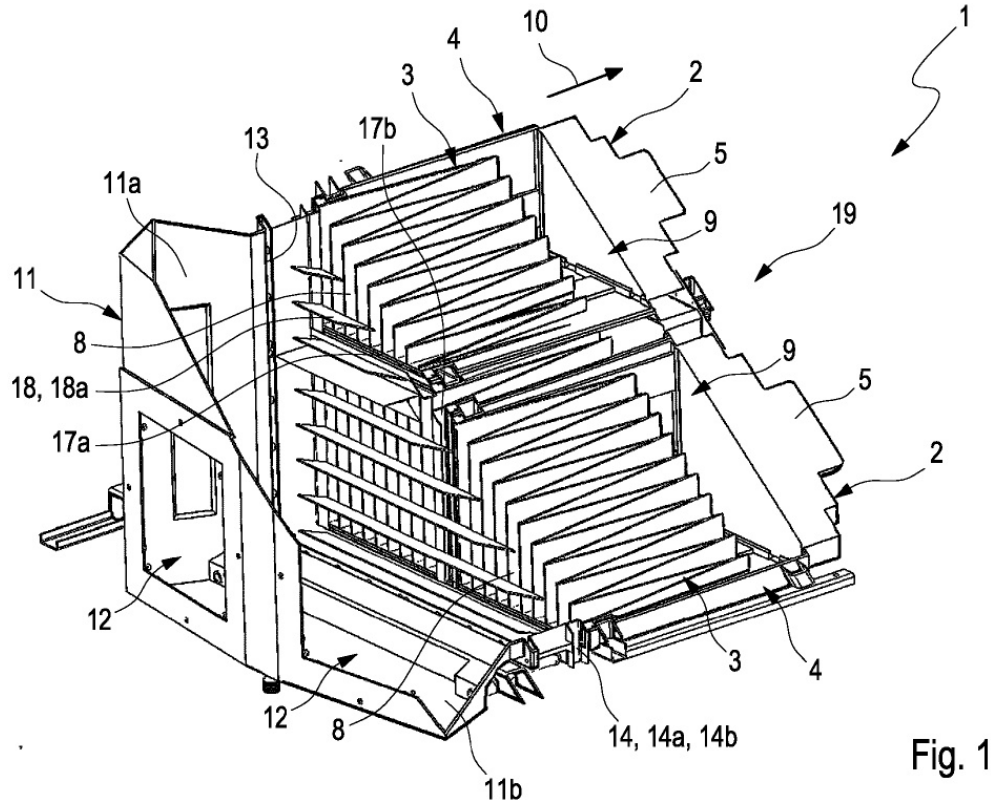
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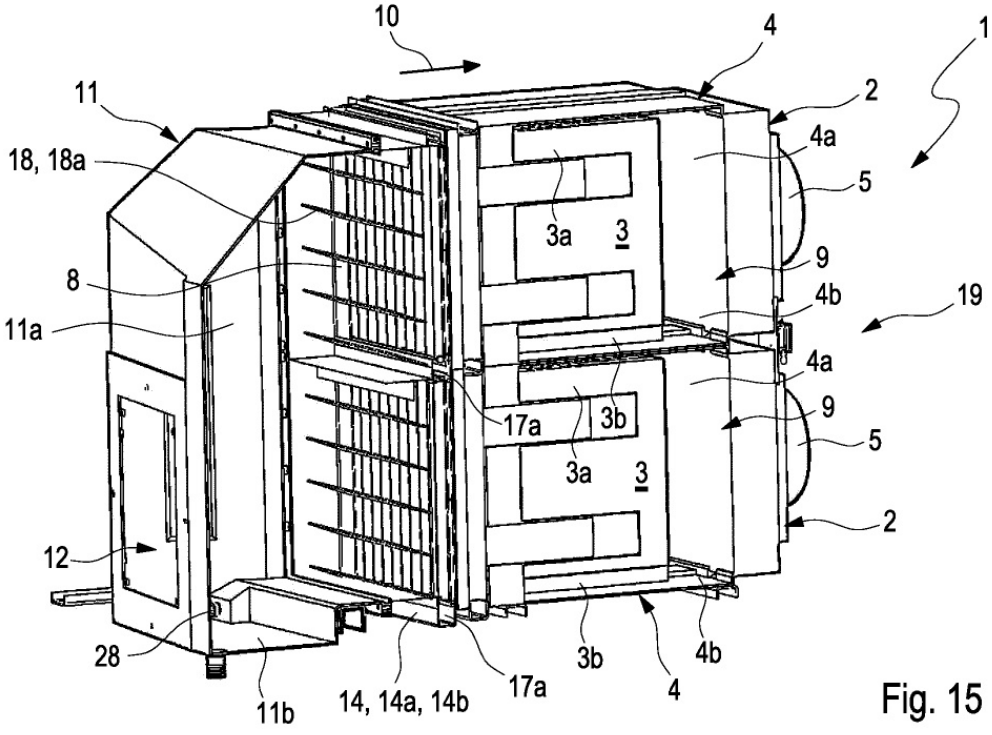
Fig. 14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11b
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17a
3b
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4b

Fig. 15