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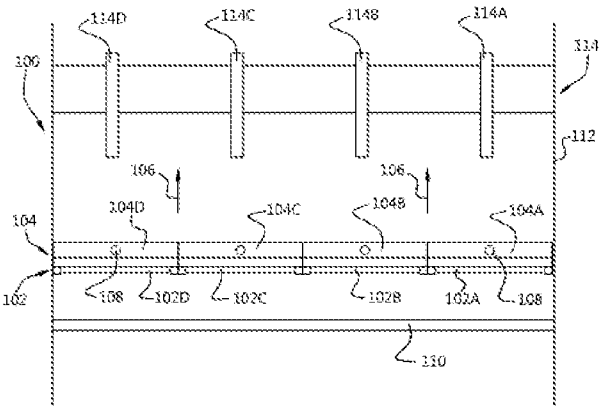
(54) **AIR DUCT SYSTEM AND METHOD**

(57) The application describes an air duct system (100) comprising an ionisation section (102) and a particle collection section (104). The particle collection section is configured for removing particles from an airflow through the air duct system. The particle collection section comprises one or more particle collection members (104A, 104B, 104C, 104D). Each particle collection member is rotatable about a rotational axis between a first position wherein airflows mainly through the particle collection member and a second position wherein the air flows mainly along the particle collection members.



AIR DUCT SYSTEM AND METHOD

TECHNICAL FIELD

The subject disclosure relates to an air duct system. The invention further relates to a method for an air duct system.

BACKGROUND ART

Air ducts or air channels or air shafts are used for ventilation. This air ducts can be provided with many devices and systems for actuating air in the air ducts, heat exchangers, fans, valves and doors, filters, safety or rain gratings, and the like.

Air duct systems for large constructions, like air ducts that are used for instance for parking garages, are dimensioned for the specific building to meet the desired specification with regard to ventilation capacity and safety.

For large air duct system, the maximum volume flow rate is defined by regulations to suck sufficient air out of a room or to blow air into the room in case of fire. Furthermore, fire dampers are installed in the ducts to prevent the fire in a room from spreading through the ventilation system to another room. These requirements in turn determine the minimum capacity of the fan and the minimum dimensions of a duct. In order not to increase the costs too much, the capacity of a ventilator will be slightly above the minimum capacity and the dimensions of the ducts will be slightly above the minimum dimensions. To avoid malfunctions of the fire dampers, the fire dampers require regular preventive maintenance. This requires them to be accessible to a service technician. Therefore, the fire dampers are located quite close to the inlet of an air duct.

In order to reduce air pollution from extracted air from parking garages, air filters are planned to be installed in existing air duct systems of parking garages. The air filters have to reduce the particulate material, pollutants, NOx, fine particles and fine dust, generated by engines in a building in the air blown out of the building. However, adding features in an air duct, especially filters, will increase the air resistance through the system and the power of the fan may no longer be sufficient to achieve the desired flow rate in maximum ventilation mode. The existing fan will then have to be replaced by a more powerful one.

The term particulates – also known as atmospheric aerosol particles, atmospheric particulate matter, particulate matter (PM) or suspended particulate matter (SPM) – are microscopic particles of solid or liquid matter suspended in the air. The term aerosol commonly refers to the particulate/air mixture, as opposed to the particulate matter alone. Sources of particulate matter can be natural or anthropogenic. They have impacts on climate and precipitation that adversely affect human health, in ways additional to direct inhalation.

Types of atmospheric particles include suspended particulate matter; thoracic and respirable particles; inhalable coarse particles, designated PM10, which are coarse particles with a diameter of 10 micrometers (μm) or less; fine particles, designated PM2.5, with a diameter of 2.5 μm or less; ultrafine particles, with a diameter of 100 nm or less; and soot.

The IARC and WHO designate airborne particulates as a Group 1 carcinogen. Particulates are the most harmful form (other than ultra-fines) of air pollution due to their ability to penetrate deep into the lungs, blood streams and brain, causing health problems including heart attacks, respiratory disease, and premature death.

In general, dust collection systems are used to control particulate emissions. These systems generally include inertial collectors (cyclonic separators); fabric filter collectors (baghouses), electrostatic filters used in facemasks, wet scrubbers, electrostatic precipitators, and combinations thereof.

Electrostatic filtering requires an ioniser where particles are charged and an electrostatic filter where charges particles are captured. The ioniser and electrostatic filter are, in flow direction separated from one another. The ioniser is usually upstream of the electrostatic filter. The electrostatic filter is consequently downstream of the ioniser.

Various components can often be hindering one another, in particular obstructing access to one another and/or creating high air resistance, obstruction to the airflow pattern and ventilation capacity. Especially in relatively large air ducts, adding functional elements, such as a particle filter, can be challenging.

SUMMARY OF INVENTION

It is an object of the subject technology to provide a technology which enables to add a filtering function to existing air duct systems which overcomes at least one of the problems described above.

According to an aspect of the subject technology, this object is achieved by an air duct system having the features of claim 1. Advantageous embodiments and further ways of carrying out the present technology may be attained by the measures mentioned in the dependent claims.

An air duct system according to the subject technology comprises a particle collection section. The particle collection section is configured for removing particles from an airflow through the air duct system. The particle collection section comprises one or more particle collection members. Each particle collection member is rotatable about a rotational axis between a first position wherein air flows mainly through the particle collection member and a second position wherein the air flows mainly along the particle collection member.

A functioning particle collection section increases the air resistance of an air duct system. When a particle collection section is added to an existing air duct system, the air resistance can become so high that the maximum air volume flow generated by the existing air flow generation unit falls below the value required by a directive. The ability to rotate the one or more particle collection members of the particle collection section makes it possible, depending on the desired application of the air duct system, to put the particle collection section in a closed status enabling the particle collection section to filter the air flow through the particle collection section or in an open status enabling to minimize the air resistance through the air duct system. The open status further allows access for a service technician from a downstream side of the particle collection section to an upstream side of the particle collection section. This provides the ability to perform maintenance on parts of the air duct system upstream the particle collection section.

In an embodiment, the particle collection section comprises at least two particle collection members forming a slat structure with substantially parallel rotational axes. These features provide a simple construction to obtain a particle collection section that can alternately be placed in an open and in a closed position.

In a further embodiment, each particle collection member is individually rotatable about its rotational axis. This feature allows the filter properties and the air resistance of the particle collection section to be changed in a number of steps.

In an embodiment, the rotational axis substantially coincides a central body axis of a particle collection member. This feature provides particle collection members in which the rotational force exerted on the particle collection member by an air flow is not dependent on the direction of air flow through the air duct system.

In an embodiment, each particle collection member has a rectangular shape, wherein its rotational axis is along a length side of the rectangular shape. This feature is advantageous when there is very little space in a shaft, for example, between the filter and fire dampers. This allows the fire dampers to be approached easily for maintenance.

In an embodiment, to each of the one or more particle collection members a part of said ionisation section is mounted to rotate together with the particle collection member about the rotational axis. This feature is advantageous when fire dampers can only be reached for maintenance via the duct space occupied by the ionisation section and particle collection section.

In an embodiment, the air duct system further comprises an ionisation section upstream the particle collection section. An ionisation section can significantly improve particle capture. The ionisation section charges the particles in the air flow and thus increases the particle capture performance of an actively charged electrostatic filter element, an electret filter element or an electrostatic precipitator element using charged conductive plates. At the same time, the use of an ionisation section allows the pressure drop over the particle collection section to be reduced. The improved particle capture by ionisation allows the performance of lower cost lower grade filters with lower pressure drop to be improved while the particle capture performance remains the same or even increases compared to a system without an ionisation section but with a particle collection section with higher grade filters that have a higher pressure drop.

In an embodiment, the air duct system further comprises an actuator system for rotating one or more particle collections members of the particle collection section. This allows the one or more particle collection members to be

brought into the desired rotational position automatically and/or remotely. In a further embodiment, the actuator system comprises a corresponding actuator element for each of the one or more particle collection members to rotate each particle collection member individually. In a further embodiment, when an actuator element is not powered, the corresponding particle collection member is forced in the second position. This feature is advantageous in combination with a fire protection system to provide a fail-safe system. If there is a power failure, the one or more particle collection members automatically rotate to the position with the lowest air resistance so that, in the event of a fire, smoke can be easily drawn through the system out of the building or smoke-free air blown into the building.

In a further embodiment, the air duct system comprises a control unit to control the actuator system in response to a volumetric flow rate indicative of the desired volumetric flow rate through the air duct. These features make it possible to add a filter function to an existing ventilation system, so that almost no additional adjustments, such as a more powerful fan, are required to meet the specification of the existing air duct system and particles can be removed from the air flow through the ventilation system in most circumstances.

In an embodiment, the air duct system comprises a fire damping section, wherein the ionisation section and the particle collection section are upstream the fire damping section. The one or more rotatable particle collection members allow for easy access via an air inlet opening to the fire dampers for maintenance.

In an alternative embodiment, the particle collection section forms a filter for particles that in operation runs through said air duct, said valve comprising a series of aligned slats substantially in a particle collection plane, the slats having a longitudinal axis and which are rotatable about a slat rotational axis, wherein the slats have a closed slat position in which the slats together close off the air duct for particles, and an open slat position in which the slats allow particles to flow through the air duct downstream the particle collection section.

In an embodiment, the particle collection section comprises one or more collection elements taken from a group comprising: a fiber dust filter element, an actively charged electrostatic filter element, an electret filter element or an electrostatic precipitator element using charged conductive plates. In principle any type of particle collection element may be used.

In a second aspect there is provided method for an air duct system, comprising:

providing an air duct system according to any one of the preceding claims,

rotating the one or more particle collection members in a first position when the air duct system is in an operating status to remove particulate material from a flow of air through a duct; and,

rotating at least one of the one or more particle collection members in a second position when the air duct system is in another operating status of the air duct system. These features make it possible for an existing air duct system to which a particle collection section is subsequently added to still meet the original specification in terms of maximum flow rate without having to use more powerful fans.

The terms “upstream” and “downstream” relate to an arrangement of items or features relative to a flow of air. Relative to a first position within a stream of air, e.g. a fire damper, a second position in the stream of air closer to the air inlet opening is “upstream”, and a third position within stream of air further away from the air inlet opening is “downstream”.

The term “substantially” herein, such as in “substantially parallel” or in “substantially coincides”, will be understood by the person skilled in the art. The term “substantially” may also include embodiments with “entirely”, “completely”, “all”, etc. Hence, in embodiments the adjective substantially may also be removed. Where applicable, the term “substantially” may also relate to 90% or higher, such as 95% or higher, especially 99% or higher, even more especially 99.5% or higher, including 100%. The term “comprise” includes also embodiments wherein the term “comprises” means “consists of”.

The term "functionally" will be understood by, and be clear to, a person skilled in the art. The term “substantially” as well as “functionally” may also include embodiments with “entirely”, “completely”, “all”, etc. Hence, in embodiments the adjective functionally may also be removed. When used, for instance in “functionally parallel”, a skilled person will understand that the adjective “functionally” includes the term substantially as explained above. Functionally in particular is to be understood to include a configuration of features that allows these features to function as if the adjective “functionally” was not present. The

term “functionally” is intended to cover variations in the feature to which it refers, and which variations are such that in the functional use of the feature, possibly in combination with other features it relates to in the invention, that combination of features is able to operate or function. For instance, if an antenna is functionally coupled or functionally connected to a communication device, received electromagnetic signals that are receives by the antenna can be used by the communication device. The word “functionally” as for instance used in “functionally parallel” is used to cover exactly parallel, but also the embodiments that are covered by the word “substantially” explained above. For instance, “functionally parallel” relates to embodiments that in operation function as if the parts are for instance parallel. This covers embodiments for which it is clear to a skilled person that it operates within its intended field of use as if it were parallel.

Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects, properties and advantages will be explained hereinafter based on the following description with reference to the drawings, wherein like reference numerals denote like or comparable parts, and in which:

Fig. 1 schematically shows a first embodiment of a part of an air duct system with a particle collection section in a first position;

Fig. 2 schematically shows the first embodiment with the particle collection section in a second position;

Fig. 3 schematically shows the first embodiment with the particle collection section in the second position with partially removable air inlet grating;

Fig. 4 schematically shows a second embodiment of a part of an air duct system with a particle collection section in the first position;

Fig. 5 schematically shows the second embodiment with the particle collection section in the second position;

Fig. 6 schematically shows a third embodiment of a part of an air duct system with a particle collection section in the first position;

Fig. 7 schematically shows the third embodiment with the particle collection section in the second position;

Fig. 8 shows a perspective view of a first assembly comprising an ionisation section and particle collection section in the first position;

Fig. 9 shows a perspective view of the first assembly in the second position; and,

Fig. 10 shows a front view of the first assembly in the second position.

DESCRIPTION OF EMBODIMENTS

Fig. 1 – 2 schematically show a first embodiment of a part of an air duct system 100. An air duct system 100 according to the subject technology comprises one or more coupled air ducts 112, an ionisation section 102 and a particle collection section 104, one or more air flow generators (not shown), e.g. fans, one or more air inlet openings, one or more air outlet openings, and optionally a fire damper section 114. For safety reasons, the air openings are provided with safety gratings 110. The air ducts system can also be provided with many other devices and systems for actuating air in the air ducts, heat exchangers, valve, doors, filters or rain grating. The term air duct 112 also includes air channel or air shaft. The combination of ionisation section 102 and the particle collection section 104 forms an air duct particle collection system. The current air ducts in which the air duct particle collection system can be applied have a cross sectional area of at least 0.5 m^2, in particular at least 1 m^2. More in particular, the cross sectional area is at least 4 m^2. Usually, the air duct has a cross sectional area smaller than 25 m^2. Usually in most applications, the cross sectional area is smaller than 10 m^2.

The ionisation section comprises wires, needles, brushes or barbed-wire like structures, metal strips with one or more edges forming a row of conona

points or an ionising source, e.g. UV light, to charge particulate material passing through the ionisation section.

In an air flow through a duct, the ionisation section 102 is located upstream the particle collection section 104. The particle collection section 104 is configured for removing particulate material from an airflow through the air duct system. The particle collection section comprises one or more particle collection members 104A, 104B, 104C, 104D; each particle collection member is rotatable about a rotational axis 108 between a first position, shown in Fig. 1 and a second position, shown in Fig. 2. In the first position, air flows mainly through the particle collection member. In the second position the air flows mainly along the particle collection member.

Functionally when the air duct system filters at least 75% of all pollutants from an air flow sucked from a building space, the ionisation section 102 is located in the air duct system upstream to the particle collection section 104. The direction of the air flow through the air duct 112 is indicated by reference 106. The ionisation section will charge the air particulates and the particle collection section captures the charged particles. The particle collection members 104A, 104B, 104C and 104D can be any type of assembly or material suitable to attract charged particles. Types of assembly or material are not limited to: a fiber dust filter element, an actively charged electrostatic filter element, an electret filter element and an electrostatic precipitator element using charged conductive plates.

The main feature of electret filter elements is their ability to remove particulate matter from polluted air by strong electrostatic forces generated by the static electret fibres from which they are made. Electret filter elements are not actively charged filters.

In the first embodiment, the particle collection members form a slat structure with substantially parallel rotational axes 108. Each particle collection member may be individually rotatable about its rotational axis 108. The rotational axis 108 of each particle collection member substantially coincides a central body axis of a particle collection member. Each particle collection member has a rectangular shape, wherein its rotational axis is along a length side of the rectangular shape. To each of the particle collection members 104A, 104B, 104C, 104D, an ionisation part 102A, 102B, 102C, 102D of said ionisation section 102 is

mounted to rotate together with the particle collection member about the rotational axis 108.

The air duct system 100 further comprises a fire damper section 114. The fire damper section comprises four fire damper units 114A, 114B, 114C, 114D. In Fig. 1, the fire dampers are in the open state. In this state, the air stream flows freely through the fire damper section. To prevent unauthorised excess into the air duct system, a safety grating or rain grating 110 is provided in the duct.

The slat structure functions as a venetian blind wherein the slats can be in open position and closed position. Fig. 1 schematically shows a first position, also named closed position or filter position of the slat structure. In this position substantially all of the air flowing through the air duct system flows through the particle collection members. In the first position, the particle collection section captures at least 75% of the particulate material from the air stream flowing through the duct. In the first position, the particle collection section increases the air resistance of the air duct system. Depending on the air flow, the pressure drop over the particle collection section can be 10 Pa.

Fig. 2 schematically shows the first embodiment with the particle collection section in a second position. In this position, the particle collection members 104A-D are rotate a quarter turn with respect to the first position. The second position is a maximal volumetric flow rate position or a maintenance position. When the air duct particle collection system is built in an existing air duct system, the capacity of the air flow generation device may be insufficient to generate a volumetric flow rate that is at least a specified minimal calamities volumetric flow rate when the particle collection members are in the first position. Calamities include, but are not limited to, fire and/or exceeding a predefined CO level or other hazardous gas level in a building space. By rotating the particle collection member from the first to the second position, the air resistance of the air duct particle collection system decreases significantly, as a result the capacity of the air flow generation system will be sufficient to generate a volumetric flow rate that exceeds the specified minimal calamities volumetric flow rate. Furthermore, the second position allows excess to a service technician to perform regular preventive maintenance. By removing the safety gratings 110, the service

technician can reach the fire dampers by passing the created openings between two particle collection members.

Fig. 3 schematically shows the first embodiment with the particle collection section in the second position with partially removable air inlet grating 110A. In this embodiment, when the particle collection section is in the second position, there is a distance between the particle collection members and the fire dampers of at least 50 cm, which is sufficient to reach each of the fire dampers for maintenance.

In an embodiment of the ionisation section, the ionisation section comprises a corona electrode structure formed by wires, needles, brushes or barbed-wire like structures and a non-corona electrode structure formed by a grid of wires, or strips with one or more edges forming a row of conona points. If the ionisation section is attached to the particle collection members, the particle collection members may be in direct contact with the non-corona electrode structure.

Fig. 4 schematically shows a second embodiment of a part of an air duct system with a particle collection section in the first position. In this embodiment, the ionisation section 102 is attached to the gratings 110. Fig. 5 schematically shows the second embodiment with the particle collection section in the second position. By removing the gratings and ionisation section, a service technician is able to service the fire damper. As the air resistance of the ionisation section is substantially lower than the air resistance of the particle collection section, only the particle collection members have to be positioned in a plane perpendicular to the direction of the air flow, which is the second position, if the capacity of the air flow generator system is not sufficient to exceed the minimal desired volumetric air flow in case of calamities. In this embodiment, the ionisation section 102 and particle collection section are spaced from another.

Fig. 6 schematically shows a third embodiment of a part of an air duct system with a particle collection section in the first position and Fig. 7 schematically shows the third embodiment with the particle collection section in the second position. This embodiment differs from the previous embodiments in that the rotational axis 108 is along a side of the particle collection members 104A-D. This has the advantage that a larger opening is created between two neighbouring particle collection members for a service technician to perform

maintenance. In the third embodiment the ionisation section is attached to the grating 110. It might be clear to the skilled person that the ionisation elements 102A-D can also be attached to the particle collection members 104A-D. In the third embodiment, the non-corona electrode structure of the ionisation section may be attached to the particle collection members and consequently rotates simultaneously with the particle collection members. The corona electrode structure and non-corona electrode structure may also be combined to form a stationary structure in the air duct that is attached to the grating.

Figs. 8 and 9 show a perspective view of a first assembly comprising an ionisation section and particle collection section. The assembly comprise two particle collection members 804 and ionisation elements 802 attached to each other by spacers 816. The spacers set the ionisation elements at distance from the particle collection member 804. The particle collection member 804 comprises a rotational bar 808. The rotational bar 808 couples the particle collection member at a bottom side to a bottom frame part 822 and at a top side to a top frame part 820. The top frame part accommodates an actuator system configured to rotate each of the particle collection members about its rotational axis. The actuator system can comprise a corresponding actuator element for each of the particle collection members to rotate each particle collection member individually. In another embodiment of the actuator system, the system is configured to rotate al particle collection members simultaneously. For safety reason, when an actuator element is not powered, the corresponding particle collection member is forced in the second position.

The actuators can be driven by compressed air, oil pressure, air pressure, an electromotor. In an embodiment, the particle collection section is kept in the first position by the actuator or motor, and moves to the second position if the actuator stalls.

Fig. 10 shows a front view of the first assembly in the second position. For a person skilled in the art it will be clear that the air resistance of the first assembly will be very low.

In the embodiments described above, the particle collection members have a vertical rotational axis. In a vertical shaft, the rotational axis may be horizontally. When the particle collection members are in the first position, they form a horizontally positioned filter.

It will be clear to the skilled person that both the ionisation elements and the particle collection members may be individually rotatable.

Normally, an existing air duct system comprises a control unit to control the air flow generators, valves and fire dampers independence of sensor signals or human input. For example, the volumetric air rate in the air duct system depends on the measured pollution of air in the building. When a fire sensor detects a fire in a room of the building, some fire dampers will be closed and the air generator unit will be controlled to suck air with smoke out of a space or push fresh air in to said room. When an air duct particle collection system according to the subject disclosure is added to an existing air duct system, the control unit has to be adapted to control also the actuators for moving the air duct particle collection system in the desired position. For example, the control unit is adapted to control the actuator system in response to a volumetric flow rate indicative of the desired volumetric flow rate through the air duct.

The control unit performs a method for an air duct system, comprising:

rotating the one or more particle collection members in a first position when the air duct system is in an operating status to remove particulate material from a flow of air through a duct; and,

rotating at least one of the one or more particle collection members in a second position when the air duct system is in another operating status of the air duct system.

When actuator elements are used that forces continuously the collection members into the first position when the actuators are powered and the collection members into the second position when the actuators are not powered, this has the advantage that a simple on/off control signal may be used to control a particle collection assembly. In an embodiment of an actuator element, an actuator motor moves a collection member to the first position at the same time as tensioning a return spring structure. The collection member is turned back to the second position by spring force when the supply voltage is interrupted. The control signal only needs to switch on the mains voltage of the particle collection assembly to supply power to both the ionisation section and the actuators of the particle collection section, so that the particle collection assembly will function as particle filter. Then, the ionisation section will charge the particulate material in the

air flow and the actuators will force the particle collection members into the first position, so that the particle collection section will collect the charged particulate material in the air flow. When the control signal switches off the mains voltage, the ionisation section will become idle and the particle collection section will go in the second position. Now the particle collection assembly is in a state with low air resistance and also in a state for maintenance, as there will be no high voltage present in the ionisation section.

From the description above you can learn that the particle collection section forms a filter valve for particles that in operation runs through said air duct. Said filter valve comprises a series of aligned slats substantially in a particle collection plane. The slats have a longitudinal axis and are rotatable about a slat rotational axis. The slats have a closed slat position in which the slats together close off the air duct for particles, and an open slat position in which the slats allow particles to flow through the air duct downstream the particle collection section.

The devices, apparatus and systems herein are amongst others described during operation. As will be clear to the person skilled in the art, the invention is not limited to methods of operation or devices in operation.

In the embodiments described above a particle collection section is used to reduce the amount of particulate material in the flow of air. The particle collection section may also be combined with material suitable for capturing gaseous pollutants, such as NOx from the air stream through the air duct system. Material that may be used is not limited to active carbon, an active media comprising a metal-organic framework (MOF) containing an amine functional group capable of reacting with the pollutant, or a coating capable of reacting with the pollutant. Filters suitable to capture gaseous pollutants have normally a higher air resistance than filters collecting particulate material.

In the embodiments described above an ionisation section is present. An ionisation section can significantly improve particle capture. The ionisation section charges the particles in the air flow and thus increases the particle capture performance of an actively charged electrostatic filter element, an electret filter element or an electrostatic precipitator element using charged conductive plates. At the same time, the use of an ionisation section allows the pressure drop over the particle collection section to be reduced. The improved particle capture by ionisation allows the performance of lower cost lower grade filters with lower

pressure drop to be improved while the particle capture performance remains the same or even increases compared to a system without an ionisation section but with a particle collection section with higher grade filters that have a higher pressure drop. If there is only need to reduce the dust in an air flow in a duct system to ventilate a building, dust filters can be used without ionisation section. However, if the same duct system is also used to ventilate the building in case of a fire, a much higher volumetric flow rate is needed. A particle collection section described above allows increasing the volumetric flow rate by moving the one or more particle collection members from the first position to the second position.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device or apparatus claims enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

The invention further applies to an apparatus or device comprising one or more of the characterising features described in the description and/or shown in the attached drawings. The invention further pertains to a method or process comprising one or more of the characterising features described in the description and/or shown in the attached drawings.

The various aspects discussed in this patent can be combined in order to provide additional advantages. Furthermore, some of the features can form the basis for one or more divisional applications.

CONCLUSIES:

1. Een luchtkanaalsysteem (100) omvattende een deeltjesverzamelsectie (104), waarin de deeltjesverzamelsectie geconfigureerd is voor het verwijderen van deeltjes uit een luchtstroom door het luchtkanaalsysteem,
met het kenmerk dat,
de deeltjesverzamelsectie omvat een of meer deeltjesverzamelorganen (104A, 104B, 104C, 104D), elk deeltjesverzamelorgaan is draaibaar om een rotatieas (108) tussen een eerste positie waarin lucht hoofdzakelijk door de deeltjesverzamelorganen stroomt en een tweede positie waarbij de lucht voornamelijk langs de deeltjesverzamelorganen stroomt.

2. Het luchtkanaalsysteem volgens conclusie 1, waarbij de deeltjesverzamelsectie ten minste twee deeltjesverzamelorganen omvat die een lamellenstructuur met in hoofdzaak evenwijdige rotatie-assen vormen.

3. Het luchtkanaalsysteem volgens conclusie 2, waarbij elk deeltjesverzamelorgaan afzonderlijk roteerbaar is om zijn rotatieas.

4. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, waarbij de rotatieas in hoofdzaak samenvalt met een centrale lichaamsas van een deeltjesverzamelorgaan.

5. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, waarbij elk deeltjesverzamelorgaan een rechthoekige vorm heeft, waarbij zijn rotatieas langs een lengtezijde van de rechthoekige vorm ligt.

6. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, waarbij het luchtkanaalsysteem verder een ionisatiesectie (102) stroomopwaarts van de deeltjesverzamelsectie omvat.

7. Het luchtkanaalsysteem volgens conclusie 6, waarbij aan elk van de een of meer deeltjesverzamelorganen een deel (102A, 102B, 102C, 102D) van de

ionisatiesectie (102) is gemonteerd om samen met het deeltjesverzamelorgaan (104A, 104B, 104C, 104D) om de rotatieas (108) te roteren.

8. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, omvattende een aandrijfsysteem voor het positioneren van het deeltjesverzamelsectie in de eerste positie en/of in de tweede positie.

9. Het luchtkanaalsysteem volgens conclusie 8, waarbij het aandrijfsysteem een corresponderend aandrijfelement voor elk van de een of meer deeltjesverzamelorganen omvat om elk deeltjesverzamelorgaan afzonderlijk te roteren.

10. Het luchtkanaalsysteem volgens conclusie 9, waarbij wanneer een aandrijfelement niet van energie wordt voorzien, het corresponderende deeltjesverzamelorgaan in de tweede positie wordt gedwongen.

11. Het luchtkanalensysteem volgens een van de conclusies 8 - 10, verder omvattende een regeleenheid om het aandrijfsysteem te regelen in reactie op een debiet dat een indicatie geeft van het gewenste debiet door het luchtkanaal.

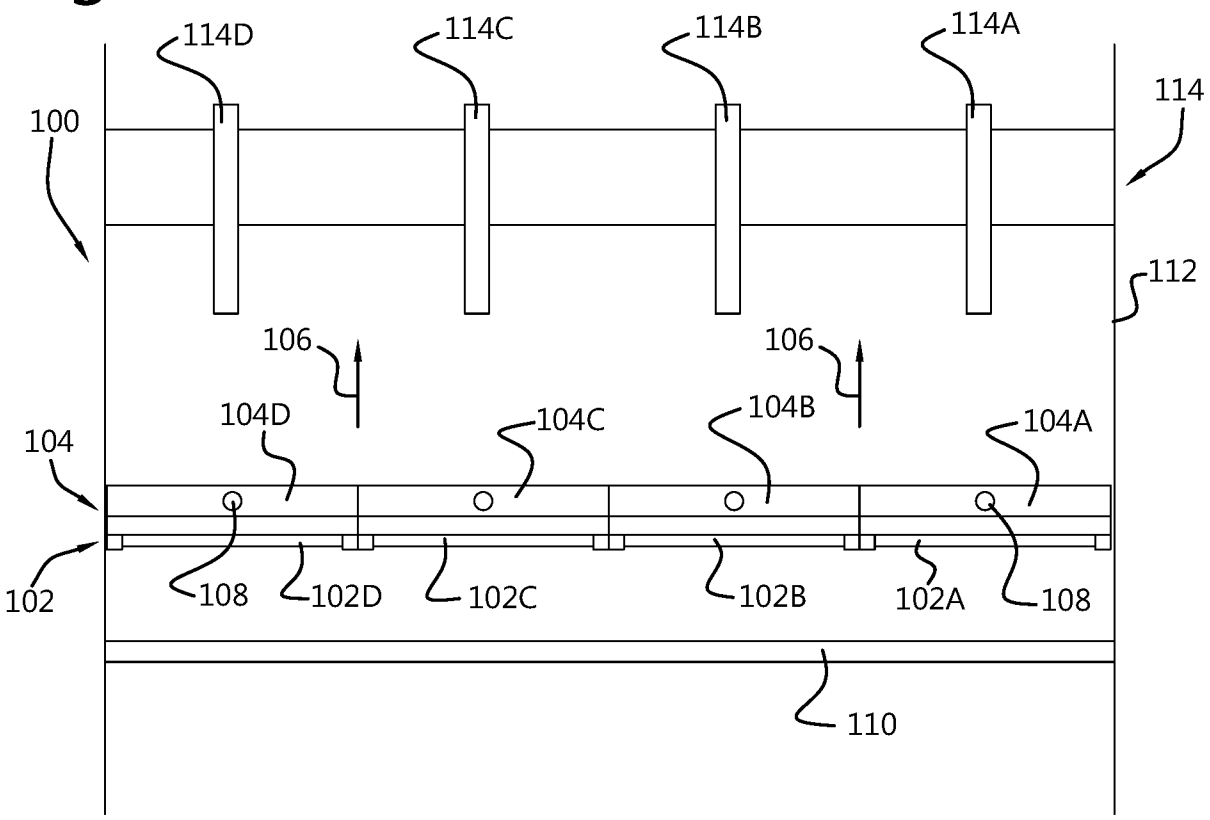
12. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, verder omvattende een branddempsectie (114), waarbij de ionisatiesectie (102) en de deeltjesverzamelsectie (104) stroomopwaarts van de branddempsectie zijn gelegen.

13. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, waarbij de deeltjesverzamelsectie filter vormt voor deeltjes dat in bedrijf door het luchtkanaal loopt, waarbij de klep een reeks uitgelijnde lamellen omvat die in hoofdzaak in een deeltjesverzamelvlak liggen, waarbij de lamellen een lengteas hebben en roteerbaar zijn om een lamellenrotatie-as, waarbij de lamellen een gesloten lamelstand hebben waarbij de lamellen samen het luchtkanaal afsluiten voor deeltjes, en een open lamelstand waarbij de lamellen deeltjes toestaan door het luchtkanaal te stromen stroomafwaarts van de deeltjesverzamelsectie.

14. Het luchtkanaalsysteem volgens een van de voorgaande conclusies, waarbij de deeltjesverzamelsectie een of meer deeltjesverzamelorganen omvat genomen uit een groep omvattende: een vezelstoffilterelement, een actief geladen elektrostatisch filterelement, een electret filterelement of een elektrostatisch precipitatorelement met geladen geleidende platen.

15. Werkwijze voor een luchtkanaalsysteem, bestaande uit:
het verschaffen van een luchtkanaalsysteem (100) volgens een van de voorgaande conclusies,
het roteren van de een of meer deeltjesverzamelorganen (104A, 104B, 104C, 104D) in een eerste positie wanneer het luchtkanaalsysteem in een bedrijfstoestand is om deeltjesmateriaal te verwijderen uit een luchtstroom door een kanaal (112); en,
het roteren van ten minste één van de een of meer deeltjesverzamelorganen in een tweede positie wanneer het luchtkanaalsysteem in een andere bedrijfstoestand van het luchtkanaalsysteem is.

Fig. 1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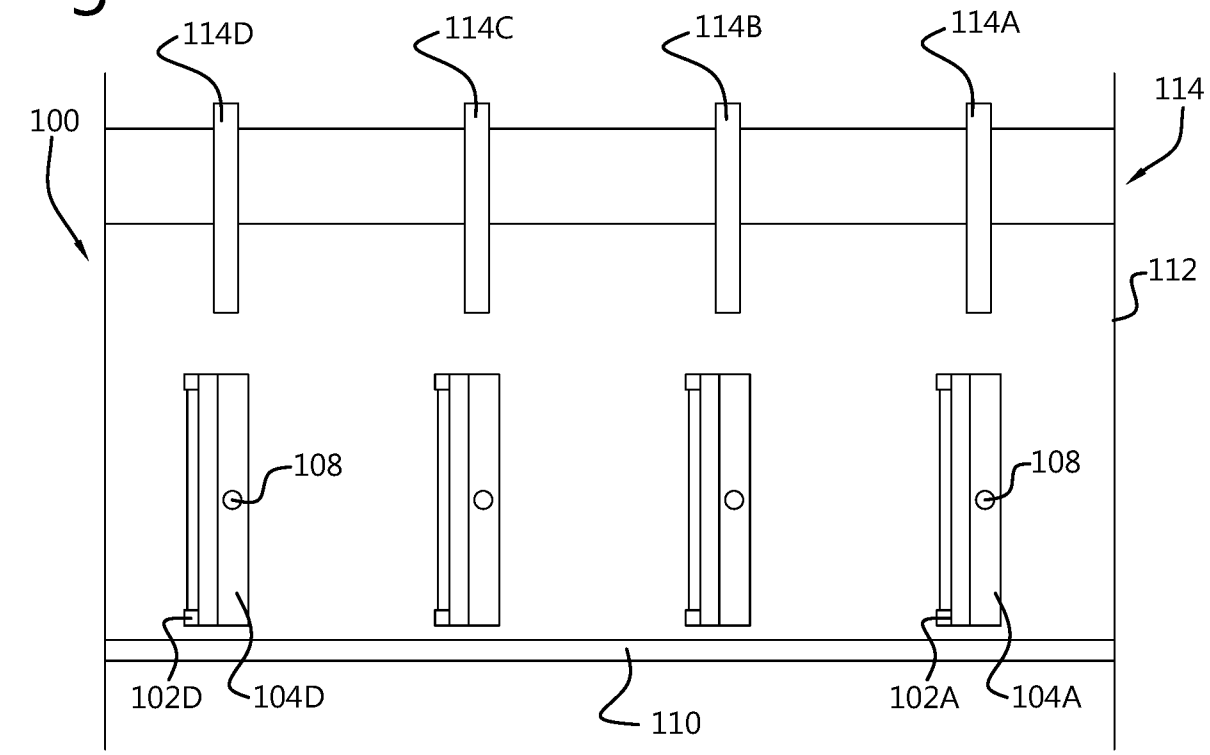
114C
114B
114A
114
100
112
106
106
104D
104C
104B
104A
104
102
108
102D
102C
102B
102A
108
110

Fig. 2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114A
114
100
112
108
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102D
104D
110
102A
104A

Fig. 3

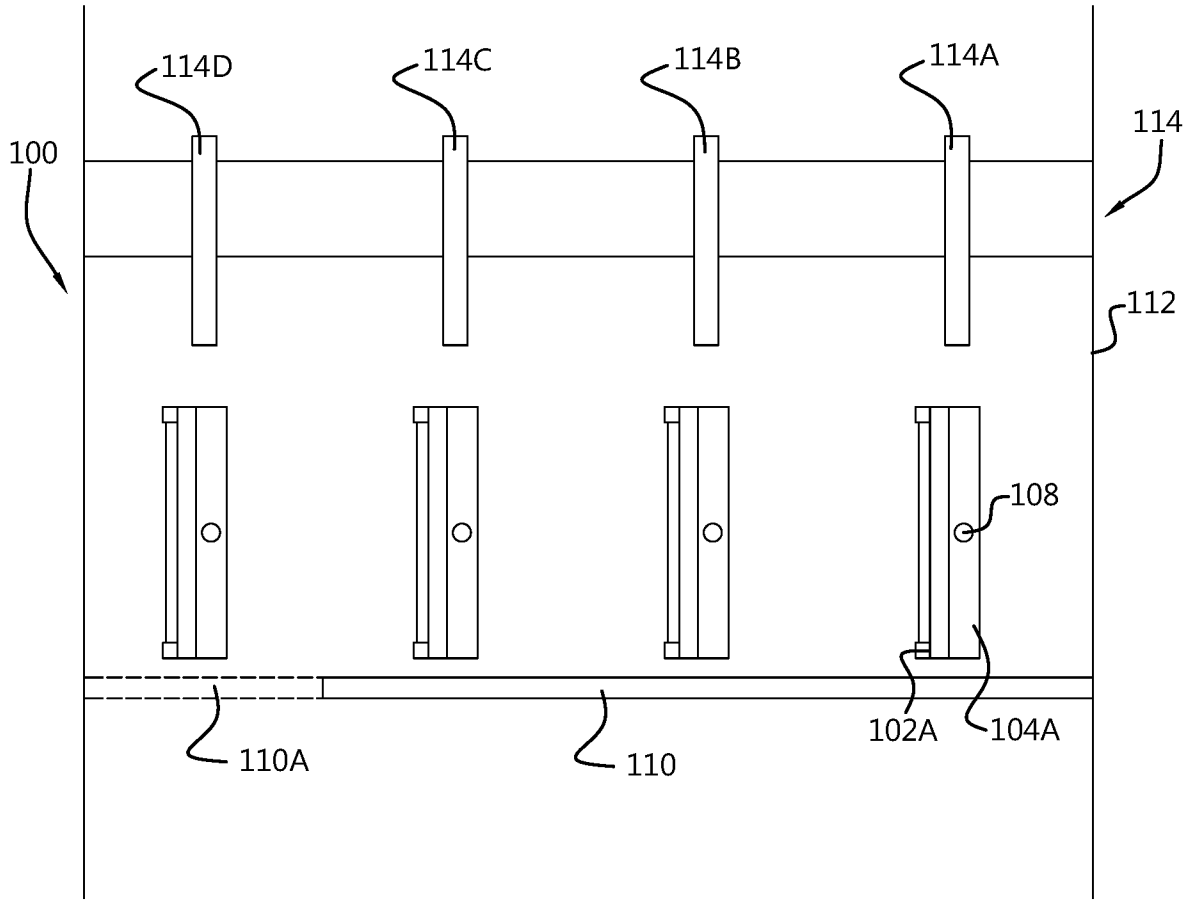
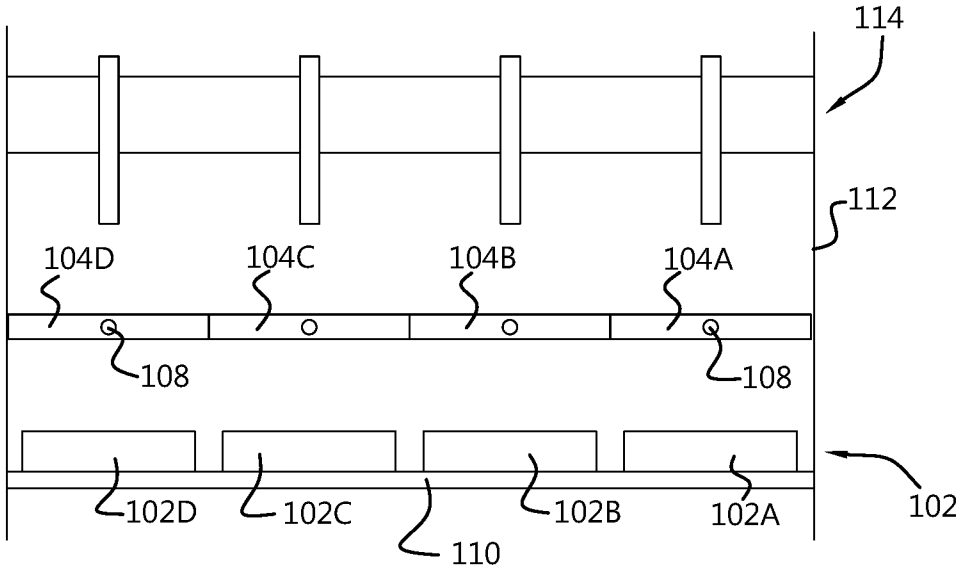


Fig. 4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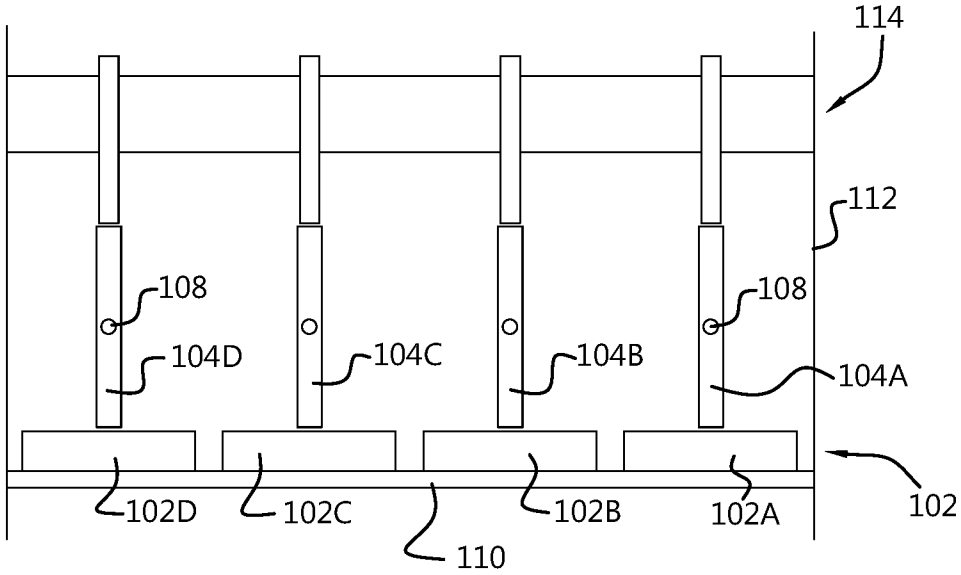
112
104D
104C
104B
104A
108
108
102D
102C
110
102B
102A
102

Fig. 5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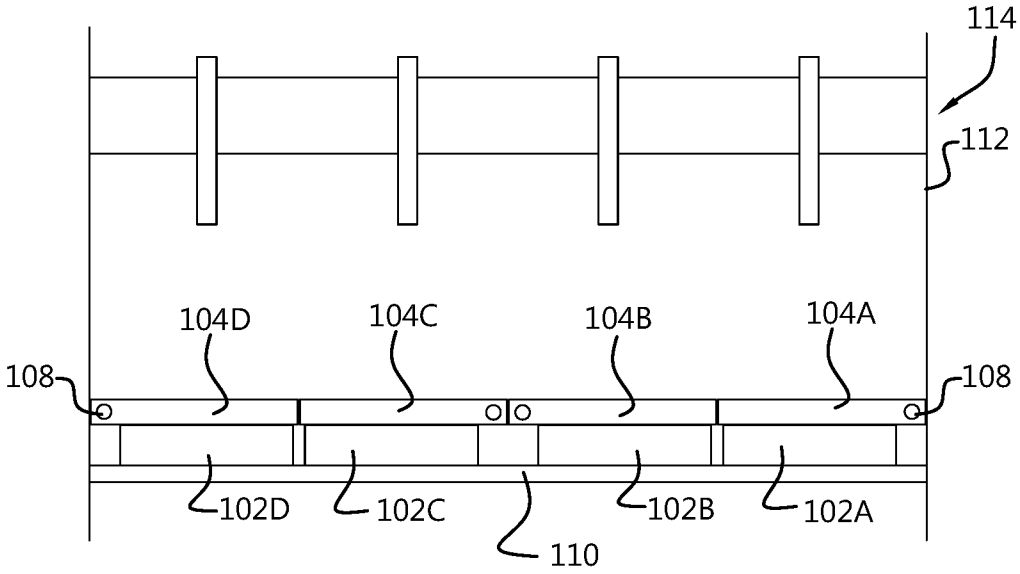
104D
104C
104B
104A
102D
102C
110
102B
102A
102

Fig. 6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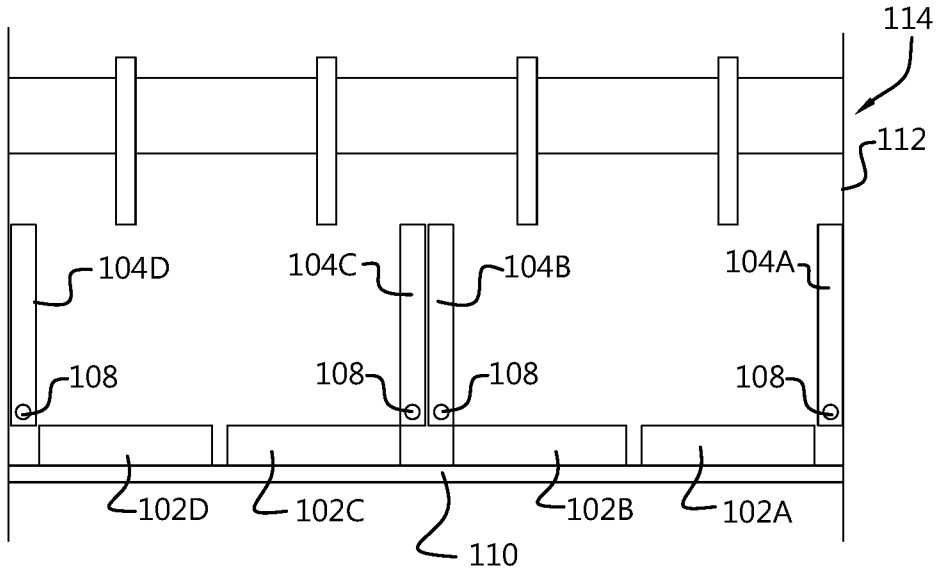
112
104D
104C
104B
104A
108
108
102D
102C
110
102B
102A

Fig. 7


114
112
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104C
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104A
108
108
108
108
102D
102C
110
102B
102A

Fig. 8

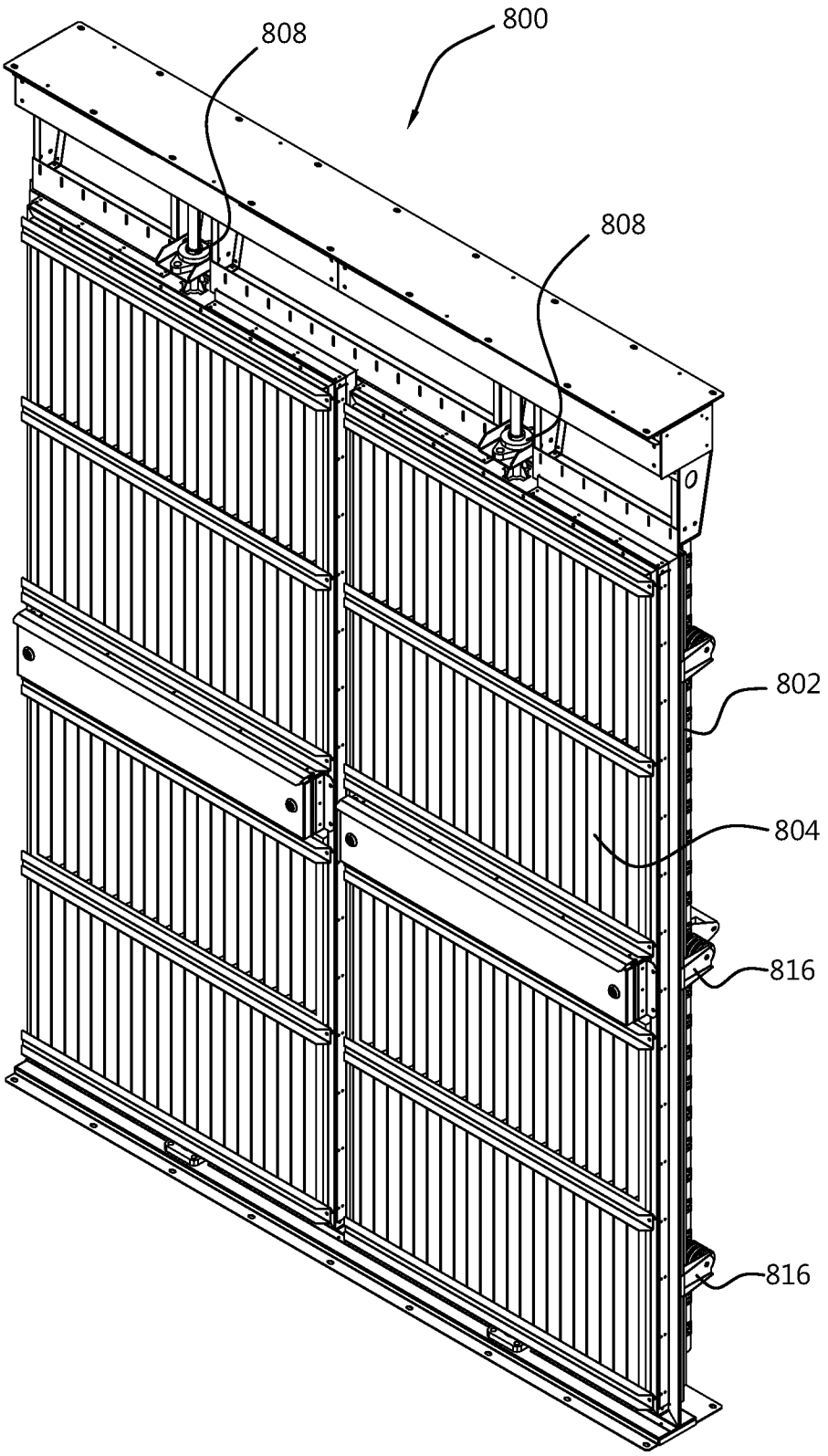


Fig. 9

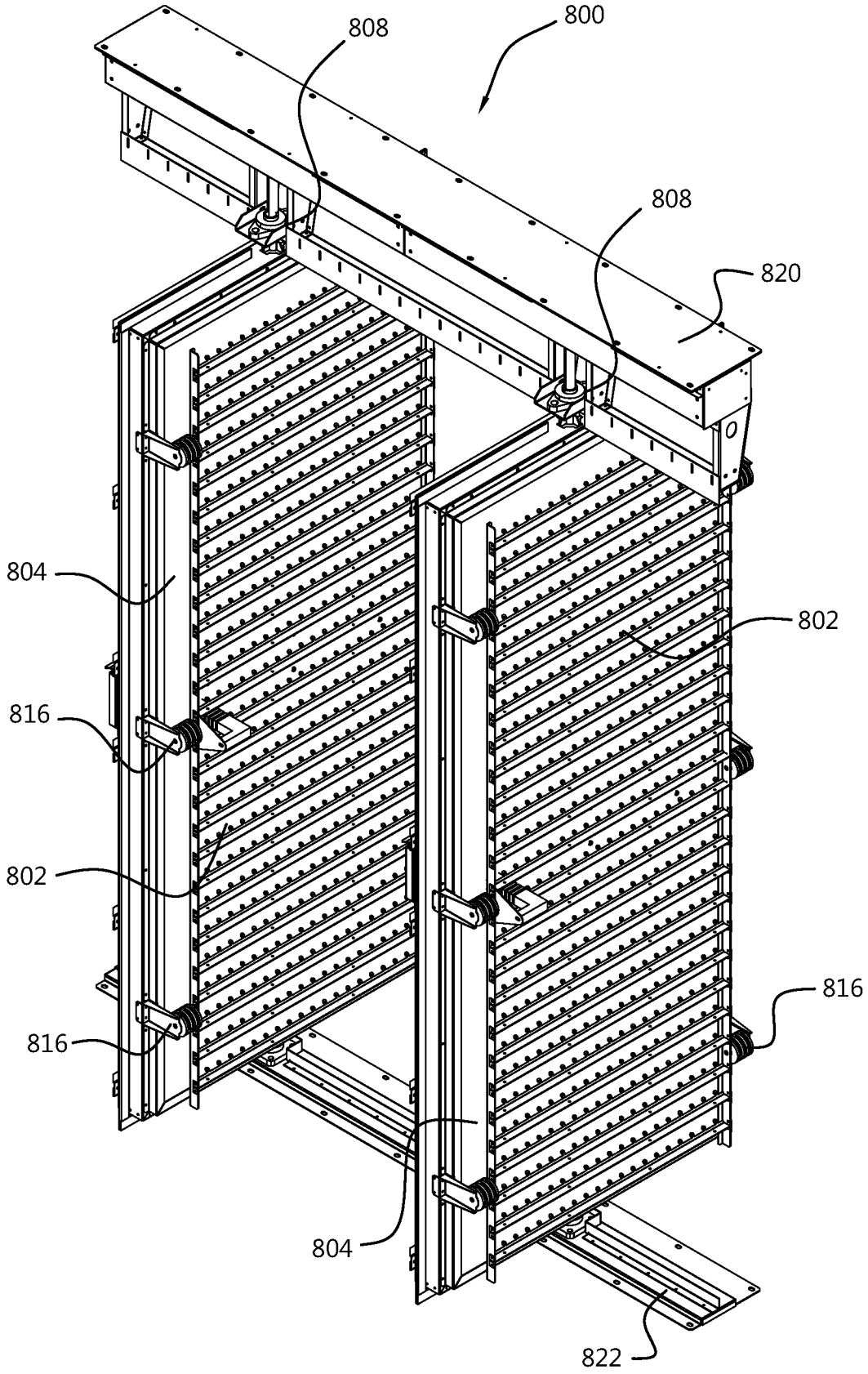
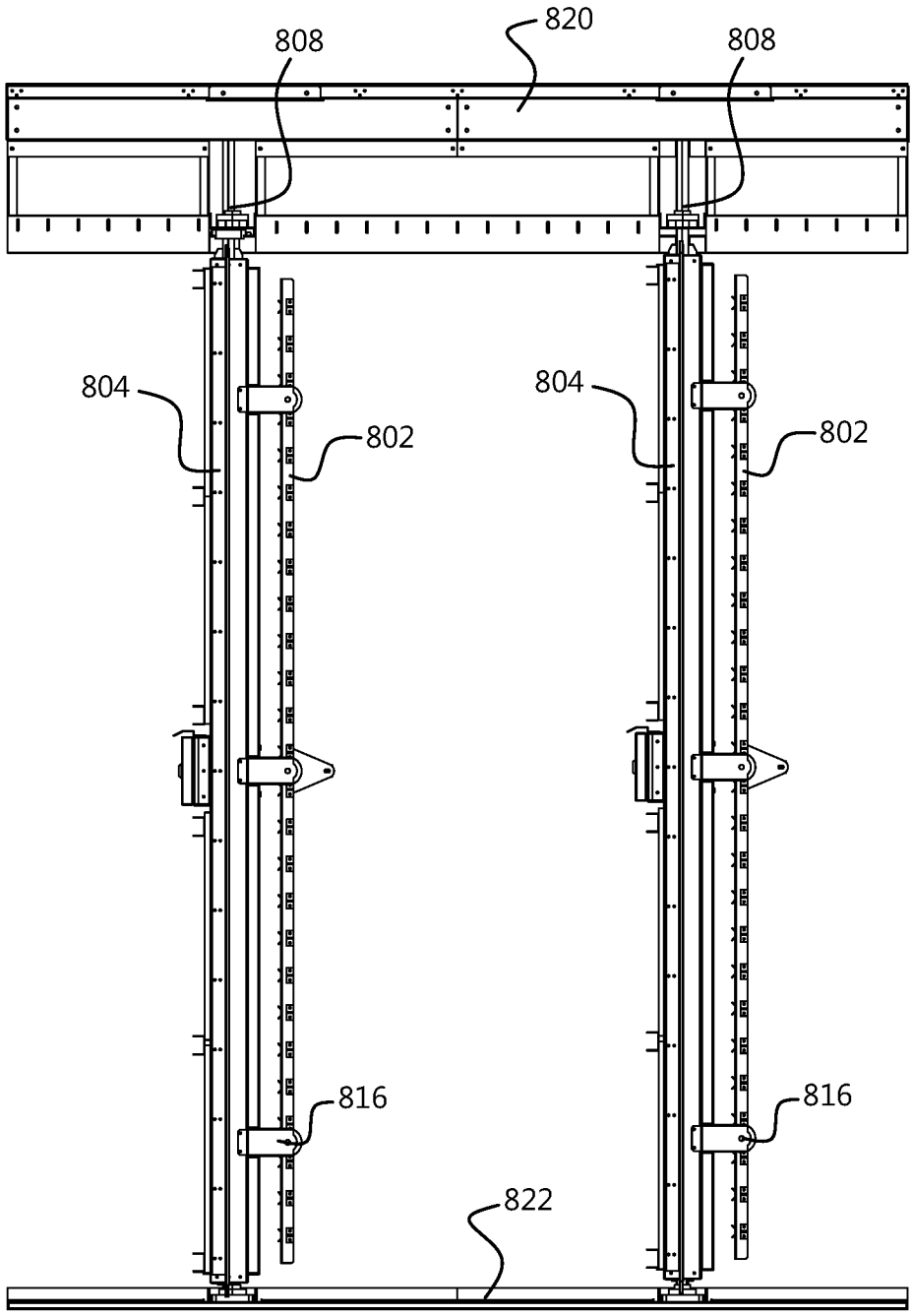


Fig. 10



SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
Nederlands aanvraag nr. **2032412**	Indieningsdatum **07-07-2022**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Virus Free Air B.V., et al**	
Datum van het verzoek voor een onderzoek van internationaal type **06-08-2022**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN81830**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

Zie onderzoeksrapport

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**Zie onderzoeksrapport**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2032412

A. CLASSIFICATIE VAN HET ONDERWERP
INV. F24F8/10 F24F8/30 F24F11/33
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
F24F

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	EP 1 434 012 A2 (SAMSUNG ELECTRONICS CO LTD [KR]) 30 juni 2004 (2004-06-30) * het gehele document * -----	1-15
X	CN 113 915 653 A (NINGBO FOTILE KITCHEN WARE CO) 11 januari 2022 (2022-01-11) * alinea [0004] - alinea [0021] * * samenvatting; figuren * -----	1
X	EP 3 121 524 A1 (LAW SUI CHUN [CN]) 25 januari 2017 (2017-01-25) * alinea [0032] - alinea [0045] * * figuren 13a,13b * -----	1
X	US 2013/055890 A1 (LIM HAE KYU [KR]) 7 maart 2013 (2013-03-07) * alinea [0025] - alinea [0030] * * figuren * -----	1
	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
3 februari 2023	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	**Mattias Grenbäck**

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2032412

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	EP 2 225 498 A1 (UNIV KONKUK IND COOP CORP [KR]) 8 september 2010 (2010-09-08) * alinea [0019] - alinea [0027] * * samenvatting; conclusies; figuren *	1

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

NL 2032412

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
EP 1434012	A2 30-06-2004	CN 1510352 A	07-07-2004
		EP 1434012 A2	30-06-2004
		KR 20040056142 A	30-06-2004
		US 2004118276 A1	24-06-2004
CN 113915653	A 11-01-2022	GEEN	
EP 3121524	A1 25-01-2017	CN 106461246 A	22-02-2017
		EP 3121524 A1	25-01-2017
		US 2017082305 A1	23-03-2017
		WO 2015139606 A1	24-09-2015
US 2013055890	A1 07-03-2013	CN 102974170 A	20-03-2013
		DE 102011087776 A1	07-03-2013
		JP 6006927 B2	12-10-2016
		JP 2013056654 A	28-03-2013
		KR 20130026811 A	14-03-2013
		US 2013055890 A1	07-03-2013
EP 2225498	A1 08-09-2010	CN 101861498 A	13-10-2010
		EP 2225498 A1	08-09-2010
		JP 5379798 B2	25-12-2013
		JP 2010539432 A	16-12-2010
		KR 20090050504 A	20-05-2009
		US 2010285731 A1	11-11-2010
		WO 2009064074 A1	22-05-2009

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN81830	07.07.2022		NL2032412

International Patent Classification (IPC)
INV. F24F8/10 F24F8/30 F24F11/33

Applicant
Virus Free Air B.V., et al

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Examiner
Mattias Grenbäck

Application number

WRITTEN OPINION

NL2032412

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the application as filed.

   b. ☐ furnished subsequent to the filing date for the purposes of search,

      ☐ accompanied by a statement to the effect that the sequence listing does not go beyond the disclosure in the application as filed.

3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the application, this opinion has been established to the extent that a meaningful opinion could be formed without a WIPO Standard ST.26 compliant sequence listing.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	7, 9, 10, 12
	No:	Claims	1-6, 8, 11, 13-15
Inventive step	Yes:	Claims	
	No:	Claims	1-15
Industrial applicability	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 EP 1 434 012 A2 (SAMSUNG ELECTRONICS CO LTD [KR]) 30 juni 2004 (2004-06-30)

D2 CN 113 915 653 A (NINGBO FOTILE KITCHEN WARE CO) 11 januari 2022 (2022-01-11)

D3 EP 3 121 524 A1 (LAW SUI CHUN [CN]) 25 januari 2017 (2017-01-25)

D4 US 2013/055890 A1 (LIM HAE KYU [KR]) 7 maart 2013 (2013-03-07)

D5 EP 2 225 498 A1 (UNIV KONKUK IND COOP CORP [KR]) 8 september 2010 (2010-09-08)

1 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

1.1 D1 discloses (the references in parentheses applying to this document): Een luchtkanaalsysteem (figure 5A) omvattende een deeltjesverzamelsectie (510), waarin de deeltjesverzamelsectie geconfigureerd is voor het verwijderen van deeltjes uit een luchtstroom door het luchtkanaalsysteem (paragraph 18), ~~**met het kenmerk** dat,~~
de deeltjesverzamelsectie (510) omvat een of meer deeltjesverzamelorganen (510a, 510b, 510c), elk deeltjesverzamelorgaan is draaibaar om een rotatieas (512a, 512b, 512c) tussen een eerste positie waarin lucht hoofdzakelijk door de deeltjesverzamelorganen stroomt (figure 5A) en een tweede positie waarbij de lucht voornamelijk langs de deeltjesverzamelorganen stroomt (figure 5B).

1.2 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 15, which therefore is also considered not new.

1.3 Furthermore documents D2 to D5 discloses all the features of claim 1 rendering it not new.

2 Dependent claims 2-14 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements in respect of novelty and/or inventive step.

2.1 Document D1 discloses the additional features of claims 2-6, 8, 11, 13 and 14, see description, paragraphs 13, 14, 18-20 and 22, figures 2-9. The subject-matter of the above mentioned claims is therefore not new.

2.2 In respect of the disclosure of document D1, see especially the disclosure of paragraphs 13, 14, 18-20 and 22 and figures 2-9, the combination of features of claims 7, 9, 10 and 12 represent merely one of several straightforward possibilities which the skilled person would select, depending on the circumstances, without exercising inventive skill. The subject-matter of the above mentioned claims does therefore not involve an inventive step.

Re Item VII

Certain defects in the application

The relevant background art disclosed in document D1 is not mentioned in the description, nor is this document identified therein.