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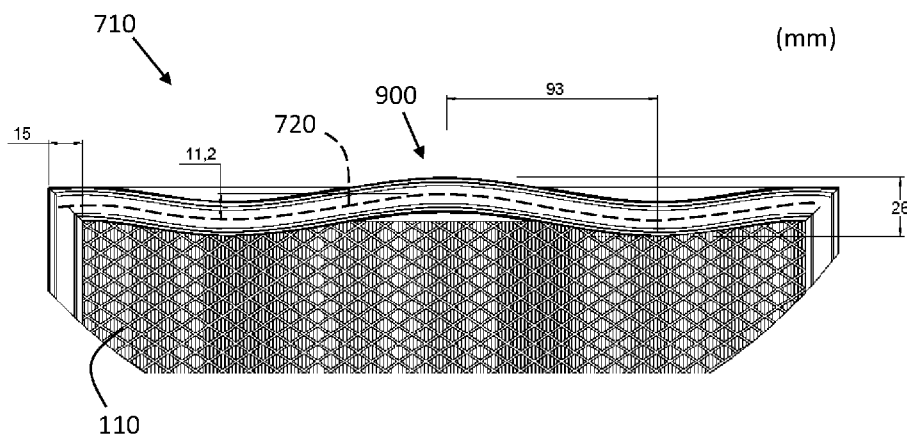


FIG. 10

(57) Abstract: An air cleaner (100) comprising an air cleaner body (101) with a main air intake aperture (102) that extends in an aperture plane (P), where the air cleaner body (101) is arranged to hold an essential filter (110) that extends in a filter plane (F) parallel to the aperture plane (P) and covers the main air intake aperture (102), the air cleaner (100) comprising a fan (160) arranged to generate a flow of air through the essential filter (110), when the essential filter (110) is held in the air cleaner body (101), the air cleaner body (101) comprising a contact surface (180) arranged to sealingly contact a periphery of the essential filter (110) when held in the air cleaner body (101), where at least a first part (210) of the contact surface (180) extends along an oscillating path (720) in the aperture plane (P).



AN AIR CLEANER COMPRISING A FILTER ARRANGEMENT HAVING AN OSCILLATING CONTACT SURFACE

TECHNICAL FIELD

5 The present disclosure relates to air cleaners for use on construction sites and in other environments where it is desired to remove particulate matter from the ambient air. The air cleaners discussed herein are active air cleaners which filter the ambient air by means of a fan and filter arrangement to capture particulate matter and unwanted gas in the surrounding environment.

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BACKGROUND

Construction work such as concrete processing operations often involve processes that generate dust that can be harmful to personnel at the construction site. Construction site work tasks may also involve coating operations, such as painting
15 and spraying, which release harmful matter into the ambient air.

An air cleaner can be used to filter the ambient air at a construction site in order to remove harmful particles and gas from the air.

There is a desire for air cleaners which are efficient and easy to use. Cost is also an important factor; hence cost-effective solutions are sought. It is also important that the
20 air cleaners are reliable and filter the air in a dependable manner without unexpected interruption.

SUMMARY

It is an objective of the present disclosure to provide improved air cleaners and also
25 essential filters for use together with the disclosed air cleaners. This objective may at least in part be obtained by an air cleaner comprising an air cleaner body with a main air intake aperture that extends in an aperture plane. The air cleaner body is arranged to hold an essential filter that extends in a filter plane that is parallel to the aperture plane in use, or at least essentially parallel to the aperture plane, and which covers
30 the main air intake aperture. The air cleaner comprises a fan arranged to generate a flow of air through the essential filter, when the essential filter is held in the air cleaner

body. The air cleaner body also comprises a contact surface that is arranged to sealingly contact a periphery of the essential filter when the essential filter is held in the air cleaner body such that the essential filter sealingly covers the main air intake aperture. An improved function is obtained due to the fact that at least a first part of the contact surface extends along an oscillating path in the aperture plane, i.e., a path that is curved and not straight, and that moves back and forth in a regular and repeated manner. This at least partly non-straight contact surface between the air cleaner body and the essential filter brings several advantages to the air cleaner in use. The feature for instance allows for a larger total contact surface area between air cleaner and filter which more evenly distributes the contact force between essential filter and air cleaner compared to a straight line contact surface that does not oscillate. The oscillating shape contact surface area also acts as a guide when assembling an essential filter and an air cleaner body, and verification to ensure that the essential filter is correctly mounted in relation to the air cleaner body. The oscillating contact surface furthermore acts as a key that matches the filter to the air cleaner so as to ensure that only the correct type of filters can be fitted into the air cleaner. If a standard essential filter with a flat straight contact surface is used, or one with an incorrectly formed oscillating contact surface, then the filter will either not fit or not form a sealing contact with the air cleaner contact surface. A pressure sensor can for instance be arranged in the air cleaner interior to detect air leakage past the essential filter, and to trigger a warning signal in case an incorrect filter is installed, or in case an essential filter is installed in an incorrect manner.

An oscillating contact surface is a surface which repeatedly moves back and forth in one or more dimensions, to follow an evenly shaped waveform for instance. A sinusoid shape is, for instance, an example of an oscillating shape. An oscillating contact surface can oscillate in one or two dimensions, i.e., in the aperture plane, transversal to the aperture plane, or both.

The first part of the contact surface that extends along the oscillating path is preferably at least partly delimited by protrusions that extend out in direction normal to the aperture plane to define the oscillating part of the contact surface. A matching oscillating part on the essential filter can be received between these protrusions such that an airtight seal, or at least an essentially airtight seal, is formed between the aircleaner body and the essential filter.

The air cleaner body is preferably arranged to hold an essential filter that is of cuboid shape, with a rectangular front surface that extends in the filter plane and is arranged to cover the main air intake aperture when the essential filter is held in the air cleaner body. Rectangular filters of this kind are suitable for air cleaners that are naturally box shaped, such as heavy-duty air cleaners intended for use at construction work sites. The contact surface is preferably a rectangular like contact surface with an upper section, a lower section, and two side sections, where the first part of the contact surface that extends along an oscillating path is arranged along the upper section in the normal operating position of the air cleaner. However, other geometries can also be used, such as disc-shaped filters, cylindrical filters, and so on. The teachings herein are not limited to any particular filter geometry, nor to any particular air cleaner geometry. Most of the essential filters discussed herein have a rectangular front surface arranged to face the fan in use, and a back surface which is parallel to the front surface and arranged to face away from the fan in use. The front surface and the back surface of the essential filter are separated by the filter media of the essential filter, which may be a pleated filter media.

According to an example, the part of the contact surface that extends along an oscillating path has a variable offset from the aperture plane that follows a continuous curve, i.e., the contact surface oscillates in a direction out from the aperture plane in addition to oscillating in the aperture plane. Combinations of oscillation away from the aperture plane and in the aperture plane provide further advantages, such as making it even harder to assemble the essential filter incorrectly in the air cleaner body.

A continuous curve is a curve without discontinuities that may prevent the essential filter from sliding into the correct position as it is inserted into the air cleaner body. The part of the contact surface that has a variable offset from the aperture plane may for instance follow a continuous waveform curve with six peaks and five valleys measured in direction of the essential filter when the essential filter is held in the air cleaner body.

According to some other aspects, a part of the contact surface has a convexly curved shape that extends out towards the essential filter when the essential filter is held in the air cleaner body. This convex shape contributes to building pressure between the essential filter and the separating wall against which the essential filter is pressed to form the sealing contact between essential filter and air cleaner body. The convex shape is particularly suitable in case the essential filter is pressed against

a separating wall of the air cleaner by brackets arranged along the sides of the essential filter, since it promotes an increased pressure at the center part of the convex surface, as will be discussed in more detail below.

At least two guide pins optionally extend out from the contact surface of the air cleaner in the direction of the essential filter when the essential filter is held in the air cleaner body. Each guide pin is arranged to be received in a corresponding guide slot of the essential filter when the essential filter is held in the air cleaner body. The guide pins ensure that the essential filter is inserted into the air cleaner body in the correct way, and also provides a guiding function during filter installation.

According to some aspects, the contact surface forms part of a separating wall of the air cleaner and the fan of the air cleaner is mounted in connection to an aperture formed in the separating wall. The separating wall may then comprise at least one guide ridge arranged to engage a side surface of the essential filter when the essential filter is held in the air cleaner body. The guide ridge provides increased mechanical strength, and also acts as a guide which guides the essential filter into position as it is installed in the air cleaner body.

The separating wall can be integrally formed with a lid portion of the air cleaner which also holds electronics and power supply interfaces. This way all active components on the air cleaner are comprised in the same module, which is an advantage. A further advantage of this modular design is that the non-planar contact surface formed on the separating wall is integrally formed with the lid portion and can thus be keyed to a specific filter or to a range of filters suitable for use with, e.g., the fan mounted on the separating wall. This way a modular air cleaner is provided where the active components, comprising control electronics, electrical power, and fan, can be replaced in a convenient manner, and where the use of essential filters suitable for a given active component set-up is ensured by the non-planar contacting surface. A user of the air cleaner wanting to use another type of fan, such as a battery powered fan instead of a fan powered from electrical mains, is automatically guided to also change the essential filter to a filter that is suitable for use with the new air cleaner set-up.

The air cleaners disclosed herein can be arranged to also hold a planar pre-filter upstream of the essential filter, in order to capture more coarse dust particles that may otherwise clog the essential filter. The air cleaner can also be arranged to hold an activated carbon filter downstream of the essential filter, for instance in a matching

recess formed in a separating wall of the air cleaner that also supports the fan and comprises the contact surface. An impact protection grate can also be arranged upstream of the essential filter in order to protect the filter elements against damage in use at a work site.

- 5 According to some aspects, a sleeve coupling is arranged upstream of the essential filter. The sleeve coupling is arranged to interface with a suction hose, ventilation drum, or the like, which extends the application areas of the air cleaner, and allows it to draw air to be filtered from a more remote location.

Aspects of the present disclosure also relate to an essential filter for the air cleaners discussed herein. The essential filter is of cuboid shape with a rectangular front surface that extends in a filter plane. The front surface of the filter comprises a peripheral portion extending around the filter edge that is arranged to sealingly contact a matching contact surface of the air cleaner when the essential filter is held in the air cleaner body. At least a part of the peripheral surface of the essential filter extends
10 along an oscillating path in the filter plane. This essential filter with an at least partly non-straight contact surface facing the air cleaner contact surface for sealingly contacting the air cleaner contact surface is intended for use in the air cleaners discussed herein and is therefore associated with the same technical effects and advantages as described above. The peripheral surface of the essential filter is
15 preferably a rectangular like peripheral surface extending along an edge of the essential filter, with an upper section, a lower section, and two side sections, where the part of the peripheral surface that extends along an oscillating path in the filter plane is arranged along the upper section. The part of the peripheral surface that extends along an oscillating path preferably follows a continuous curve, i.e., a shape
20 without discontinuities, which facilitate assembly of the essential filter in the air cleaner. According to some examples the oscillating path is a sinusoidal curve that goes back and forth across a centrum line.

According to some aspects, the part of the peripheral surface that extends along an oscillating path is matched to a waveform curve with six peaks and five valleys
30 measured in direction of the essential filter when the essential filter is held in the air cleaner.

According to some other aspects, the part of the peripheral surface that extends along an oscillating path is matched to a waveform curve with three peaks and two valleys.

At least two guide slots are optionally arranged in the peripheral surface, as discussed above, where each guide slot is arranged to receive a corresponding guide pin of the air cleaner. The guide slots formed in the essential filter cooperate with the guide pins on the air cleaner to ensure that the essential filter is correctly received in the air
5 cleaner body.

The essential filter may comprise a rectangular back surface that is arranged to face away from the air cleaner fan in use. The rectangular back surface is preferably parallel to and separated the front surface by filter media. The back surface of the essential filter optionally comprises a wing that extends along an upper part of the
10 back surface opposite to the oscillating path. This wing is arranged to engage a pre-filter or an impact protection grate of the air cleaner in order to further promote the seal around the periphery of the essential filter.

It is an advantage of the essential filters disclosed herein that they can be matched to a specific lid portion module of an air cleaner. This keying feature prevents a user
15 from using the wrong type of essential filter together with an integrally formed lid module as discussed above. One type of essential filter may, for instance, be designed for use with a battery powered air cleaner having a certain type of fan, while another type of essential filter is matched to an electrical mains powered lid module having a more powerful fan.

20 There are also disclosed methods and control units associated with the same advantages as discussed above in connection to the different apparatuses.

Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, step, etc." are to be
25 interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated. Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following
30 description. The skilled person realizes that different features of the present invention may be combined to create embodiments other than those described in the following, without departing from the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure will now be described in more detail with reference to the appended drawings, where:

- Figures 1A-B schematically show an example air cleaner;
- 5 Figure 2A illustrates an essential filter matched to a separating wall of an air cleaner;
- Figure 2B shows details of an essential filter and a separating wall;
- Figure 3A shows views of a separating wall comprising a fan aperture;
- Figure 3B shows cross-section views of a separating wall;
- Figures 4-5 illustrate an air cleaner filter;
- 10 Figure 6 schematically illustrates a filter plane parallel to an air cleaner aperture plane;
- Figure 7 shows an essential filter matched to a separating wall of an air cleaner;
- Figure 8 illustrates details of a separating wall of an air cleaner;
- Figure 9 illustrates an example essential filter for an air cleaner;
- Figure 10 shows details of an example essential filter; and
- 15 Figures 11A-C shows optional aspects of an essential filter.

DETAILED DESCRIPTION

- Aspects of the present disclosure will now be described more fully with reference to the accompanying drawings. The different devices and methods disclosed herein can,
- 20 however, be realized in many different forms and should not be construed as being limited to the aspects set forth herein. Like numbers in the drawings refer to like elements throughout.

- The terminology used herein is for describing aspects of the disclosure only and is not intended to limit the invention. As used herein, the singular forms "a", "an" and
- 25 "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

An air cleaner is a device which filters the ambient air on a location such as a construction site, workshop, paintshop or laboratory. The present disclosure relates mainly to air cleaners for use at construction sites to remove unwanted matter such

as dust and harmful gas from the ambient air at the construction site. The air cleaners discussed herein may, for instance, be used to capture fine particle concrete dust generated by a floor grinding operation or from the use of cut-off tools and core drilling equipment. Some of the air cleaners disclosed herein may be connected via sleeve
5 coupling to a suction hose, to draw air in through the suction hose and filter the air before releasing the filtered air into the ambient environment.

Air cleaners normally comprise a fan arranged to draw air through some form of filter arrangement, often a pre-filter followed by an essential filter. An impact protection grate may be arranged in front of the filters to protect them from damage. The direction
10 of the flow of air generated by the fan is used herein to describe relative positions of various components in relation to each other. A first component upstream from a second component receives the flow of air before it reaches the second component. The air stream through the air cleaner preferably but not necessarily first passes a pre-filter, then an essential filter, before reaching the fan. However, the fan can also
15 be placed upstream of the filters, or inbetween the pre-filter and the essential filter. There may also be more than one fan in an air cleaner. Both serially arranged fans and fans arranged in parallel are possible. More than two filters are also possible, such as an additional activated carbon filter.

The fan can, generally, be powered from electrical mains or by battery.

20 A pre-filter is a relatively coarse filter which traps larger particles, while the essential filter is a finer filter that is able to trap very small particles. The fine particle dust trapped by the essential filter is often considered more harmful to a person compared to the coarser particles trapped by the pre-filter.

Particle filters are discussed in, e.g., the International Electrotechnical Commission (IEC) standard 60335-2-69. The essential filter, i.e., the finer filter arranged
25 downstream from the coarser pre-filter in the air cleaners discussed herein, is sometimes referred to as a high efficiency particulate arresting (HEPA) filter, but this denomination is not entirely accurate. The term essential filter is to be interpreted broadly herein to mean a filter device with the ability to trap fine particles of dust.

30 Figures 1A and 1B schematically illustrate an air cleaner 100 according to an example of the techniques and technical features discussed herein. Figure 1A is a front view and Figure 1B is an exploded view. It is appreciated that most of the components seen on the air filters are not inextricably linked to each other. In other words, many

of the components can be used separately from each other and do not require each other to provide their respective technical effects, as will be appreciated by the skilled person.

5 The air cleaner has a lid portion 140 which among other things comprises a user interface 150 and handles 145, 146 arranged at opposing sides of the lid portion 140. The separating wall can be integrally formed with the lid portion, and the fan 160 can be mounted into the lid portion module, as shown in Figure 1B.

10 An extendable handle 146 can be vertically pulled out from the air cleaner 100, along arrow H in Figure 1A. The air cleaner 100 can then be transported conveniently on a pair of wheels arranged at the bottom end of the air cleaner, similar to how many airplane cabin bags are designed. These wheels are not shown in Figures 1A and 1B, but a wheel housing 147 can be seen in Figure 1A.

15 The air cleaner 100 comprises an air cleaner body 101 which in the illustrated examples is of a general cuboid shape with rectangular sides and rounded corners. The air cleaner body 101 has a main air intake aperture 102 through which an air flow generated by a fan 160 is drawn into the air cleaner and filtered before it is released back into the ambient environment. Note that a side section of the body 101 has been removed to show the fan 160 in Figure 1A. The air cleaner body 101 normally encloses an internal volume of the air cleaner, as shown in Figure 1B.

20 The air is cleansed from coarse particulate matter by an optional pre-filter 120 followed by an essential filter 110 which removes more fine particulate matter. The air cleaner has an outlet (not shown) after the fan, which releases the filtered air back into the environment. An impact protection grate 130 protects the air cleaner filters from mechanical damage by objects at the work site.

25 The essential filter 110 comprises a main body 111, illustrated in the examples as a cuboid shaped main body, i.e., a box-like shape with right-angle corners.

30 Some air cleaners also comprise additional filters 125, such as activated carbon filters. The example air cleaner 100 in Figure 1B comprises an additional filter 125 which fits in a matching recess 126 formed in the separating wall 165. An additional filter such as an activated carbon filter can thus be inserted inbetween the fan and the essential filter if desired and left out of the assembly if not deemed necessary for a given air filtering operation, without other modification to the air cleaner. This is because the essential filter 110 is in sealing contact with the separating wall 165

around a periphery of the essential filter 110, which periphery extends beyond the periphery of the additional filter 125, i.e., the projection of the additional filter 125 onto the filter plane F is enclosed by the projection of the essential filter 110 onto the same filter plane F. The additional filter 125 is, according to some examples of cuboid shape
5 with rectangular front and rear surfaces that fit into a corresponding rectangular recess 126 formed in the separating wall 165. A disc shaped additional filter can also be used, in which case the matching recess 126 formed in the separating wall 165 is of circular shape. Other geometrical forms of additional filters and matching recesses formed in the separating wall 165 are of course also possible, the main technical
10 feature being that the additional filter can be received in a matching recess formed between the essential filter and the separating wall, which recess is sealed by the contact surface between the essential filter and the separating wall.

The fan 160 is in the example of Figures 1A and 1B arranged supported by the separating wall 165, where it draws air through a fan aperture formed in the separating
15 wall. It is preferred that the fan is arranged downstream of the pre-filter 120 and the essential filter 110, and also downstream of the additional filter 125 if present. However, it is appreciated that the fan 160 can be arranged upstream of the filters, downstream of the filters, or inbetween the pre-filter and the essential filter. More than one fan can also be used, as mentioned above. Either in serial configuration or in
20 parallel configuration.

An air conduit, such as a tubular member, may be arranged extending from a pressure sensor inside the lid portion 140 to an aperture 310 that opens up into the volume formed between the separating wall 165 and the essential filter 110. The aperture 310 is illustrated in Figure 3A, which shows different views of the separating wall and also
25 some example dimensions of the separating wall 165 in mm. The aperture 310 and the pressure sensor allow a control unit of the air cleaner 100 to monitor the air pressure in the volume formed between the essential filter 110 and the separating wall 165, and to detect events such as a particle laden filter and also filter malfunction. A particle laden filter, i.e., a clogged filter, will result in a decrease in pressure in the
30 volume between the essential filter and the fan. Filter malfunction comprising a damaged leaking filter will result in an increase in the pressure in the volume between the essential filter and the fan, compared to a nominal operating pressure. An incorrectly installed essential filter, or an essential filter having the wrong form-factor

and/or shape will also result in an increase in the pressure in the volume between the essential filter and the fan, compared to a nominal operating pressure.

A particle sensor can be arranged downstream of the separating wall, or at least downstream of the essential filter 110, to monitor particle levels in the filtered air.

- 5 The air cleaner body 101 comprises first and second elongated pivotable and opposing brackets 170, 171 extending along two opposing sides of the main input aperture of the air cleaner body 101. The two opposing sides extend vertically in a normal operating position of the air cleaner, as shown in Figures 1A and 1B. The opposing brackets 170, 171 are arranged to pivot about respective pivoting axes
10 extending parallel to the opposing sides of the main input aperture, i.e., vertically in Figure 1A and Figure 1B, from respective open positions to respective closed positions. Latches 172 are arranged on both sides (only one latch is shown in Figure 1A) to hold each bracket in its closed position.

- The opposing brackets 170, 171, when in the open position, are arranged to allow the
15 essential filter 110 to be received in the air cleaner body 101 at least partly via the main input aperture of the air cleaner 100. The opposing brackets can then be rotated such that, when in the closed position, they press against the essential filter 110 received in the air cleaner body 101 to hold the essential filter 110 in position and promote the sealing contact between the essential filter 110 and the separating wall
20 165. The opposing brackets can then be locked in this position to hold the essential filter securely in the air cleaner by the latches 172, which is a main purpose of the brackets.

- The opposing brackets 170, 171 optionally comprise respective slots 173, 174 extending parallel to the opposing sides as illustrated in Figure 1A. The slots are
25 opposing in the closed position of the opposing brackets and arranged to slidably receive the pre-filter 120 and the impact protection grate which, when received in the slots 173, 174, also prevent pivoting by the opposing brackets 170, 171.

- A notable feature of the air cleaners 100 and the essential filters 110 described herein is that the contact surface 180 between essential filter 110 and the separating wall
30 165 of the air cleaner 100 is not straight. Rather, at least a part of the contact surface 180 extends along an oscillating path.

An oscillating path is a path that goes back and forth in a repeated manner across some reference line or plane. A sinusoid curve is an example of an oscillating curve.

The oscillating path may undulate in a plane that is parallel to the aperture plane P, but also in a plane extending orthogonally to the aperture plane P. An example of oscillation in the aperture plane P will be discussed below in connection to Figures 7-11. An example of oscillation in direction normal to the aperture plane P will be discussed below in connection to Figure 3B and Figure 4.

Thus, according to one example the contact surface between the essential filter and the air cleaner body has a variable offset from the aperture plane P along the contact surface, where the offset is measured along a normal to the aperture plane P. In other words, the contact surface between the essential filter and the air cleaner is not planar (flat), but unevenly curved away from the aperture plane. According to another example the oscillating path extends in the aperture plane P, as will be discussed below in connection to Figures 7-11.

This type of non-straight contact surface between essential filter and air cleaner body has several beneficial technical effects and provides several advantages. First of all, it allows for a larger contact surface area which more evenly distributes the contact force between essential filter and air cleaner compared to a planar contact surface. Secondly the oscillating contact surface area acts as a guide and a check to ensure that the essential filter is correctly mounted. It will, for instance, not be possible or at least more difficult to move the opposing brackets into the closed position if the essential filter is not received properly in the air cleaner. Thirdly the oscillating contact surface acts as a key that ensures that only the correct type of filters can be fitted into the air cleaner. If a standard essential filter with a straight contact surface is used then the filter will either not fit or not form a sealing contact with the air cleaner contact surface.

The case where at least a part of the peripheral surface 115 of the essential filter 110 extends along an oscillating path 720 in the filter plane F, as shown in, e.g., Figure 10, is particularly advantageous in a box-shaped air cleaner arranged to be supported on a ground surface, since this makes insertion of the essential filter into the air cleaner body easier, with a reduced risk of inserting the filter incorrectly.

An advantage associated with a peripheral surface 115 of the essential filter 110 that extends along an oscillating path 720 in the filter plane F is that the magnitude of the oscillation can be increased compared to oscillation in a direction away from the filter plane.

The peripheral surface 115 preferably comprises a gasket material, such as a rubber seal or other sealing material.

Figure 2A illustrates details 200 of an air cleaner separating wall 165 and an essential filter 110 according to some aspects of the teachings herein. The essential filter 110 has a periphery which is shaped so as to form a seal against the contact surface 180 on the separating wall 165 of the air cleaner 100. As the fan 160 draws air through the filter, an underpressure builds downstream of the essential filter 110 between the fan and the essential filter. This underpressure draws the essential filter 110 against the contact surface 180 in sealing contact there inbetween. The contact surface 180 of the separating wall 165 is at least partly uneven, i.e., not perfectly planar with a variable offset relative to the aperture plane and the filter plane, where the variable offset exhibits an oscillating form, going out from the aperture plane and then in, and so on. In this example a first part 210 of the contact surface 180 forming an upper section has a variable offset from the aperture plane P, measured along a normal to the aperture plane P. A second part 220 of the contact surface 180, in this example located at the bottom of the contact surface 180 when the air cleaner is positioned in its normal use position (with the lid portion 140 facing upwards) instead has a convex shape that extends out towards the essential filter in the middle. The convex shape is not an oscillating shape, merely a non-straight contact surface.

A tab 280 extends out from the upper part of the essential filter 110. This tab allows a user to conveniently pull the essential filter out from the air cleaner body.

To summarize, there is disclosed herein an air cleaner 100 that comprises an air cleaner body 101. The air cleaner body 101 has a main air intake aperture 102 that extends in an aperture plane P. The aperture plane P is indicated in, e.g., Figure 1B and in Figure 6. The air cleaner body 101 is arranged to hold an essential filter 110 that extends in a filter plane F parallel to the aperture plane P when the essential filter is held in the air cleaner body such that it covers the main air intake aperture 102 to provide the intended filtering function of the air cleaner. The filter plane F is indicated in, e.g., Figure 1B and schematically shown in Figure 6.

The air cleaner 100 comprises a fan 160 that is arranged to generate a flow of air through the essential filter 110, when the essential filter 110 is held in the air cleaner body 101. With reference to Figures 1A and 1B, the flow of air passes through the impact protection grate 130, then through the pre-filter 120 before it reaches the

essential filter 110. The air flow finally passes through the additional filter 125 before it passes through the aperture formed in the separating wall 165.

The air cleaner body 101 of the air cleaners 100 discussed herein comprises a contact surface 180 that is arranged to sealingly contact a periphery of the essential filter 110 when held in the air cleaner body 101. This periphery extends around an edge part of a surface of the essential filter, as illustrated in the drawings. The air flow generated by the fan 160 draws the essential filter 110 towards the separating wall 165, whereupon contact pressure is generated between the essential filter 110 and the separating wall 165 from the underpressure that is built up between the downstream face of the essential filter 110 and the fan 160. A key feature of the air cleaners discussed herein is that the air cleaner body 101 comprises a contact surface 180 arranged to sealingly contact a periphery of the essential filter 110 when held in the air cleaner body 101, where at least a first part 210 of the contact surface 180 extends along an oscillating path in the aperture plane P.

According to an example, at least a first part 210 of the contact surface 180 also has a variable offset from the aperture plane P, measured along a normal to the aperture plane P, i.e., the contact surface 180 is not entirely planar in direction of the essential filter 110.

According to a preferred embodiment, the first part 210 of the contact surface 180 follows a waveform shape in the aperture plane P, as illustrated in Figures 7-10.

Thus, there are at least two ways in which the contact surface 180 can be configured so that at least a first part 210 of the contact surface 180 extends along an oscillating path. The oscillating path can be configured to oscillate transversally with respect to the aperture plane P as illustrated in, e.g., Figure 4, or in the plane P as illustrated in, e.g., Figure 10. Combinations of the two oscillations are possible, i.e., a part or all of the contact surface between the essential filter and the air cleaner body may oscillate both in the aperture plane as in Figure 10 and transversal to the aperture plane as in Figure 4.

The contact surface 180 preferably forms part of the separating wall 165 of the air cleaner, and the fan 160 is preferably mounted in connection to an aperture formed in the separating wall 165, as illustrated in the drawings. It is, however, appreciated that alternative fan mountings are also possible.

According to a preferred embodiment of the air cleaner 100, the lid portion 140 comprises the control electronics of the air cleaner and is integrally formed with the separating wall 165 and the fan 165, and the separating wall also comprises the at least partly non-planar contact surface 180 that engages the essential filter 110 when the essential filter is received in the air cleaner body. This is advantageous since then the non-planar contact surface 180 is comprised in the same module as the electronics, the power interface, and the fan. This integrally formed module can be replaced with another module having the same form factor in relation to the air cleaner body, but which is intended to be used with another type of essential filter, e.g., because it has a different type of fan or has some other functionality. Due to the keying effect of the non-planar contact surface on the separating wall, the wrong type of filter is difficult or even impossible to use together with a given lid portion module, since the non-planar contact surface on the lid portion module ensures that only suitable essential filters can be fitted into the air cleaner body. By integrally forming the active components of the air cleaner which determine the performance characteristics of the air cleaner with the contact surface that determines which essential filters that can be used in the air cleaner, a more versatile and reliable air cleaner architecture is obtained.

Figure 2A illustrates an example of how the peripheral surface 115 of the essential filter 110 can make contact with the separating wall along the contact surface 180. The insert 202 schematically illustrates an example first part 210 of the contact surface 180 that has a variable offset from the aperture plane P, measured along a normal to the aperture plane P. In this example the contact surface oscillates in a direction transversal to the aperture plane P.

The peripheral surface 115 preferably comprises a gasket material, such as a rubber seal or other sealing material.

Figure 3A shows an example separating wall 165 with the first part 210 of the contact surface. The example dimensions in Figure 3A are given in mm. Figure 3A shows three views 301, 302, 303 of the same example separating wall 165.

View 301 is a front view showing the front side of the separating wall 165, which is the side facing the essential filter 110 in use. In this example the guide pins 250 are arranged 5,1mm in from the ends of the upper section of the contact surface, which in this case is the first part 210 of the contact surface. The guide ridges 275 are shown as 2,8mm wide. A height of the contact surface, measured approximately from the

middle off the lower section to the middle of the upper section is 420 mm. In this example the upper section, i.e., the first part of the contact surface, has a variable offset from the aperture plane P, measured along a normal to the aperture plane P.

View 301 also shows the locations of two cross-sections, cross section view A-A and cross section view B-B, which are shown in Figure 3B and will be discussed below. The cross-section view A-A cuts the separating wall at the first part 210 which has the variable offset from the aperture plane P, measured along a normal to the aperture plane P as indicated in Figure 3A. The cross-section view B-B instead cuts the lower section of the contact surface 180, as indicated in Figure 3A.

View 302 is a side view that shows a height of 448,5mm measured approximately between the extreme points of the contact surface 180 in the vertical direction in use. The guide ridges in this example extend about 7mm out from the separating wall.

View 303 is a top view of the separating wall 165. A distance between the guide pins 250 is shown here as 337,9mm, which is approximately 340mm. A distance between the guide ridges 275 is shown as 350,7mm, which is approximately 350mm.

The dimensions given in Figure 3A are mere examples and should not be construed as limiting to the overall disclosure. It is appreciated that the dimensions may be changed to be different from those given in the examples presented herein.

Figure 3B shows cross section views along A-A and along B-B as indicated in Figure 3A. The example dimensions in Figure 3B are also given in mm.

Cross section view B-B illustrates an example of an air cleaner body 101 that comprises a contact surface 180 that is arranged to sealingly contact a periphery of the essential filter 110 when held in the air cleaner body 101, where at least a first part 210 of the contact surface 180 has a variable offset from the aperture plane, measured along a normal to the aperture plane. This is also illustrated more schematically by the dashed line insert in Figure 3B. The distance between the peaks and the neighboring valleys of the waveform shape is 30mm. The valleys are recessed by 2,5mm and the peaks are recessed by 1,0mm compared to a reference plane of the separating wall 165.

Cross section view A-A is a cross section view of the lower section of the contact surface 180. In this example the lower section has a convex shape that extends out from the separating wall in the direction of the essential filter 110 when it is received in the air cleaner body 101. The convex shape is schematically illustrated by the dash-

dotted curve inserted in Figure 3B. The peak of the convex curve extends 0,5mm more out from the filter plane compared to the ends of the convex curve. The dimensions given in Figure 3B are mere examples and should not be construed as limiting to the overall disclosure.

5 Figure 4 shows a side view of an example essential filter 110 with a peripheral surface 115 matched to the contact surface 180 of the air cleaners 100 discussed herein. Some example dimensions of the essential filter 110 are indicated in mm in Figure 4. The non-planar peripheral surface 115 is here illustrated as a continuously curved surface with peaks and valleys. The maximum extension of the non-planar surface
10 measured normal to the filter plane F is 8mm in the example of Figure 4. The distance between the valleys and the peaks of the non-planar surface is 30mm as indicated in Figure 4. Note also that there is a variation in the height of the peaks at 0,4mm, 0,2mm, and a variation in the depth of the valleys at 2mm, 1,8mm and 1,6mm. This variation, together with the distance between the valleys and the peaks of the surface
15 waveform, acts as a key that can be matched to a contact surface of the air cleaner. The dimensions given in Figure 4 are mere examples and should not be construed as limiting to the overall disclosure.

Figure 5 shows a side view, a front view, and a top view of an example essential filter 110. The dimensions are given in mm. The filter has a thickness of about 100mm, a
20 height of about 450mm and a width of about 350mm.

Various types of essential filters 110 can be used together with the air cleaners described herein. However, according to some preferred aspects, the essential filter is a pleated filter where the filter media 500 is pleated at a pleated depth of between 50mm-100mm, and preferably about 75mm. I.e., each fold of the filter media 500
25 measures about 75mm across. The pleating direction is preferably vertical in use, i.e., the folds are made along lines extending essentially in a vertical direction in a normal operating position of the air cleaner 100.

The essential filters described herein have been carefully optimized to provide improved filtering performance, in particular at work sites where concrete dust is
30 present. It has been realized that certain filter parameter selections are superior to other filter parameter selections.

In the example of Figure 5 there are 83 folds in the pleated filter media 500. The filter media of the essential filters 110 discussed herein may generally comprise between 70-90 folds, and preferably about 80-86 folds, and more preferably 83 folds.

5 According to aspects of the present disclosure, a ratio of the fold depth of the pleated essential filter to the thickness of the essential filter is between 0,7-0,8, and preferably about 0,74. This relatively large fold depth improves filtering capacity and also results in a mechanically stable filter suitable for use at construction sites and the like.

10 The pleated filter media preferably has between 2 and 3 folds per cm of filter media, and preferably about 2,37 folds per cm of filter media, measured across the fold direction, i.e., horizontally in the normal operating position of the air cleaner 100.

The filter media 500 of the essential filter 110 is preferably configured to generate a pressure drop of between 350-450 Pa over the essential filter at an air flow through the essential filter of 1000m³/h, and more preferably about 400 Pa at 1000m³/h.

15 A pressure drop in Pa per fold of the pleated filter media 500 is preferably between 4,5 Pa and 5 Pa per fold, and preferably about 4,82 Pa per fold. An area of a front surface of the filter media (the surface indicated as the front view in Figure 5) is about 1500-1600 cm² and preferably about 1575 cm².

20 The above filter media specifications may be applied also in other types of essential filters, having different contact surface geometries. The filter media specifications are, for example, applicable also with the essential filter exemplified in Figures 7-10.

25 According to some aspects, the air cleaner body 101 is arranged to hold an essential filter 110 that is of cuboid shape, as illustrated in the drawings, with a rectangular front surface that extends in the filter plane F and is arranged to cover the main air intake aperture when the essential filter is held in the air cleaner body 101. It is, however, appreciated that the teachings herein can be generalized to disc-shaped filters, cylindrically shaped filters, and so on, where the contact surface between the essential filter and the air cleaner body is non-planar at least along a section of the contact surface.

30 With reference to, e.g., Figure 2A and 3A, the contact surface 180 may be a rectangular contact surface with an upper section, a lower section, and two side sections 230, 240, where the first part 210 of the contact surface that extends along an oscillating path and possibly also has a variable offset from the aperture plane P is arranged along the upper section. The first part 210 of the contact surface 180 that

extends along an oscillating path preferably follows a continuous curve, i.e., a curve in one or two dimensions (in the aperture plane and normal to the aperture plane) without sharp discontinuities. The part of the contact surface illustrated in Figure 3B and Figure 4 has a variable offset from the aperture plane P that follows a waveform with six peaks and five valleys measured in direction of the essential filter 110 when the essential filter 110 is held in the air cleaner body 101.

The first part 210 of the contact surface 180 that extends along an oscillating path illustrated in Figures 7-11 has three peaks and two valleys, i.e., the contact surface goes down relative to the centrum line C twice over the width of the essential filter 110, denoted O1 and O2 in Figure 9. Some example dimensions in mm are shown in the drawings. These dimensions will be discussed in more detail below. Note that the oscillating path 720 extends up over the essential filter cuboid body.

A part of the contact surface may also have a convexly curved shape that extends out towards the essential filter 110 when the essential filter 110 is held in the air cleaner body 101. This is exemplified in Figure 3B, by the cross section along B-B, where the peak of the convex curve extends 0,5mm more out from the aperture plane P compared to the ends of the convex curve. The convex shape used at the bottom of the air cleaner in the examples is not inextricably linked to the waveform shape used at the top portion of the air cleaners in the examples.

The air cleaner 100 may also comprise at least two guide pins 250, 255 that extend out from the contact surface in the direction of the essential filter 110 when the essential filter 110 is held in the air cleaner body 101. Each guide pin 250, 255 is arranged to be received in a corresponding guide slot 260, 265 of the essential filter 110 when the essential filter 110 is held in the air cleaner body 101, as illustrated in, e.g., Figure 2B. The guide pins and the corresponding guide slots formed in the essential filter 110 help to align the essential filter correctly against the contact surface 180 such that proper sealing contact can be achieved.

The separating wall 165 may comprise at least one guide ridge 270, 275 arranged to engage a side surface of the essential filter 110 when the essential filter 110 is held in the air cleaner body 101. The guide ridges 270, 275 prevent the essential filter 110 from moving sideways when received in the air cleaner body 101. Each guide ridge extends vertically down along the separating wall 165.

The present disclosure also relates to an essential filter 110 for an air cleaner 100 such as the example air cleaners discussed above. The essential filter 110 is of cuboid shape with a rectangular front surface that extends in a filter plane F. A rectangular back surface of the essential filter is parallel to the front surface and separated from the front surface by the filter media. The air flow through the essential filter enters via the back surface and then passes through the front surface towards the fan. The front surface comprises a peripheral surface 115 arranged to sealingly contact a matching contact surface of the air cleaner 110 when the essential filter 110 is held in the air cleaner body 101. A key feature of the essential filters discussed herein is as discussed above that at least a part of the peripheral surface 115 of the essential filter 110 extends along an oscillating path in the filter plane F.

According to an example, at least a part of the peripheral surface 115 of the essential filter 110 can also be configured with a variable offset from the filter plane F, measured along a normal to the filter plane F. This variable offset on the essential filter matches the shape of the contact surface 180 on the separating wall to form a sealing contact between the essential filter and the separating wall.

The peripheral surface 115 may, as discussed above, be formed as a rectangular peripheral surface with an upper section, a lower section, and two side sections, where the part of the peripheral surface 115 that extends along an oscillating path is arranged along the upper section. An example essential filter having this geometry is illustrated in Figures 7-11 along with some example dimensions given in mm.

Another example essential filter where a part of the peripheral surface 115 extends along an oscillating path is illustrated in Figure 4, along with some example dimensions given in mm. Note that the part of the peripheral surface 115 that has a variable offset from the filter plane F follows a continuous curve without discontinuities. The particular part of the peripheral surface 115 illustrated in Figure 4 has a variable offset from the aperture plane P that is matched to a waveform curve with six peaks and five valleys measured in direction of the essential filter 110 when the essential filter 110 is held in the air cleaner 100.

Figure 7 shows an essential filter 110 matched to a separating wall 165 of an air cleaner such as that illustrated in Figure 1. In this case the oscillating contact surface 710, 720 between air cleaner body and essential filter extends in the filter plane F and in the aperture plane P, back and forth upwards and downwards in the normal operating position of the air cleaner 100, as illustrated in Figure 7. The oscillating

contact surface is delimited by protrusions 730 that extend out from the separating plane 165 to define the oscillating part of the contact surface.

Note that the oscillating contact surface 710, 720 extends beyond the cuboid shaped filter main body 111. The example essential filter in Figure 9 for instance has a central part 900 of the contact surface 710 which extends above the main filter body. This feature of the essential filter is not inextricably linked to the other features discussed herein. Consequently, there is disclosed an essential filter 110 for an air cleaner 100 such as the air cleaner in Figures 1A-B. The essential filter 110 comprises a main body 111 arranged to hold filter media, such as the pleated filter media discussed above or other filter media. The main body 111 has a cuboid shape, i.e., a rectangular box-like shape with right-angle corners. A front surface of the essential filter 110 extends in the filter plane F. The front surface comprises a peripheral surface 115 arranged to sealingly contact a matching contact surface of the air cleaner 110 when the essential filter 110 is held in the air cleaner body 101, as discussed herein. At least a part 900 of the peripheral surface 115 of the essential filter 110 extends beyond the cuboid shape main body 111 in the filter plane F.

Figure 8 illustrates details of a separating wall of an air cleaner, in particular a front view of the separating wall 165.

Figure 9 illustrates a view of an example essential filter 110, seen from the rear face of the filter. The oscillating contact surface 710 can be seen at the top of the filter 110. Note how the contact surface goes back and forth in an oscillating manner relative to a centrum line C. In this case the contact surface goes down relative to the centrum line twice over the width of the essential filter 110, denoted O1 and O2 in Figure 9.

Figure 10 shows details of an example essential filter comprising an oscillating form contact surface having a sinusoidal shape, i.e., at least similar to a sinusoidal waveform. Some example dimensions are indicated in mm in Figure 10. The width of the contact surface is about 15mm, i.e., somewhere in a range 13-17mm. The “amplitude” of the oscillating contact surface is 11.2mm in this example. The amplitude is here defined as the distance from the midpoint of the waveform to the extreme points as shown in Figure 10. The amplitude may generally be between 5-15 mm, and preferably about 11 mm. The “wavelength” of the oscillating contact surface is 186mm, i.e., the distance from a valley to a peak in the waveform is about 93mm. A wavelength in the range 170-200mm may be suitable for air cleaners of the type discussed herein, and preferably about 190 mm. A total height of the oscillating

form contact surface is about 26mm in Figure 10. The total height may be configured somewhere in a range 20-30mm.

Figures 11A-C shows some optional aspects of the essential filter 110 where a wing 1100 has been attached to the upper part of the back surface of the essential filter 110. Figures 11A-B show perspective views of the essential filter 110 while Figure C shows a back view, a side view, and a front view of the essential filter 110.

This wing 1100 is configured to engage the pre-filter 120 and/or the protection grate 130 in use, thus promoting air filtration by preventing unfiltered air to flow past the essential filter 110.

10 The wing 1100 extends along the entire upper part of the back surface of the filter, and extends beyond the filter body 111 in the filter plane F, as shown, e.g., in Figures 11A-C. The wing extends out from the filter body 111 at an angle 1120 measured relative to the filter plane F. The angle 1120 may be on the order of 20-50 degrees.

15 The wing 1100 is at least partly held in place by regularly spaced supports 1110 attached to the upper side of the essential filter.

The wing 1100 can be formed in a rigid plastic material or in a resilient material such as rubber.

The wing feature is not inextricably linked to any of the other features discussed herein.

20 Consequently, Figures 11A-C illustrate an essential filter 110 for an air cleaner 100. The essential filter 110 comprises a main body 111 of cuboid shape arranged to hold filter media. A front surface of the essential filter 110 extends in a filter plane F, as discussed above. The front surface comprises a peripheral surface 115 arranged to sealingly contact a matching contact surface of the air cleaner 110 when the essential filter 110 is held in the air cleaner body 101, where a back surface of the filter 110 is parallel to and separated from the front surface by filter media, where a wing 1100 extends out from an upper part of the back surface of the essential filter in use.

CLAIMS

1. An air cleaner (100) comprising an air cleaner body (101) with a main air intake aperture (102) that extends in an aperture plane (P),

where the air cleaner body (101) is arranged to hold an essential filter (110) that extends in a filter plane (F) parallel to the aperture plane (P) and covers the main air intake aperture (102),

the air cleaner (100) comprising a fan (160) arranged to generate a flow of air through the essential filter (110), when the essential filter (110) is held in the air cleaner body (101),

the air cleaner body (101) comprising a contact surface (180) arranged to sealingly contact a periphery of the essential filter (110) when held in the air cleaner body (101), where at least a first part (210) of the contact surface (180) extends along an oscillating path (720) in the aperture plane (P).

2. The air cleaner (100) according to claim 1, where the contact surface (180) is a rectangular contact surface with an upper section, a lower section, and two side sections, where the first part (210) of the contact surface that extends along an oscillating path is arranged along the upper section.

3. The air cleaner (100) according to claim 1 or 2, where the air cleaner body (101) is arranged to hold an essential filter (110) that is of cuboid shape, with a rectangular front surface that extends in the filter plane (F) and is arranged to cover the main air intake aperture when the essential filter is held in the air cleaner body (101).

4. The air cleaner (100) according to any previous claim, where the oscillating path follows a continuous waveform-shaped curve.

5. The air cleaner (100) according to any previous claim, where the first part (210) of the contact surface that extends along the oscillating path is at least partly delimited by protrusions (730) that extend out in direction normal to the aperture plane (P) to define the oscillating part of the contact surface.

6. The air cleaner (100) according to any previous claim, where the oscillating path has a variable offset from the aperture plane (P), measured along a normal to the aperture plane (P).

7. The air cleaner (100) according to claim 6, where the part of the contact surface that has a variable offset from the aperture plane (P) follows a waveform shaped curve

with six peaks and five valleys measured in direction of the essential filter (110) when the essential filter (110) is held in the air cleaner body (101).

8. The air cleaner (100) according to any previous claim, where a part of the contact surface has a convexedly curved shape that extends out towards the essential filter (110) when the essential filter (110) is held in the air cleaner body (101).

9. The air cleaner (100) according to any previous claim, where at least two guide pins (250, 255) extend out from the contact surface in direction of the essential filter (110) when the essential filter (110) is held in the air cleaner body (101), where each guide pin (250, 255) is arranged to be received in a corresponding guide slot (260, 265) of the essential filter (110) when the essential filter (110) is held in the air cleaner body (101).

10. The air cleaner (100) according to any previous claim, where the contact surface (180) is part of a separating wall (165) of the air cleaner, where the fan (160) is mounted in connection to an aperture formed in the separating wall (165).

11. The air cleaner (100) according to claim 10, where the separating wall (165) comprises at least one guide ridge (270, 275) arranged to engage a side surface of the essential filter (110) when the essential filter (110) is held in the air cleaner body (101).

12. The air cleaner (100) according to claim 10 or 11, where the separating wall (165) is integrally formed with a lid portion (140) of the air cleaner.

13. The air cleaner (100) according to any previous claim, arranged to hold a planar pre-filter (120) upstream of the essential filter (110).

14. The air cleaner (100) according to any previous claim, arranged to hold an activated carbon filter (125) downstream of the essential filter (110).

15. The air cleaner (100) according to claim 14, arranged to receive the activated carbon filter (125) in a matching recess (126) formed in a separating wall (165) of the air cleaner (100), where the separating wall supports the fan (160) and comprises the contact surface (180).

16. The air cleaner (100) according to any previous claim, comprising an impact protection grate (130) arranged upstream of the essential filter (110).

17. The air cleaner (100) according to any of claims 1-15, comprising a sleeve coupling arranged upstream of the essential filter (110) arranged to interface with a suction hose.

18. The air cleaner (100) according to any previous claim, where the oscillating path (720) in the aperture plane (P) is a sinusoidal waveform shape with an amplitude of between 5-15 mm, and preferably about 11 mm.

19. The air cleaner (100) according to any previous claim, where the oscillating path (720) in the aperture plane (P) is a sinusoidal waveform shape with wavelength between 170-200 mm, and preferably about 190 mm.

20. The air cleaner (100) according to any previous claim, where a total height of the first part (210) of the contact surface (180) is between 20-30 mm, and preferably about 26 mm.

21. An essential filter (110) for an air cleaner (100), the essential filter (110) being of cuboid shape with a rectangular front surface that extends in a filter plane (F), the front surface comprising a peripheral surface (115) arranged to sealingly contact a matching contact surface of the air cleaner (110) when the essential filter (110) is held in the air cleaner body (101),

where at least a part of the peripheral surface (115) of the essential filter (110) extends along an oscillating path (720) in the filter plane (F).

22. The essential filter (110) according to claim 21, where the peripheral surface (115) is a rectangular peripheral surface with an upper section, a lower section, and two side sections, where the part of the peripheral surface (115) that extends along an oscillating path is arranged along the upper section.

23. The essential filter (110) according to claim 21 or 22, where the part of the peripheral surface (115) that extends along an oscillating path follows a continuous waveform-shaped curve.

24. The essential filter (110) according to any of claims 21-23, where the part of the peripheral surface (115) that extends along an oscillating path extends in the aperture plane (P).

25. The essential filter (110) according to any of claims 21-24, where the part of the peripheral surface (115) that extends along an oscillating path has a variable offset from the filter plane (F), measured along a normal to the filter plane (F).

26. The essential filter (110) according to claim 25, where the part of the peripheral surface (115) that has a variable offset from the aperture plane (P) is matched to a waveform curve with six peaks and five valleys measured in direction of the essential filter (110) when the essential filter (110) is held in the air cleaner (100).

27. The essential filter (110) according to any of claims 21-26, where at least two guide slots (260, 265) are arranged in the peripheral surface (115), where each guide slot (260, 265) is arranged to receive a corresponding guide pin (250, 255) of the air cleaner (100).

28. The essential filter (110) according to any of claims 21-27, comprising a pleated filter media (500).

29. The essential filter (110) according to claim 28, where the pleated filter media (500) has between 70-90 folds, and preferably about 80-86 folds, and more preferably 83 folds.

30. The essential filter (110) according to claim 28 or 29, where the pleated filter media (500) is pleated at a pleated depth of between 50mm-100mm, and preferably about 75mm.

31. The essential filter (110) according to any of claims 28-30, where a ratio of the fold depth of the pleated essential filter to the thickness of the essential filter is between 0,7-0,8, and preferably about 0,74.

32. The essential filter (110) according to any of claims 28-31, where the pleated filter media (500) has between 2 and 3 folds per cm of filter media, and preferably about 2,37 folds per cm of filter media.

33. The essential filter (110) according to any of claims 28-32, where a pressure drop measured in Pascal, Pa, per fold of the filter media (500) is between 4,5 Pa and 5 Pa per fold, and preferably about 4,82 Pa per fold.

34. The essential filter (110) according to any of claims 28-33, where an area of a front surface of the filter media is about 1500-1600 cm² and preferably about 1575 cm².

35. The essential filter (110) according to any of claims 28-34, where the filter media of the essential filter generates a pressure drop of between 350-450 Pa at an air flow of 1000m³/h, and preferably about 400 Pa at 1000m³/h.

36. The essential filter (110) according to any of claims 21-35, where the oscillating path (720) in the filter plane (F) is a sinusoidal waveform shape with an amplitude of between 5-15 mm, and preferably about 11 mm.

37. The essential filter (110) according to any of claims 21-36, where the oscillating path (720) in the filter plane (F) is a sinusoidal waveform shape with wavelength between 170-200 mm, and preferably about 190 mm.

38. The essential filter (110) according to any of claims 21-37, where a total height of the oscillating form contact surface is between 20-30 mm, and preferably about 26 mm.

39. The essential filter (110) according to any of claims 21-38, where a rectangular back surface of the filter (110) arranged to face away from the fan (160) in use is parallel to and separated the front surface by filter media, the back surface of the essential filter comprising a wing (1100) that extends along an upper part of the back surface opposite to the oscillating path (720).

40. An air cleaner assembly 100, (110) comprising an air cleaner according to any of claims 1-20 and an essential filter (110) according to any of claims 21-39.

41. An essential filter (110) for an air cleaner (100), the essential filter (110) comprising a main body (111) of cuboid shape arranged to hold filter media, where a front surface of the essential filter (110) extends in a filter plane (F), the front surface comprising a peripheral surface (115) arranged to sealingly contact a matching contact surface of the air cleaner (110) when the essential filter (110) is held in the air cleaner body (101), where at least a part of the peripheral surface (115) of the essential filter (110) extends beyond the cuboid shape main body (111) in the filter plane (F).

42. An essential filter (110) for an air cleaner (100), the essential filter (110) comprising a main body (111) of cuboid shape arranged to hold filter media, where a front surface of the essential filter (110) extends in a filter plane (F), the front surface comprising a peripheral surface (115) arranged to sealingly contact a matching contact surface of the air cleaner (110) when the essential filter (110) is held in the air cleaner body (101),

where a back surface of the filter (110) is parallel to and separated the front surface by filter media, where a wing (1100) extends out from an upper part of the back surface of the essential filter in use.

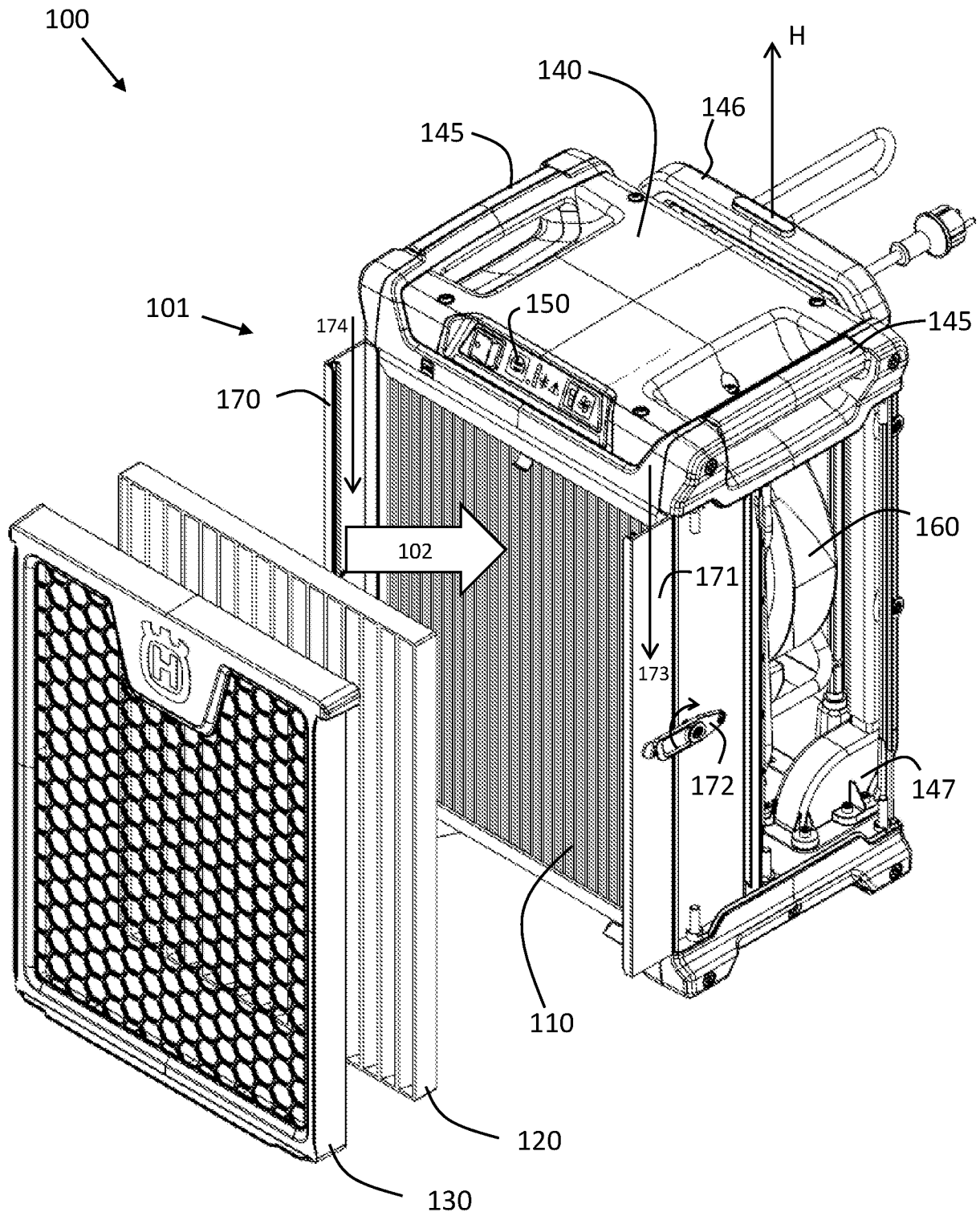


FIG. 1A

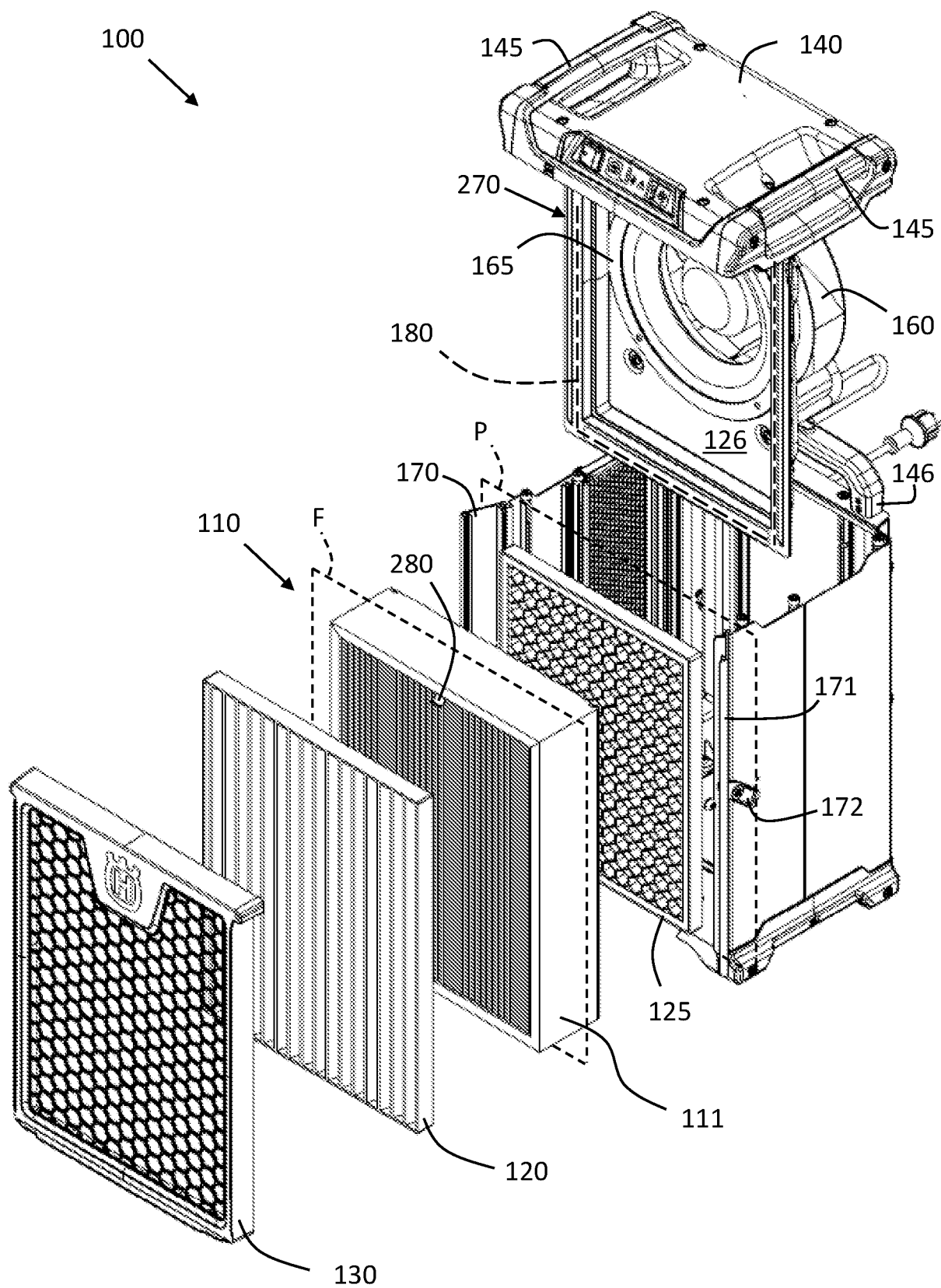


FIG. 1B

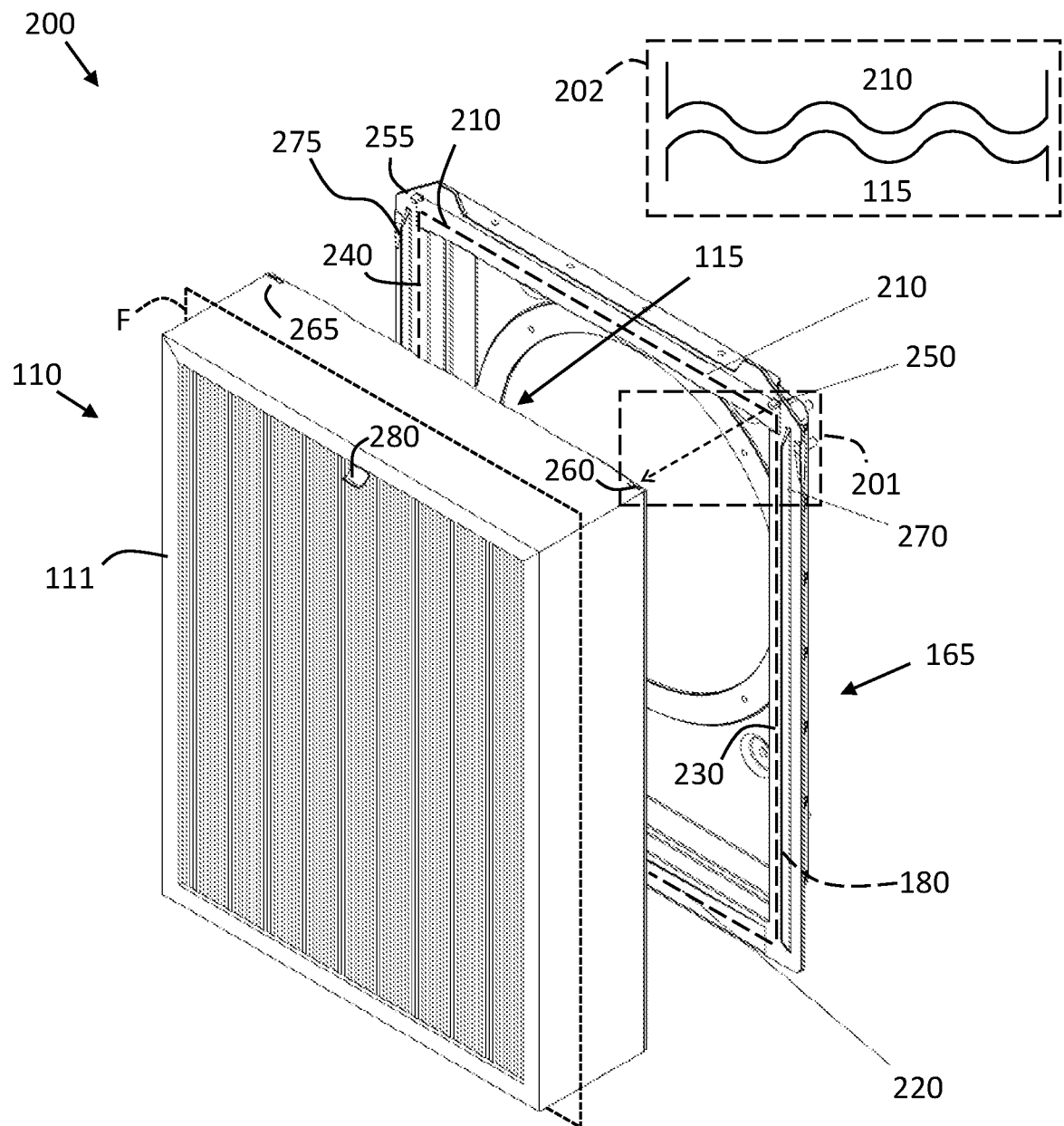


FIG. 2A

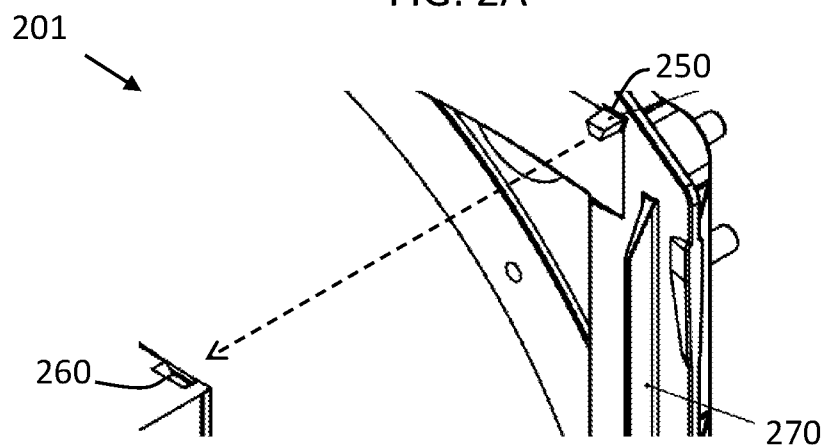


FIG. 2B

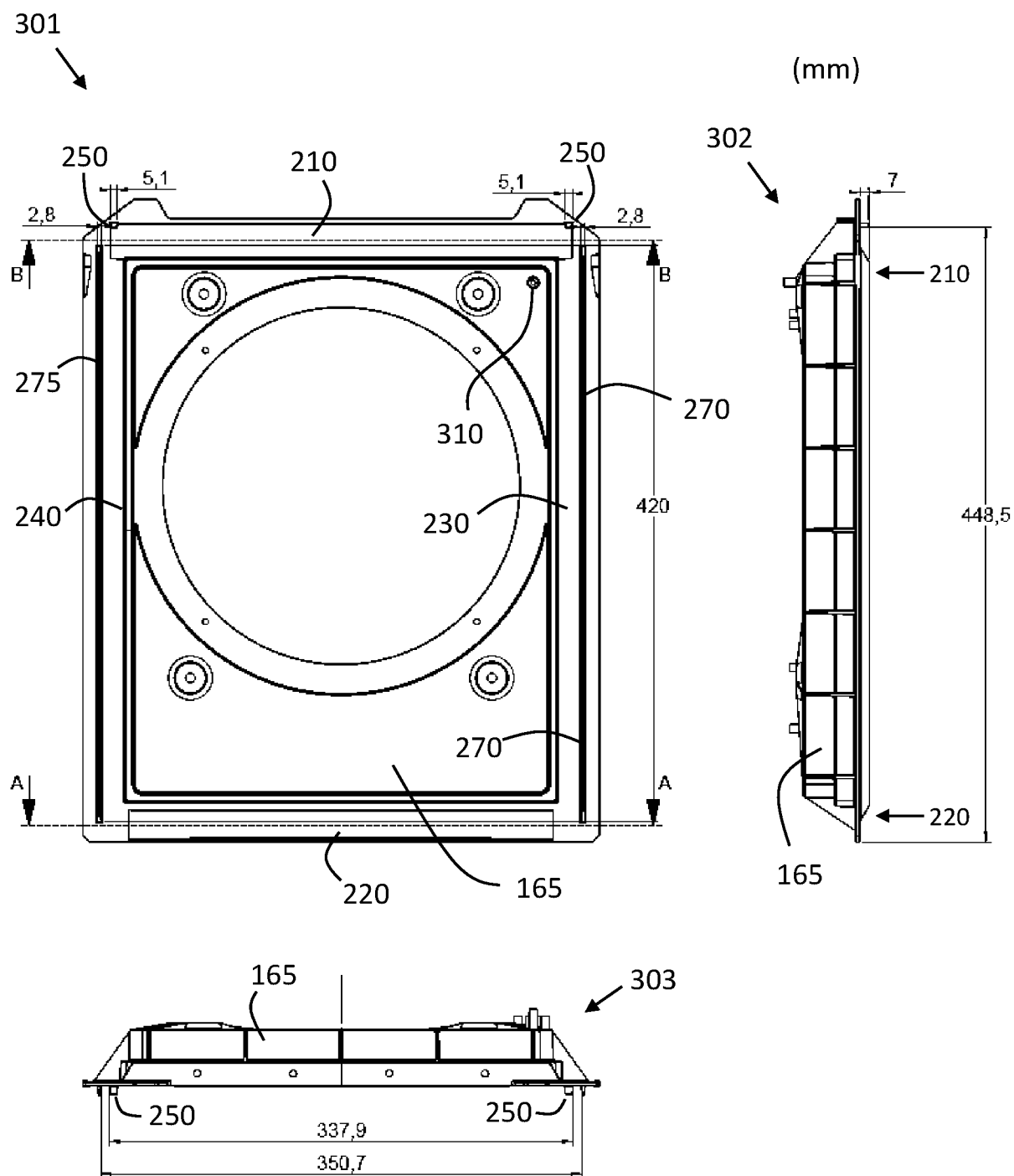


FIG. 3A

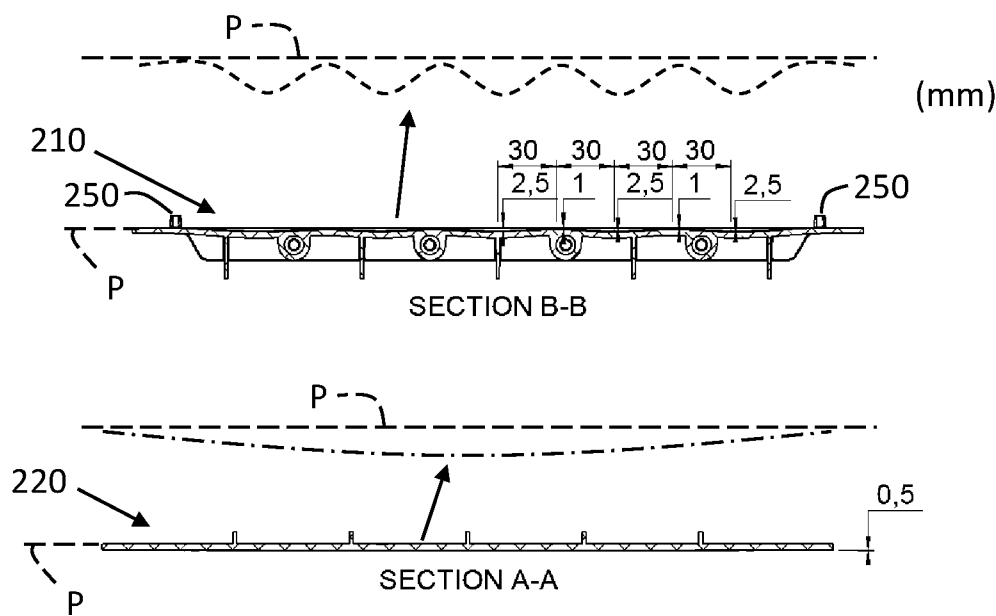


FIG. 3B

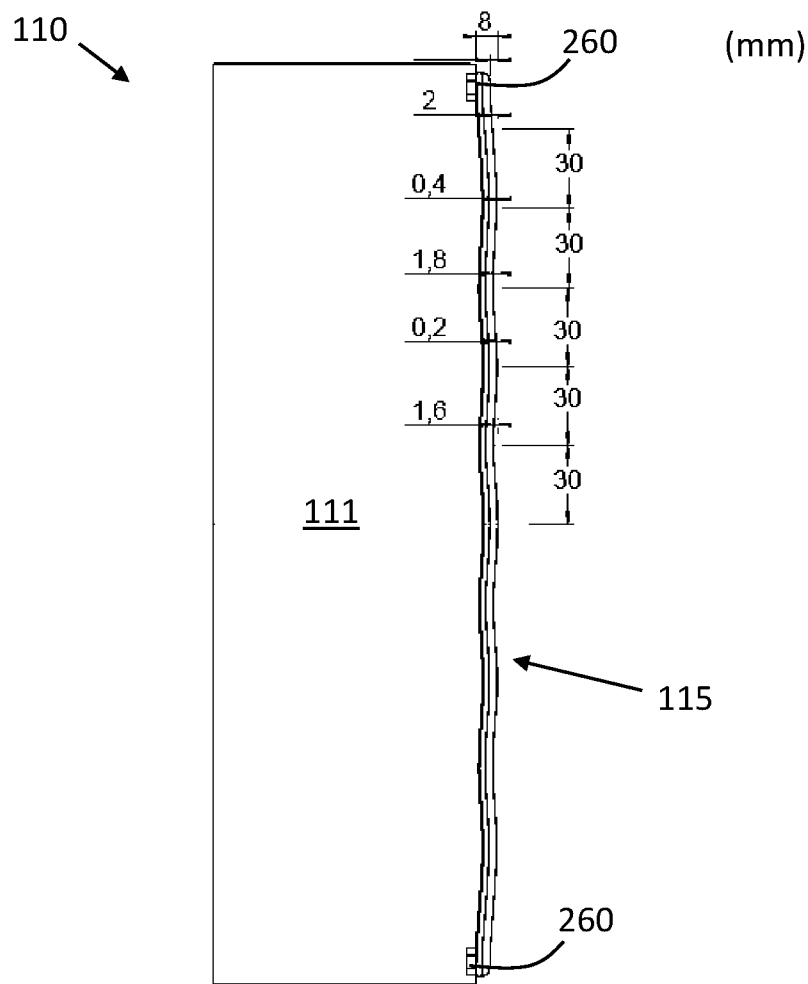


FIG. 4

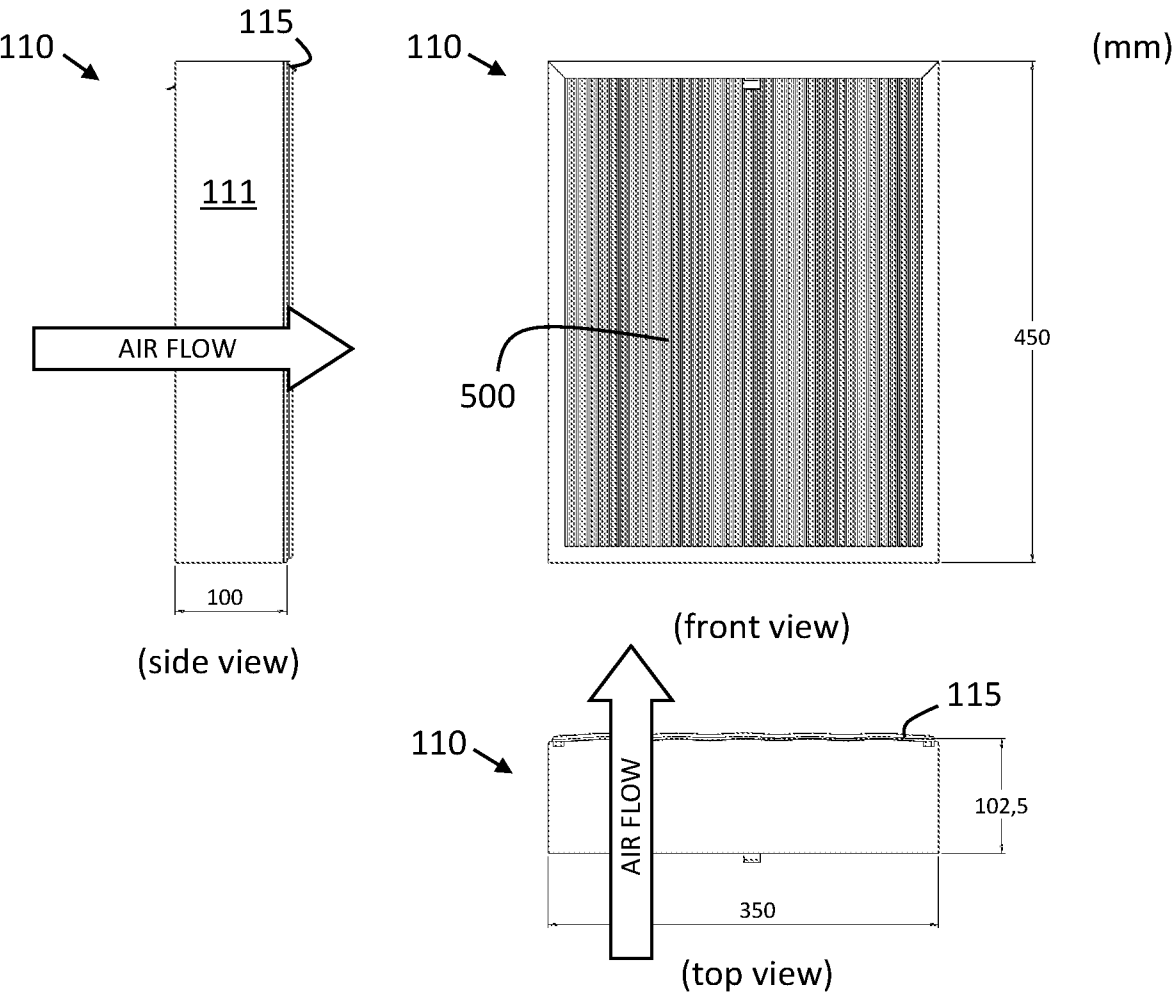


FIG. 5

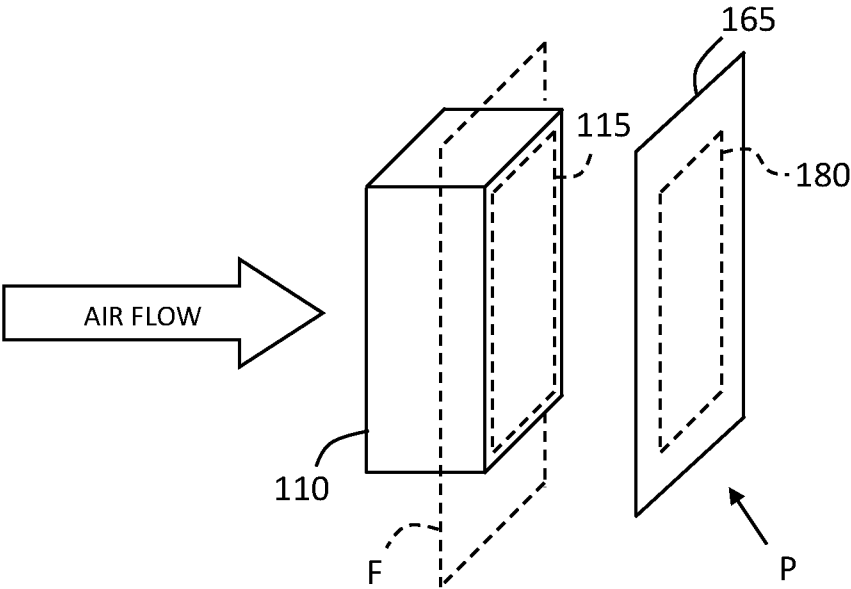


FIG. 6

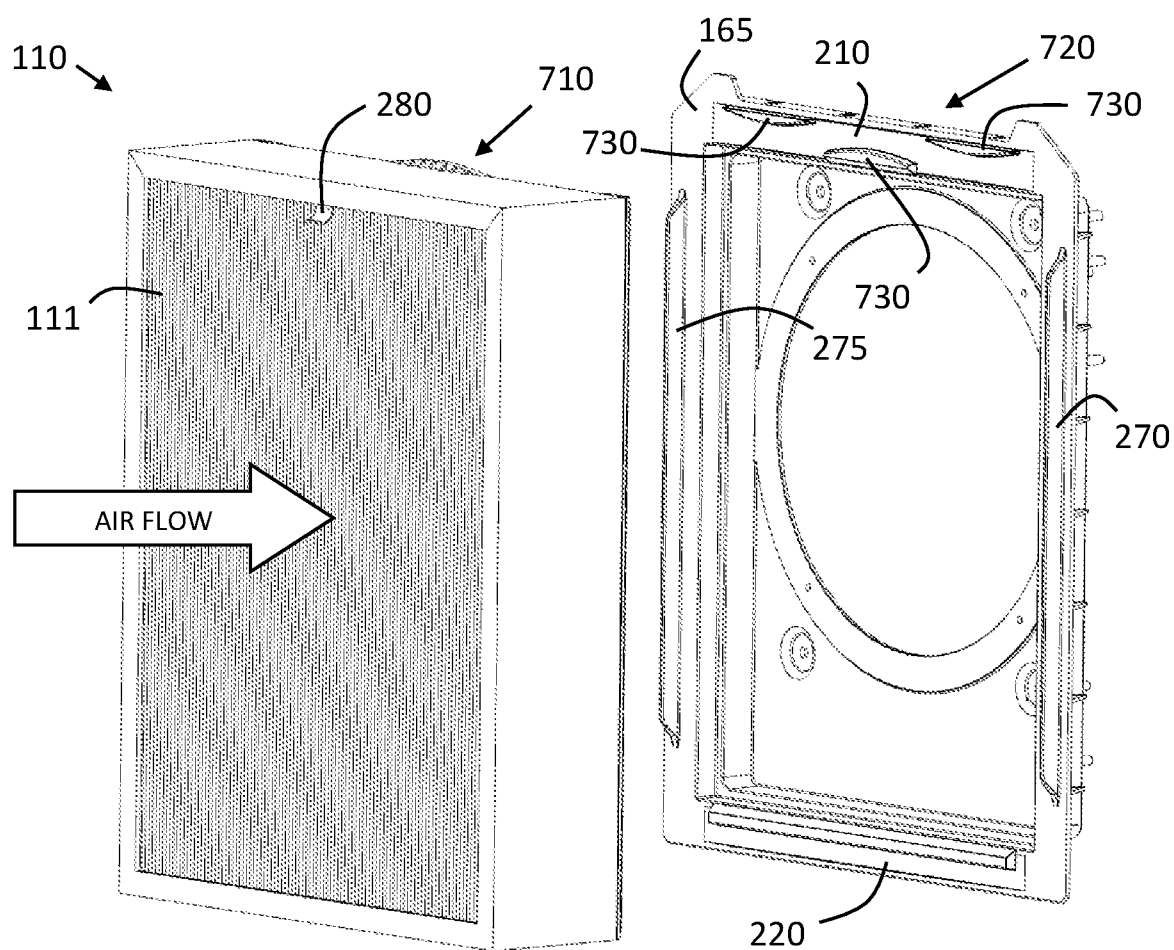


FIG. 7

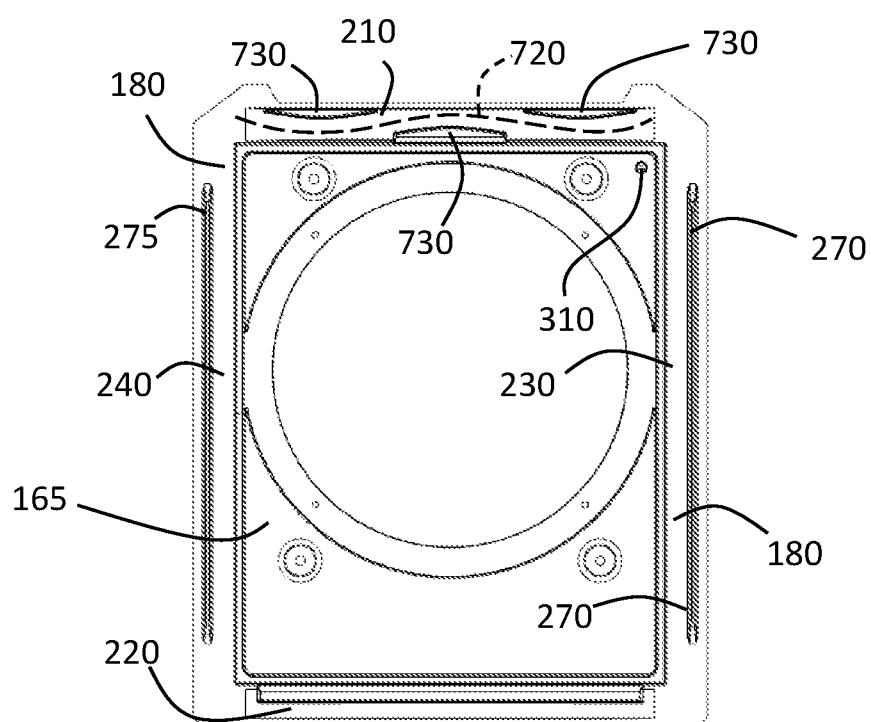


FIG. 8

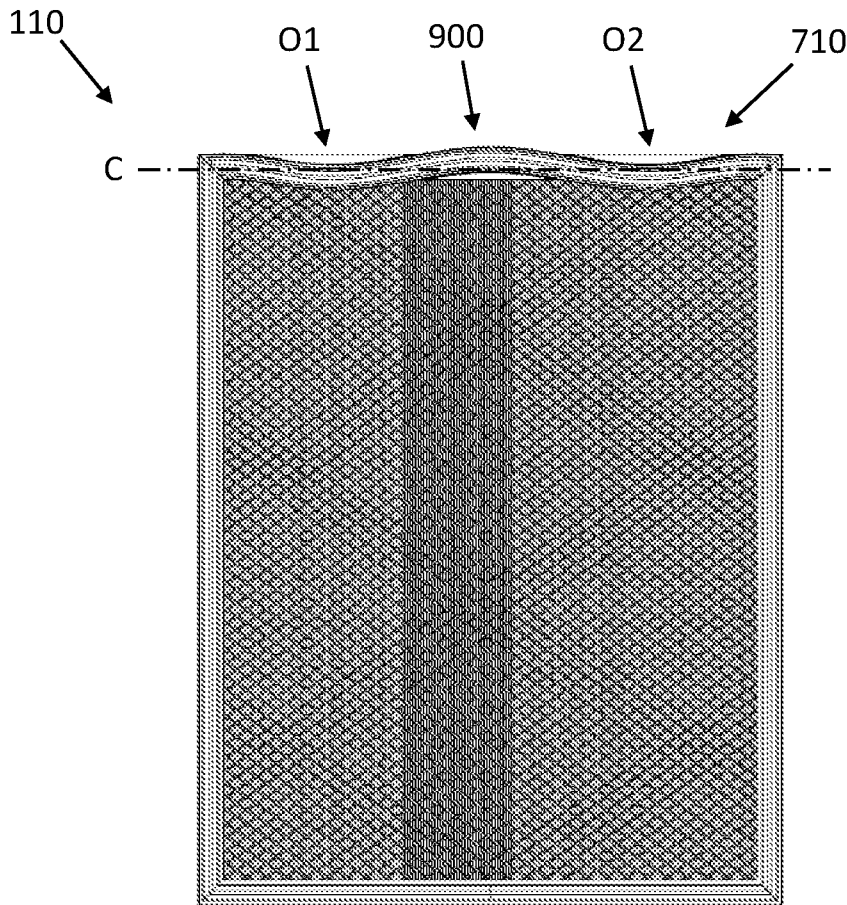


FIG. 9

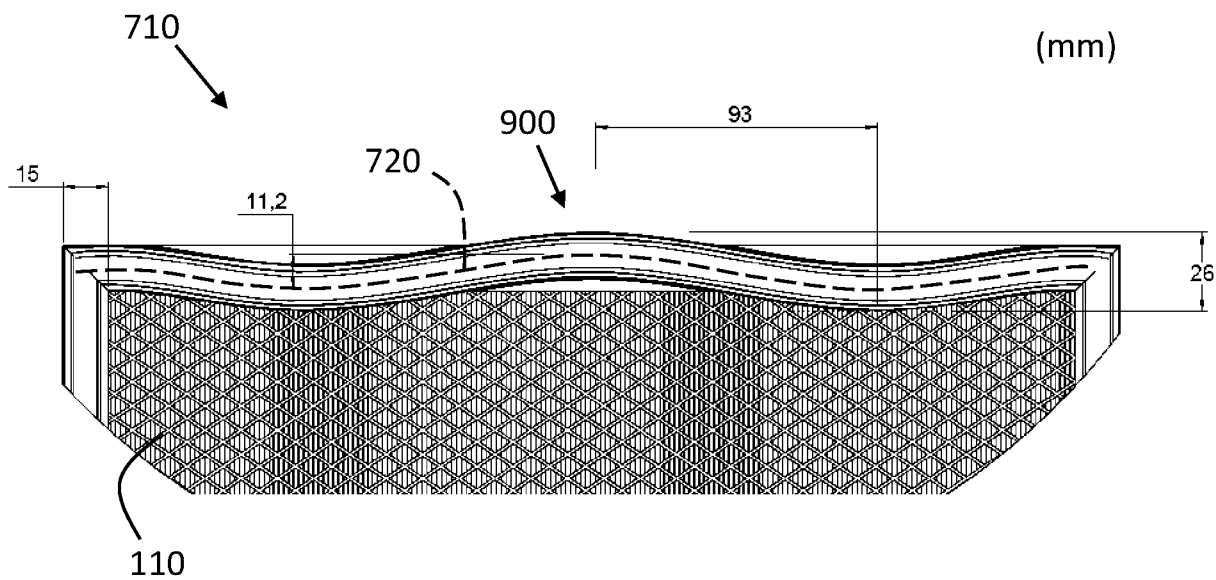


FIG. 10

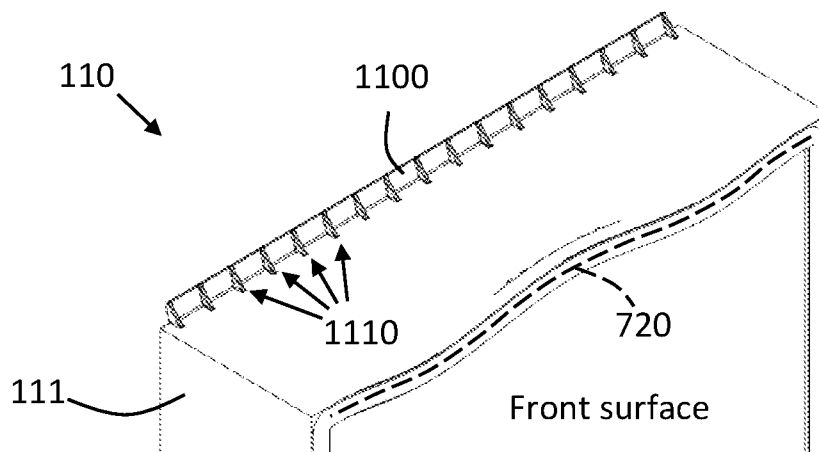


FIG. 11A

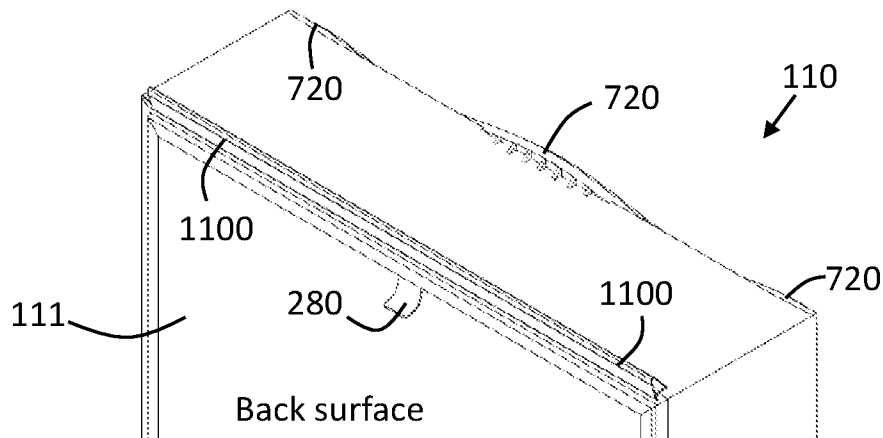


FIG. 11B

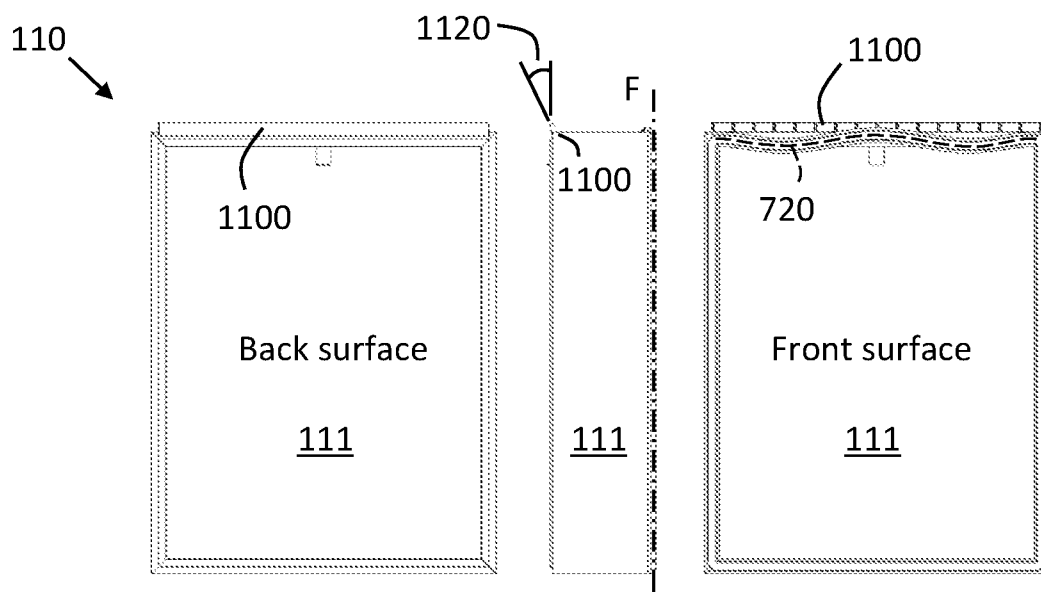


FIG. 11C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2024/050998

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B01D, F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, KIME

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20200072169 A1 (EHRENBERG BRIAN T ET AL), 5 March 2020 (2020-03-05); paragraphs [0089]-[0098], [0124]-[0126]; figures 3A-8	41
A	--	1-40
A	US 20210325063 A1 (PARK JUWAN ET AL), 21 October 2021 (2021-10-21); whole document	1-40
	--	
A	US 20030010001 A1 (BRYCE DON ET AL), 16 January 2003 (2003-01-16); whole document	1-40
	--	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	
"D" document cited by the applicant in the international application	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search
03-03-2025

Date of mailing of the international search report
03-03-2025

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Continuation of: second sheet

International Patent Classification (IPC)

F24F 8/80 (2021.01)

B01D 46/10 (2006.01)

B01D 46/52 (2006.01)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2024/050998**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-41

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Continuation of: Box No. III

1: Claims 1-40 related to an air cleaner, an essential filter and an air cleaner assembly comprising a wave seal.

2: Claim 41 related to an essential filter wherein a sealing peripheral surface extends beyond the cuboid main body of the filter.

3: Claim 42 related to an essential filter, where a wing extends out from an upper part of the back surface of the filter in use.

A partial search has been carried out, which relates to the inventions 1 and 2 mentioned above, since invention 2 did not require any additional search effort.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2024/050998

US	20200072169 A1	05/03/2020	EP	3616770 A1	04/03/2020
			EP	4062995 A1	28/09/2022
			ES	2924365 T3	06/10/2022
			US	11708809 B2	25/07/2023
			US	20220252027 A1	11/08/2022
US	20210325063 A1	21/10/2021	KR	20210129887 A	29/10/2021
			US	11965674 B2	23/04/2024
			WO	2021215680 A1	28/10/2021
US	20030010001 A1	16/01/2003	US	6610118 B2	26/08/2003