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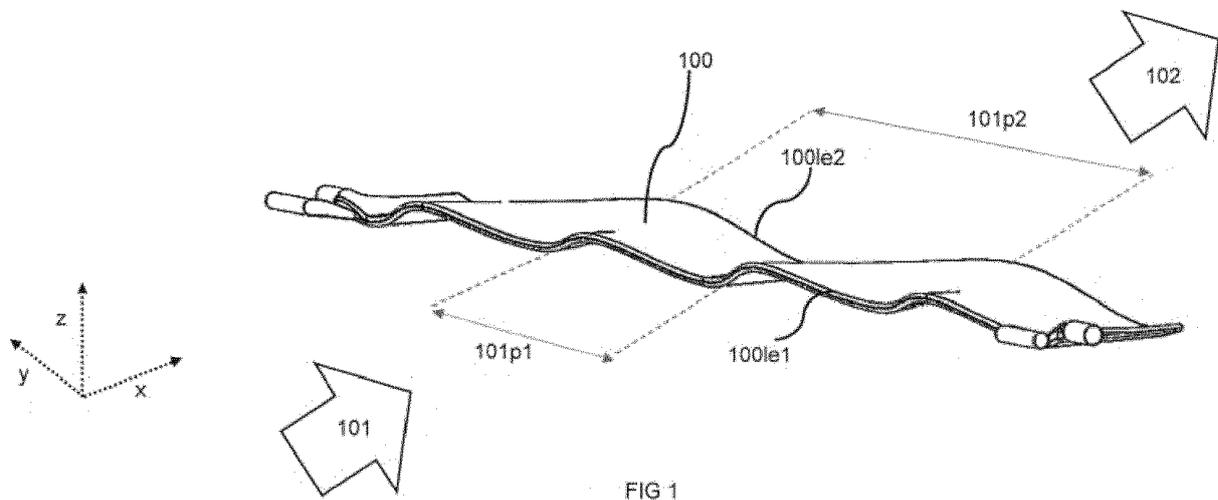
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(54) **VENTILATION APPARATUSES**

(57) An air vent blade 100 for directing an air stream 101 from a ventilation device 400, wherein the air vent blade is elongate and wherein a width 100w of the air vent blade varies along the length of the air vent blade.



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Description

TECHNOLOGICAL FIELD

[0001] Examples of the present disclosure relate to ventilation apparatuses. Some examples, though without prejudice to the foregoing, relate to an air vent blade for directing an air stream from a ventilation device. Some examples relate to an air duct chamber of a ventilation device. Some examples relate to a ventilation device comprising one or more such air vent blades and/or air duct chambers.

BACKGROUND

[0002] The provision of adequate ventilation is an important consideration in building design.

[0003] Ventilation devices enable the introduction of fresh air into a room or building. Ventilation devices may also enable heating or cooling of the introduced fresh air, e.g. via a heat recovery/exchange mechanism, as required depending on the requirements of: the room/building, time of year and climate conditions. Ventilation devices may also exhaust stale air from a room/building (and use the exhaust stale air as a heat source or heat sink in the heat recovery/exchange mechanism as required). Yet furthermore, ventilation devices may also enable the re-circulation of air within the room/building, as well as cooling or heating the re-circulated air as required e.g. via a heat recovery/exchange mechanism.

[0004] It is useful to provide an improved ventilation apparatus with enhanced air diffusion/mixing of an air stream from a ventilation device and also to provide the same in an energy efficient manner. It is also useful to provide improved acoustic properties/acoustic improved performance, i.e. so as to be quieter

[0005] The listing or discussion of any prior-published document or any background in this specification should not necessarily be taken as an acknowledgement that the document or background is part of the state of the art or is common general knowledge. One or more aspects/examples of the present disclosure may or may not address one or more of the background issues.

BRIEF SUMMARY

[0006] The scope of protection sought for various embodiments of the invention is set out by the independent claims.

[0007] Any examples/embodiments and features described in this specification that do not fall under the scope of the independent claims are to be interpreted as examples useful for understanding various embodiments of the invention.

[0008] According to at least some examples of the disclosure there is provided an air vent blade for directing an air stream from a ventilation device, wherein the air vent blade is elongate and wherein a width of the air vent

blade varies along the length of the air vent blade.

[0009] According to at least some examples of the disclosure there is provided an air duct chamber of a ventilation device, the chamber defining one or more inner walls, wherein one or more of the inner walls has a cross sectional shape that varies periodically and/or undulates.

[0010] According to at least some examples of the disclosure there is provided ventilation device comprising one or more air vent blades as mentioned above and one or more air duct chambers as mentioned above.

[0011] According to various, but not necessarily all, embodiments there is provided a method of providing and/or manufacturing the apparatuses, assemblies and/or systems as described herein.

[0012] According to various, but not necessarily all, embodiments there is provided a method of using apparatuses, assemblies and/or systems as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For a better understanding of various examples of the present disclosure that are useful for understanding the detailed description and certain examples of the present disclosure, reference will now be made by way of example only to the accompanying drawings in which:

FIG. 1 shows a rear perspective view of an example of an air vent blade according to the present disclosure;

FIG. 2 shows a plan view of the air vent blade of FIG.1;

FIG. 3 shows a front end-on view of the air vent blade of FIG.1;

FIG. 4A shows an example of a ventilation device according to the present disclosure;

FIG. 4B shows an example of a downlet end part of the ventilation device of FIG. 4A;

FIGs. 5A and 5B show a front perspective view and a front end on view the part of the ventilation device of FIG 4B;

FIGs. 6 shows a closeup front end on view of an example of an air duct chamber of the part of the ventilation device of FIG 5B; and

FIGs. 7 shows an example view of a lower internal surface of the air duct chamber of FIG. 6.

[0014] The figures are not necessarily to scale. Certain features and views of the figures may be shown schematically or exaggerated in scale in the interest of clarity and conciseness. For example, the dimensions of some elements in the figures can be exaggerated relative to

other elements to aid explication. Similar reference numerals are used in the figures to designate similar features. For clarity, all reference numerals are not necessarily displayed in all figures.

DETAILED DESCRIPTION

[0015] FIGs. 1 - 3 show: a rear perspective view, a plan view and a front end-on view of an example of an air vent blade 100.

[0016] As used herein, the term air vent blade may be an elongate member, vane, slate, louvre or other means for directing an air stream 101 from a ventilation device (e.g. such as is shown in FIG. 4A). In use, a set of air vent blades may be arranged across a downlet/outlet end of an air duct chamber of a ventilation device (the air duct chamber itself being located at a downlet/outlet of the ventilation device) and adjustably mounted thereto, e.g. so as to be moveable or rotatable, so as to provide adjustability in the direction of an air stream 101 outlet from the air duct chamber of the ventilation device (e.g. such as is shown in FIGs 4A and 4B).

[0017] The air vent blade is elongate and is substantially planar defining first and second major surfaces (i.e. upper and lower surfaces). However, as will be discussed below, the air vent blade need not be a flat planar object, but could be a curved planar object (e.g. a periodically undulating curved planar elongate member). The air vent blade defines a longitudinal direction/axis (e.g. a longitudinal y body axis/direction as indicated in FIG 1) and a lateral/transverse axis perpendicular to the longitudinal axis (e.g., a transverse/lateral x axis/direction as indicated in FIG 1). The air vent blade also defines a further direction/axis, orthogonal to the longitudinal and lateral directions (e.g. in a z axis/direction as indicated in FIG. 1).

[0018] As most clearly shown in FIG. 2, a width 100w of the air vent blade (i.e. an extend of the air vent blade in the lateral/transverse direction) varies along the length of the air vent blade. For example, it may have:

a first width 100w1 at a first position along the blade's length,

a second different (e.g. larger) width 100w2 at a second position along the blade's length, and

a third width 100w3 (e.g. that is the same as the width 100w1) at a third position along the blade's length.

[0019] In such a manner, the width of the air vent blade may be considered to vary periodically and/or undulate along the length of the air vent blade.

[0020] Advantageously, the variation of the width of the air vent blade adjusts the velocity profile of the incident airstream as it passes over and under the air vent blade. Since differing sections of the air vent blade have differing widths, the incident airstream passing across differing sections of the air vent blade passes along dif-

fering extents (i.e. differing widths/path lengths) of the air vent blade. To put it another way, differing portions of the incident air stream are in contact with/proximal to air blade for differing distances and hence differing amounts of time. Since the air vent blade affects a degree of turbulence the air stream undergoes, differing portions of the incident air stream undergo differing degrees of turbulence. Moreover, since turbulence affects the velocity of the airstream, differing portions of the incident air stream have differing velocities. Advantageously, such adjustment of the velocity profile of the incident airstream 101 so that the outlet airstream 102 has such an adjusted velocity profile aids the diffusion of the outlet airstream into a room/building, i.e. spreading out the vented air, and enhances the mixing of the outlet air stream with the ambient air. Moreover, advantageously, it has been found that the configuration and profile of the air vent blade reduces turbulence of the outlet air stream which gives rise to improved acoustic properties and acoustic performance, namely a quieter outflow of air.

[0021] The air vent blade has a first longitudinal edge 1011e1 and an opposing second longitudinal edge 1011e2. The first longitudinal edge may, in use, face towards the incoming airstream 101 from the ventilation device (e.g. an airstream urged towards the longitudinal edge by a fan of the ventilation device, or urged naturally via ambient wind where the ventilation device is installed through an exterior wall). Accordingly, the first longitudinal edge may be referred to as a "leading edge", i.e. the longitudinal edge that is in an upstream direction or an air inlet direction. The second longitudinal edge may, in use, face away from the incoming airstream, i.e. it is in a downlet direction, downstream direction or an air outlet direction. Accordingly, the second longitudinal edge may be referred to as a "trailing edge".

[0022] As most clearly shown in the plan view of FIG. 2, a shape of each of the first and second longitudinal edges varies periodically and/or undulates along its length, e.g. in the y axis direction in the x-y plane. Whilst the Figures show both the first and second longitudinal edges varying periodically/undulating along their length. In some examples, just one of the first and second longitudinal edges varies periodically/undulates along its length.

[0023] A shape of the first and/or second longitudinal edge, along an axis perpendicular to the longitudinal axis, varies periodically and/or undulates along its length. In some examples, a shape of the first and/or second longitudinal edge, along the lateral/transverse axis may vary periodically and/or undulates along the air vent blade's length (i.e. the shape varies in the y direction - as is shown in FIG. 2). In some examples, a shape of the first and/or second longitudinal edge, along an axis perpendicular to the longitudinal and lateral/transverse axes, may vary periodically and/or undulate along the air vent blade's length (i.e. the shape varies in the z direction as is shown in FIG 3).

[0024] As shown in FIG. 2, the shape of the first longi-

tudinal edge 1011e1 varies periodically in the y direction with a first period 101p1, and the shape of the second longitudinal edge 1011e2 varies periodically in the y direction with a second period 101p2 different to the first period.

[0025] Likewise, as shown in FIG. 3, the shape of the first longitudinal edge 1011e1 varies periodically in the z axis direction in the z-x plane with a first period 101p1', and the shape of the second longitudinal edge 1011e2 varies periodically in the z direction with a second period 101p2' different to the first period.

[0026] In the examples shown, the shapes vary sinusoidally.

[0027] For example, the varying shape of the first longitudinal edge in the y direction (i.e. as per FIG. 2) may be defined by:

$$y = \alpha_1 \sin\left(\frac{\pi}{\beta_1} x + \phi_1\right) + c_1$$

[0028] Wherein: α_1 affects an amplitude of the affects varying shape (i.e. the range of width variability)

β_1 affects a frequency (or period) of the sinusoidal varying shape

ϕ_1 affects a phase/frequency offset of the sinusoidal varying shape

c_1 affects a base level/average width

[0029] The varying shape of the first longitudinal edge in the z direction (i.e. as per FIG. 3) may be similarly defined with the same or differing parameters α_1 , β_1 and ϕ_1 .

[0030] The varying shape of the second longitudinal edge in the y direction (i.e. as per FIG. 2) may be defined by:

$$y = \alpha_2 \sin\left(\frac{\pi}{\beta_2} x + \phi_2\right) + c_2$$

[0031] Wherein: α_2 affects an amplitude of the sinusoidally varying shape (i.e. range of width variability)

β_2 affects a frequency (or period) of the sinusoidal varying shape

ϕ_2 affects a phase/frequency offset of the sinusoidal varying shape

c_2 affects a base level/average width

[0032] Again, the varying shape of the second longitudinal edge in the z direction (i.e. as per FIG. 3) may be similarly defined with the same or differing parameters

α_2 , β_2 and ϕ_2 .

[0033] In some examples, the frequencies (or periods) of the sinusoidally varying shapes of the first and second longitudinal edges are different. I.e. the frequencies (or periods) of the sinusoidally varying shapes of the leading and trailing edges are different.

[0034] It has been advantageously found that having the spatial period of the sinusoidally shaped first longitudinal edge (the leading edge) substantially half the spatial period of the sinusoidally shaped second longitudinal edge (trailing edge) gives rise to optimal spreading out of the air flow and its mixing/diffusion with the ambient air in the room/building (avoiding localised hot/cool spots) as well as optimal acoustic properties and performance (quieter/reduced noise of the air flow) - i.e. it is optimal to have $101p1 = \frac{1}{2} 101p2$.

[0035] In some examples, the shape of the first longitudinal edge (leading edge) varies periodically with a first phase; and the shape of the second longitudinal edge (trailing edge) varies periodically with a second phase different to the first phase. This equates to a phase offset between the longitudinal edges, i.e. a phase of the sinusoidally shaped leading edge is offset with respect to a phase of the sinusoidally shaped trailing edge. It has been advantageously found that having differing phases/phase offsets (i.e. in effect differing starting positions/initial boundary points of the sinusoidally varying pattern) enhances the diffusion and mixing of the incident airstream as well as acoustic properties and performance.

[0036] In some examples, the amplitudes of the sinusoidally varying shapes of the first and second longitudinal edges are the substantially the same. I.e. the amplitudes of the sinusoidally varying shapes of the leading and trailing edges are substantially the same.

[0037] FIG. 4A shows an example of a ventilation device 400 and a downlet side end part 400a of the same. Typically, in use and when installed in a building/room, the downlet end part would be internal of the building/room and the other end would be external of the building/room e.g. exposed to a source of fresh/ventilation air to be introduced into the building/room.

[0038] The downlet side end part 400a comprises of two outlet air duct chambers of the ventilation device. Disposed at an outlet end of each air duct chamber is an arrays/parallel set of air vent blades 100, which are movably/rotatably mounted to adjust a direction of the outlet out from the air duct chamber.

[0039] FIG. 4A also shows a body housing 401 of the ventilation device. The body housing defines a major axis of the body housing, i.e. body housing axis 401 (which, typically in use, would be horizontally aligned).

[0040] FIG. 4B shows a close up of the downlet end part 400a of the ventilation device, and the part of the housing 401a for the same which comprises the air duct chambers and arrays of a movably mounted air vent blades. In this Figure, the left-hand side set of air vent blades 1001 covering the left-hand side air duct chamber

are partially rotated in a substantially vertically downwards direction - thereby directing the left-hand side outgoing airstream 1021 towards a substantially vertically downwards direction. Whereas the right-hand side set of air vent blades 100r covering the right-hand side air duct chamber are rotated in a substantially horizontal direction - thereby directing the right-hand side outgoing airstream 102r substantially horizontally.

[0041] FIGs. 5A and 5B show front perspective and front end on views of the end/air outlet part 400a of the ventilation device of FIGs 4A and 4B and the left and right air duct chambers 500 of the same. Each air duct chamber may be a channel, pathway or passage through which an airstream (e.g. urged/propelled via a fan of the ventilation device) is guided along.

[0042] Each air duct chamber has inner walls/interior surfaces, such as upper surface 500us and lower inner surface 500ls. Each of the upper and lower surfaces has a cross sectional shape that varies periodically and/or undulates.

[0043] The air duct chamber's inner walls may define a proximal end 500pe (namely an air inlet end of the air duct chamber, i.e. an upstream end in a direction from where incident airstream comes from, e.g. an internal direction towards an inside of the ventilation device) and a distal end 500de (namely an air outlet end of the air duct chamber, i.e. a downstream end in a direction to where outlet airstream vents, e.g. an external directions towards the outside of the ventilation device). The distal end has a cross-sectional shape which varies periodically and/or undulates, whereas the proximal end may have a straight cross-sectional shape (i.e. a portion of the internal surface of the inner wall of the air duct chamber at the proximal end thereof is substantially planer).

[0044] Advantageously, such a planer proximal side aids the inflow of air, e.g. from a fan of the ventilation device, and avoids turbulence and impeding the air flow and reducing its flow rate. The provision of the periodically and/or undulating shape of the distal end, e.g. having a varying shape that matches that of the varying shape of the leading edges 100le1 of the air vent blades, avoids turbulence and impeding the air flow at the interface of the air duct chamber and the air vent blades.

[0045] FIG. 6 shows a close-up front end on view of the left-hand air duct chamber of FIGs 5A and 5B. The width W of the air duct chamber is substantially the same as the longitudinal length of one of the air vent blades. FIG. 6 more clearly shows the cross-sectional shape of the distal end 500de varying periodically and/or undulating. The cross-sectional shape of the distal end 500de may vary periodically in a manner similar to that of the periodically carrying shape of the leading edge of the blade. In this regard, the cross-sectional shape of the distal end 500de may vary sinusoidally with a period, amplitude and phase that match the period, amplitude and phase of the sinusoidally varying shape of the leading edge of the blade. For example, the amplitude H and the period D of the distal end 500de may correspond to the

amplitude 101a' and the period 101p1' of a leading edge 101le1 of an air vent blade, such a leading edge being aligned with the distal end 500de.

[0046] FIG. 6 also shows the non-varying shape of the proximal end 500pe and its straight cross-sectional shape. The surface 500ls of the inner wall starts off straight/flat planer at its proximal end then, as it extends towards the distal end, the surface starts to undulate/periodically vary, i.e. the surface undergoes 'trenching' providing a series of trenches/undulations.

[0047] FIG. 7 shows a perspective close up view of the lower internal surface 500ls of the air duct chamber 500 of FIGs. 5A, 5B and 6. This Figure shows the proximal end 500pe having a straight cross-sectional shape, whereas the distal end 500de has a periodically varying cross-sectional shape.

[0048] The length of the lower internal surface 500ls is L. An initial portion L1 of the lower internal surface, on the proximal side thereof, is substantially flat. Whereas the remaining portion, L2 is curved. In particular, after initial flat section L1, the interior surface gradually starts to undulate and periodically vary in shape until, at its distal end, its sinusoidal shape (amplitude, period and phase) matches that of the leading edge/first longitudinal edge of the air vent blades (which, in use, would be arranged along the distal side of the air duct chamber. In some alternative examples, there is no initial planer section L1, i.e. the surface gradually starts to curve straight ways without an intimal planer section such that L2 = L.

[0049] FIG. 7 also shows a part of the body housing 401a of the ventilation device and the body housing axis 402 (which, typically when the ventilation device is installed and mounted in use, would be horizontally aligned). The air duct chamber defines an air duct chamber axis 502 (i.e. major axis of the air duct chamber), which is non-parallel to the body housing axis. In FIG.7 the air duct chamber axis 502 is rotated α° with respect to the body housing axis 402. The walls of the housing 401a of the air duct chamber at a distal end thereof have a thickness h2 which is greater than the thickness of the walls h1 at a proximal end of the air duct chamber.

[0050] In such a manner the air duct chamber, in effect, extends through at least a part of the body housing (e.g. the part 400a) at a first non-zero angle with respect to the body housing axis of the housing.

[0051] Advantageously, this helps direct the flow of the outlet vented air from the ventilation device which can further aid the mixing and diffusion of the vented air, e.g. by directing the vented air upwards towards a ceiling of the building/room.

[0052] Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation. Features described in the preceding description can be used in combinations other than the combinations explicitly described. Although functions have been described with reference to certain features, those functions can be performable by other features whether described or not. Although fea-

tures have been described with reference to certain examples, those features can also be present in other examples whether described or not. Accordingly, features described in relation to one example/aspect of the disclosure can include any or all of the features described in relation to another example/aspect of the disclosure, and vice versa, to the extent that they are not mutually inconsistent. Although various examples of the present disclosure have been described in the preceding paragraphs, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as set out in the claims. For example, whilst sinusoidal shapes have been disclosed, it is to be appreciated that other shapes could be used, e.g. sawtooth, top-hat, rectilinear or other non-non-curved shapes (whether periodic/repeating or not).

[0053] The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X can comprise only one Y or can comprise more than one Y. If it is intended to use 'comprise' with an exclusive meaning then it will be made clear in the context by referring to "comprising only one ..." or by using "consisting".

[0054] In this description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term 'example' or 'for example', 'can' or 'may' in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some or all other examples. Thus 'example', 'for example', 'can' or 'may' refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class.

[0055] In this description, references to "a/an/the" [feature, element, component, means ...] are to be interpreted as "at least one" [feature, element, component, means ...] unless explicitly stated otherwise. That is any reference to X comprising a/the Y indicates that X can comprise only one Y or can comprise more than one Y unless the context clearly indicates the contrary. If it is intended to use 'a' or 'the' with an exclusive meaning then it will be made clear in the context. In some circumstances the use of 'at least one' or 'one or more' can be used to emphasise an inclusive meaning but the absence of these terms should not be taken to infer any exclusive meaning.

[0056] The presence of a feature (or combination of features) in a claim is a reference to that feature (or combination of features) itself and also to features that achieve substantially the same technical effect (equivalent features). The equivalent features include, for example, features that are variants and achieve substantially the same result in substantially the same way. The equiv-

alent features include, for example, features that perform substantially the same function, in substantially the same way to achieve substantially the same result.

[0057] In this description, reference has been made to various examples using adjectives or adjectival phrases to describe characteristics of the examples. Such a description of a characteristic in relation to an example indicates that the characteristic is present in some examples exactly as described and is present in other examples substantially as described.

[0058] Whilst endeavouring in the foregoing specification to draw attention to those features of examples of the present disclosure believed to be of particular importance it should be understood that the applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

[0059] The examples of the present disclosure and the accompanying claims can be suitably combined in any manner apparent to one of ordinary skill in the art.

[0060] Each and every claim is incorporated as further disclosure into the specification and the claims are embodiment(s) of the present invention. Further, while the claims herein are provided as comprising specific dependencies, it is contemplated that any claims can depend from any other claims and that to the extent that any alternative embodiments can result from combining, integrating, and/or omitting features of the various claims and/or changing dependencies of claims, any such alternative embodiments and their equivalents are also within the scope of the disclosure.

35 Claims

1. An air vent blade for directing an air stream from a ventilation device, wherein the air vent blade is elongate and wherein a width of the air vent blade varies along the length of the air vent blade.
2. The air vent blade as claimed in claim 1, wherein the width of the air vent blade varies periodically and/or undulates along its length.
3. The air vent blade as claimed in any previous claim, wherein the air vent blade has a first longitudinal edge and an opposing second longitudinal edge,
4. The air vent blade as claimed in claim 3, wherein:
 - a shape of the first and/or second longitudinal edge varies periodically and/or undulates along its length; and/or
 - cross-sectional shape of the first and/or second longitudinal edge varies periodically and/or undulates along its length;

5. The air vent blade as claimed in any of previous claims 3 to 4, wherein:

a shape of the first and/or second longitudinal edge, along an axis perpendicular to the longitudinal axis, varies periodically and/or undulates along its length; and/or

a shape of the first and/or second longitudinal edge, along an axis perpendicular to the longitudinal and transverse axes, varies periodically and/or undulates along its length.

6. The air vent blade as claimed in any of previous claims 3 to 5, wherein:

a shape of the first longitudinal edge varies periodically with a first period, and a shape of the second longitudinal edge varies periodically with a second period different to the first period;

a shape of the first longitudinal edge varies periodically with a first phase, and a shape of the second longitudinal edge varies periodically with a second phase different to the first phase; and/or

a shape of the first longitudinal edge varies periodically with a first amplitude, and a shape of the second longitudinal edge varies periodically with a second amplitude substantially the same as the first amplitude.

7. An air duct chamber of a ventilation device, the chamber defining one or more inner walls, wherein one or more of the inner walls has a cross sectional shape that varies periodically and/or undulates.

8. The air duct chamber as claimed in claim 7, wherein each of the one or more inner walls defines a proximal end, and a distal outlet end, wherein: the distal end has a cross-sectional shape which varies periodically and/or undulates.

9. The air duct chamber as claimed in claim 7 or 8, wherein each of the one or more inner walls defines a proximal end, and a distal outlet end, wherein: the proximal end has a straight cross-sectional shape.

10. The air duct chamber as claimed in any of claims 7 to 9, further comprising at least one air vent blade according to any of claims 1 to 6.

11. The air duct chamber as claimed in any of claims 7 to 10, wherein the cross-sectional shape of the distal end of the air duct chamber is substantially similar to the cross sectional-sectional shape of the first longitudinal edge of the at least one air vent blade.

12. The air duct chamber as claimed in any of claims 7

to 11, wherein a: period, phase and/or amplitude of the cross-sectional shape of the distal end of the air duct chamber is substantially similar to a: period, phase and/or amplitude of the cross sectional-sectional shape of the first longitudinal edge of the at least one air vent blade.

13. A ventilation device comprising:

one or more air vent blades as claimed in any of claims 1 - 6; and one or more air duct chambers as claimed in any of claims 7 — 12.

14. The ventilation device of claim 13, further comprising:

a body housing defining a body housing axis; wherein the air duct chamber defines an air duct chamber axis; and wherein the air duct chamber axis is non-parallel to the body housing axis.

15. The ventilation device of claim 14, wherein the air duct chamber extends through at least a part of the body housing at a first non-zero angle with respect to the body housing axis of the housing.

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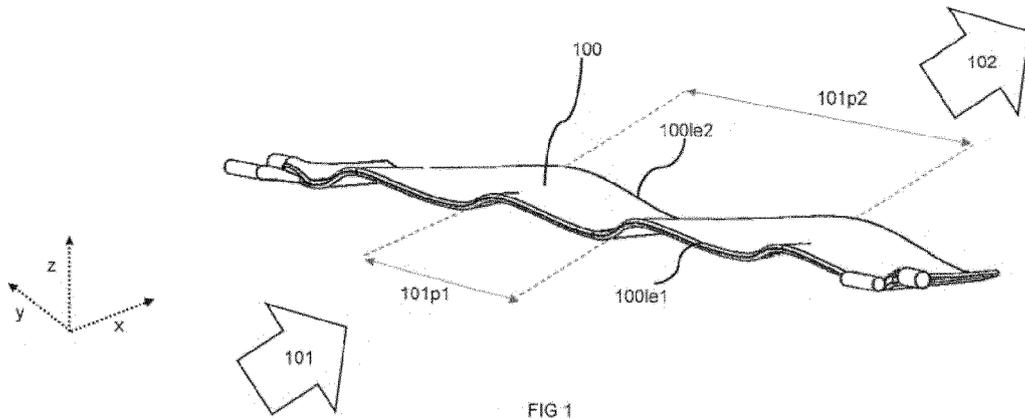


FIG 1

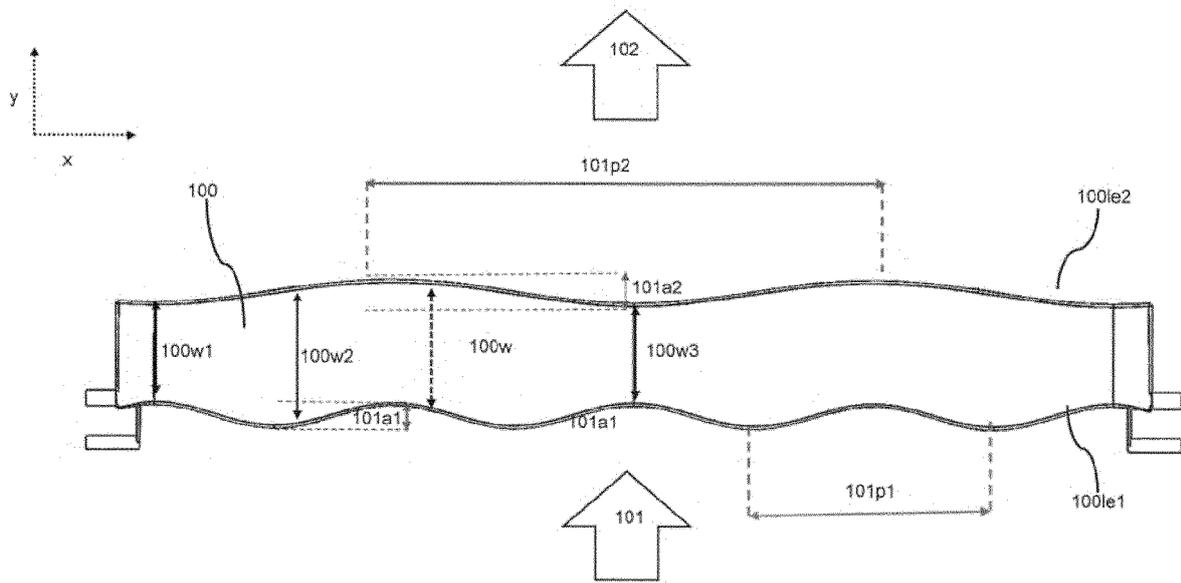


FIG 2

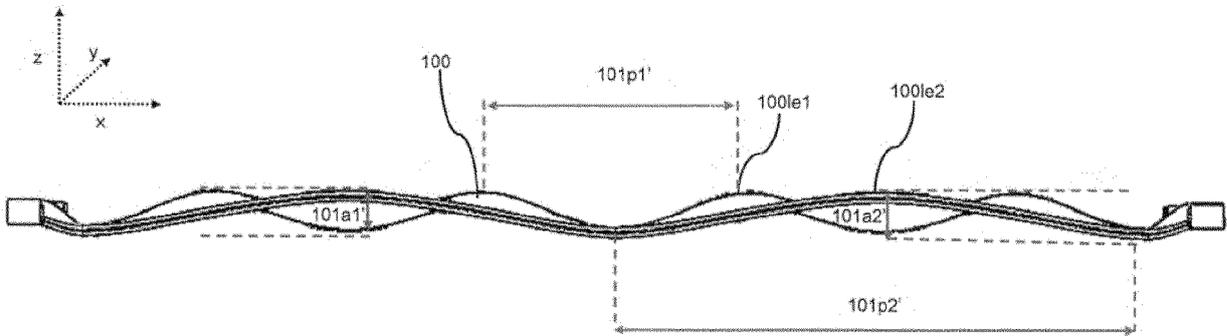


FIG 3

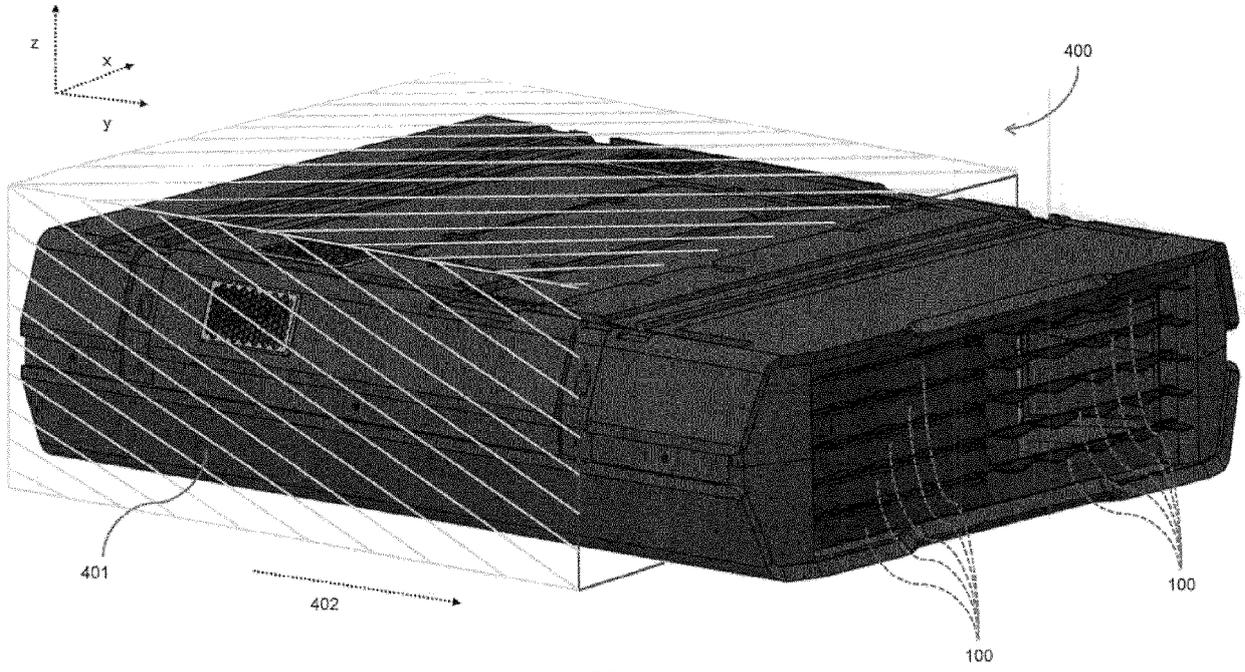


FIG 4A

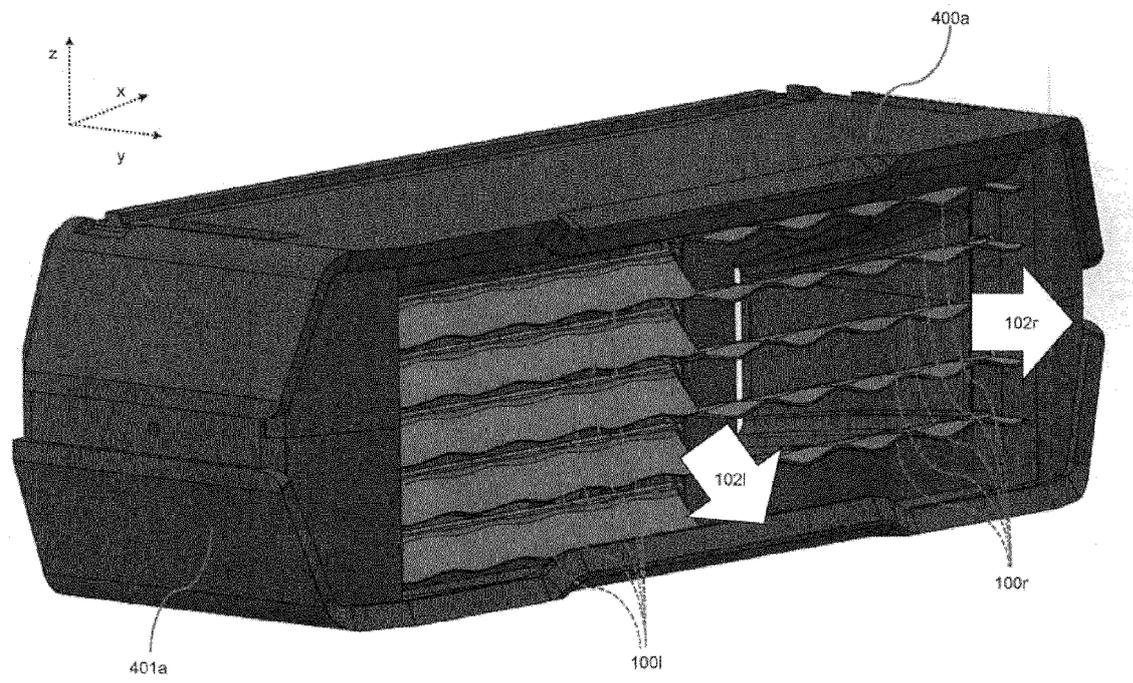
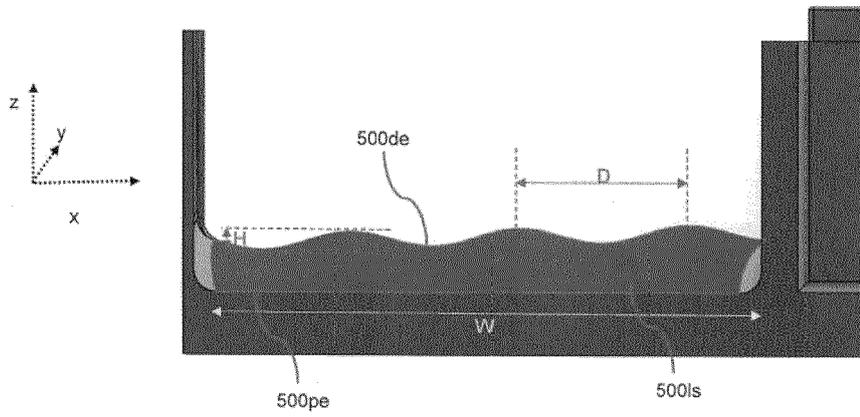
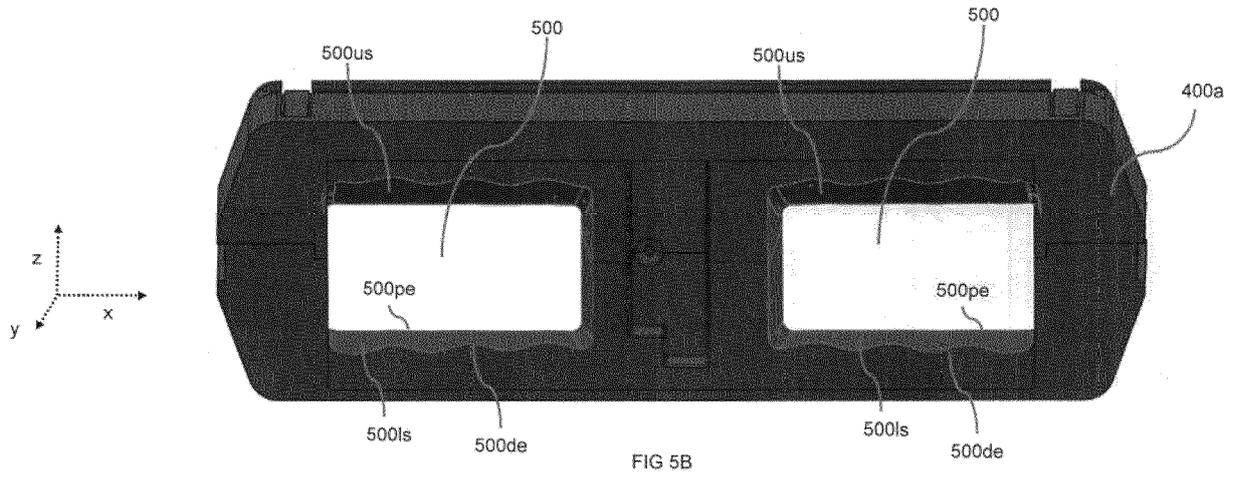
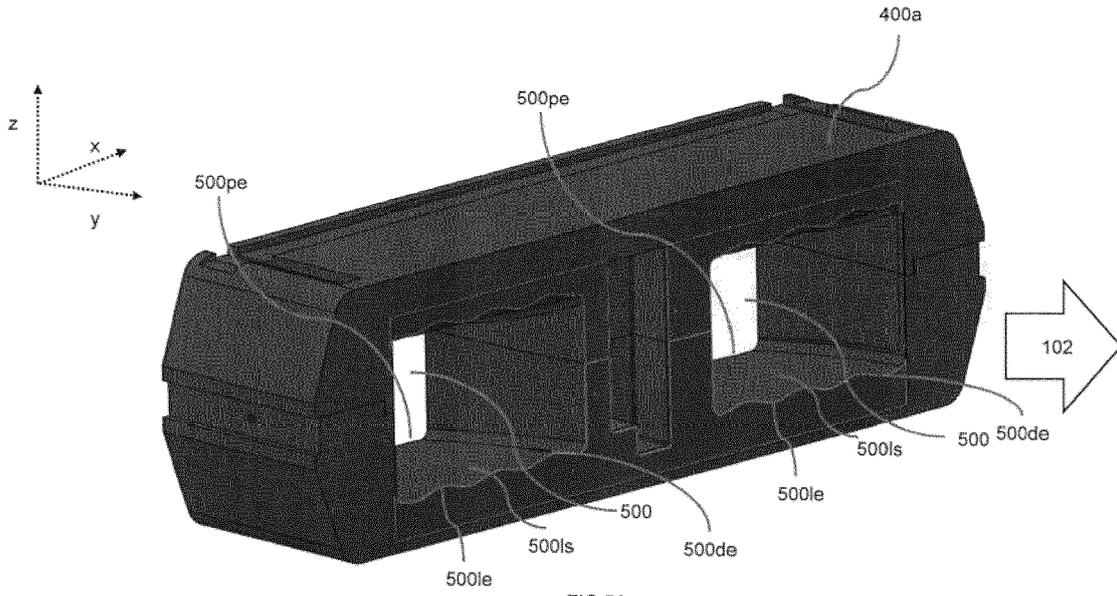


FIG 4B



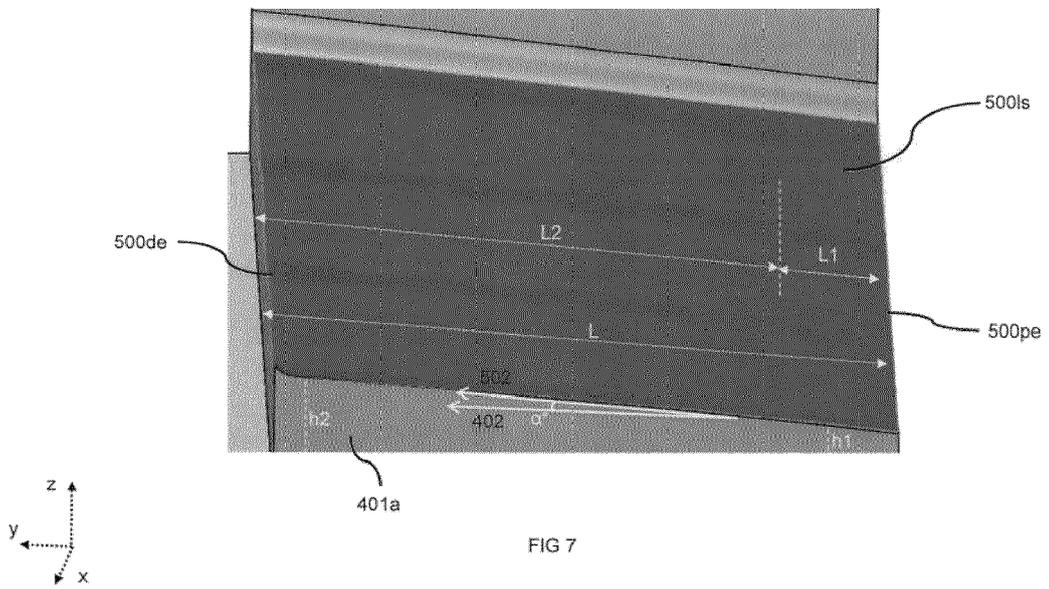


FIG 7