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(54) Title: FLYING CHAMBER FOR WIND TUNNEL AND ASSOCIATED WIND TUNNEL

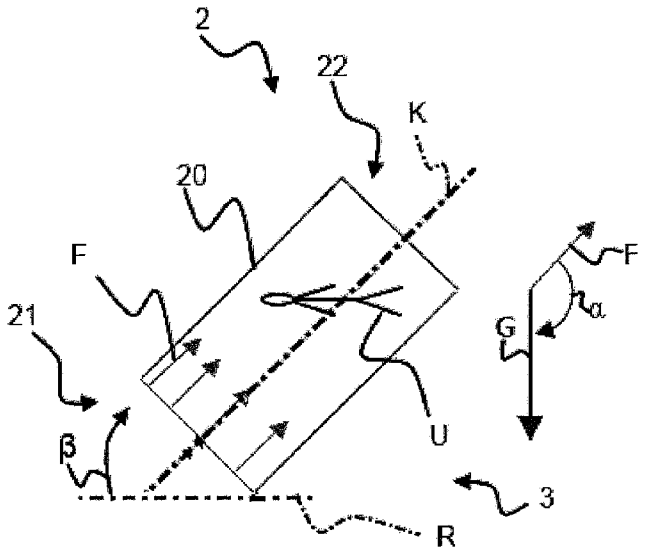

Fig.3B

(57) Abstract: Flying chamber (2) for wind tunnels (1), preferably non- recirculating wind tunnels. The flying chamber (2) comprising a support structure (20) defining an inlet opening (21) and an outlet opening (22), which allow an air flow (F) to flow between them, said inlet opening (21) and outlet opening (22) being substantially aligned along a longitudinal axis (K) of the support structure (20) itself; said support structure (20) having an inner volume that is such as to house a person or user (U), who is going to be hit by the air flow (F). The flying chamber (2) comprising at least one moving device (3), for moving at least one portion of said support structure (20); Said at least one moving device (3) having at least one degree of freedom, moving said at least one portion of said support structure (20) at least around a rotation axis (X). Said rotation axis (X) being perpendicular to said longitudinal axis (K) of the support structure (20).

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TITLE: FLYING CHAMBER FOR WIND TUNNEL AND ASSOCIATED WIND TUNNEL

The invention relates to a flying chamber for a wind tunnel and to an associated wind tunnel, for example a recreational one. Said wind tunnel can be ducted or non-ducted, in particular a non-recirculating wind tunnel, for example a vertical one, which has been improved and simplified.

Wind tunnels are known, for example vertical wind tunnels, which are commonly used for recreational purposes and are adapted to counter the gravitational force of a body through an air flow.

Vertical ducted wind tunnels are known, which have a non-recirculating air flow.

Generally speaking, vertical ducted wind tunnels require a large space. As a matter of fact, besides the flying chamber and an air flow generating device, they also require the implementation of a structure connecting them, which is very large and comprises, for example, diffusers, curved joining portions, exhaust of the generating device, etc.

Generally speaking, the volume of the flying chamber usually takes up less than 10% of the total volume of the wind tunnel.

Furthermore, the flying chambers and the generating devices or fan devices are positioned with a vertical axis, parallel to the gravitational acceleration direction, and are constrained to the remaining elements of the wind tunnel in a hyperstatic manner.

This configuration does not allow any variation of the direction of the air flow, thus not allowing users to simulate all those situations in which the direction of the air flow is not parallel to the direction of the gravitational acceleration.

The solutions comprised in the state of the art do not allow users to simulate and examine, in a simple manner, a generic situation in which a body free falls in the atmosphere and in which the transverse component of the relative body-air speed is other than zero. As a matter of fact, the solutions of the state of art necessarily require an increase of the horizontal size of the flying chamber and, consequently, of the whole wind tunnel.

The object of the invention is to solve all the aforesaid technical problems by providing a flying chamber for a wind tunnel, for example a non-recirculating wind tunnel. The wind tunnel can be ducted or non-ducted.

One aspect of the invention relates to a flying chamber for a wind tunnel having the features set forth in appended claim 1.

A further aspect of the invention relates to a wind tunnel having the features set forth in appended claim 7.

The features and the advantages of the flying chamber and of the wind tunnel according to the invention will be best understood upon perusal of the following description of embodiments of the flying chamber and of the wind tunnel with reference to the accompanying drawings, which respectively show what follows:

- figure 1 shows a recreational vertical wind tunnel, namely a ducted one, with hyperstatic connections between the components, belonging to the state of the art;

- figure 2 shows, in a schematic manner, a wind tunnel according to the invention, in particular in the embodiment of a wind tunnel that is ducted, vertical and non-recirculating;
- figures 3A and 3B show, in a schematic manner, the flying chamber according to the invention in two different operating configurations; in particular, figure 3A shows the flying chamber in a vertical configuration; whereas figure 3B shows the flying chamber in an inclined configuration relative to the vertical axis - the axis along which the gravitational acceleration acts;
- figures 4A, 4B, 4C and 4D show different possible embodiments, used by mere way of example and to be considered as non-limiting, for the creation of the moving devices; in particular, figure 4A shows a first embodiment, in which the degree of freedom is given by a rotation axis of the chamber, the rotation axis is located close to an end, in particular the lower one, of the flying chamber; figure 4B shows a second embodiment, in which the degree of freedom is given by a rotation axis, which is located close to a central portion of the flying chamber; figure 4C shows a third embodiment with different degrees of freedom, in which the flying chamber can be caused to move relative to different axes, for example rotation axes; figure 4D shows a fourth embodiment, in which the degree of freedom is given by a rotation axis of the chamber, which is located close to the lower end of the flying chamber; the latter embodiment being capable of being implemented by means of an articulated parallelepiped;
- figures 5A and 5B show, in a perspective view, a possible embodiment of the ducted non-recirculating wind

tunnel comprising a flying chamber according to the invention; in particular, figure 5A shows the tunnel in a vertical operating configuration of the flying chamber; figure 5B shows the tunnel in an inclined operating configuration of the flying chamber;

- figures 6A and 6B show two possible embodiments of a wind tunnel according to figure 2; in particular, figure 6A shows a wind tunnel in which the fan device is moved with the flying chamber; figure 6B shows a wind tunnel in which the sole flying chamber is moved and there are provided joining elements to connect it to the fan device;

- figure 7 shows, in a perspective view from above, a further embodiment of the non-ducted non-recirculating wind tunnel.

With reference to the aforementioned figures, number 2 indicates a flying chamber as a whole. The flying chamber 2 is especially adapted to be applied to wind tunnels 1. In a possible embodiment, used by mere way of example and to be considered as non-limiting, the wind tunnel 1 is ducted, for example a non-recirculating wind tunnel. In other embodiments, said wind tunnel 1 is non-ducted, for example a non-recirculating wind tunnel. Said flying chamber 2 according to the invention could be applied to other embodiments of a wind tunnel 1.

The flying chamber 2 comprises a support structure 20. The support structure 20 is shaped so as to define an inlet opening 21 and an outlet opening 22, between which an air flow “F” can flow. In particular, said inlet opening 21, when the flying chamber is implemented in a wind tunnel 1 and the latter is operating, allows the air flow “F” to get

into the flying chamber 2, in particular into the volume defined by the support structure 20. In particular, said outlet opening 22, when the flying chamber is implemented in a wind tunnel 1 and the latter is operating, allows the air flow “F” to get out of the flying chamber 2, in particular out of the volume defined by the support structure 20.

Generally speaking, said inlet opening 21 and said outlet opening 22 are substantially aligned along a longitudinal axis “K” of the support structure 20. Said longitudinal axis “K” is defined by the support structure 20. Generally speaking, said longitudinal axis “K”, in a possible definition of its, can be defined as the axis of intersection between the inlet opening 21 and the outlet opening 22.

Said support structure 20 has an inner volume that is such as to house a at least one person or user “U”, who is going to be hit by the air flow “F”, for example to float when he/she is hit by the air flow “F”.

Said support structure can have a substantially cylindrical shape or the shape of a truncated cone, or it can have any other shape, for example the shape of a parallelepiped.

Said flying chamber 2 comprises at least one moving device 3, which is at least adapted to move at least one portion of said support structure 20. In particular, said at least one moving device 3 has at least one degree of freedom, moving at least one portion of said support structure 20. Preferably, said moving device 3 is capable of moving said support structure 20, at least one portion of said support structure 20, causing at least one portion

of said flying chamber 2 to rotate around a rotation axis "X". Said rotation axis "X" preferably is perpendicular to said longitudinal axis "K" of the support structure 20.

For the purposes of the description, the expression "at least one degree of freedom" implies the possibility of moving at least one portion of the support structure 20 and/or of the flying chamber 2 relative to at least one rotation axis "X".

The moving of the support structure 20 - or at least of a part thereof - by at least one moving device 3 could be such as to change the alignment between the inlet opening 21 and the outlet opening 22. In a possible embodiment, the moving of the support structure 20 - or at least of a part thereof - by at least one moving device 3 could be such as to change the alignment of the longitudinal axis "K" of the support structure 20 relative to a vertical axis corresponding to the gravitational acceleration axis. In these possible embodiments, the moving of the support structure 20 is such as to misalign said longitudinal axis "K" and/or said inlet opening 21 and/or said outlet opening 22 relative to the vertical axis. In a further possible embodiment, the moving of the support structure 20 - or at least of a part thereof - by at least one moving device 3 could be such as to move one or more deflectors 23 so as to change their alignment relative to the vertical axis.

This degree of freedom that can be obtained by the moving device 3 allows the air flow "F", which is initially vertical, to change its direction while flowing through the flying chamber 2, in particular while flowing between said inlet opening 21 and said outlet opening 22 of the support

structure 20. Therefore, the flying chamber 2 according to the invention, thanks to the obtained degree of freedom, allows changing the direction of the air flow "F", for example until it is completely horizontal in a possible embodiment of the flying chamber 2 according to the invention, moving at least one portion of the support structure 20.

In a first preferred - though non-limiting - embodiment, said moving device 3 is capable of moving the entire support structure 20. In a second preferred - though non-limiting - embodiment, said moving device 3 is capable of only moving part of the support structure 20, for example the outer walls of the support structure and one of said openings (21, 22).

In a further embodiment, used by mere way of example and to be considered as non-limiting, said moving device 3 is capable of only moving part of the support structure 20, for example deflectors 23.

In a possible embodiment, used by mere way of example and to be considered as non-limiting, said moving device 3 comprises: a support element 31, which is rigidly constrained to at least one portion of said support structure 20; at least one actuator device 32, which is adapted to move said support element 31; and a fixed structure 33, which is adapted to support said actuator device 32. Said support element 31 is adapted to move relative to said fixed structure 33. The constraint between the support element 31 and said at least one portion of the support structure 20 can be direct or by means of a joining element 5.

Generally speaking, the moving device 3 is capable of moving at least one portion of said support structure 20 in a direct manner, by directly acting upon the support structure, or in an indirect manner by means of a joining element 5.

In a possible embodiment, used by mere way of example, said support element 31 and said fixed structure 33 are constrained to one another by means of a hinge system, in particular with one or more hinges. Figures 4A-4D schematically show possible embodiments using hinge systems, sliding and/or rotating ones, made with different degrees of manufacturing complexity.

In a first embodiment, used by mere way of example and to be considered as non-limiting, said support element 31 and said fixed structure 33 are constrained to one another, so that said support element 31 rotates around a rotation axis “X”, which is perpendicular to said longitudinal axis “K”, but parallel to a reference plane “R”.

Said reference plane “R” is, for example, a plane that is perpendicular to the vertical axis defining the gravitational acceleration “G”.

In a possible embodiment of the invention, said support element 31 and said fixed structure 33 are constrained to one another by means of an element with more than one degree of freedom, for example an articulated arm. Figure 4C shows a possible embodiment of the flying chamber 2, which comprises at least one moving device 3 comprising different degrees of freedom.

In a possible embodiment, used by mere way of example and to be considered as non-limiting, said support element 31 and said fixed structure 33 are constrained to one

another by means of said actuator device 32, as you can see, for example, in figure 4D, where said actuator device 32 is a piston.

In a further possible embodiment, used by mere way of example and to be considered as non-limiting, said support element 31 is capable of moving, for example by sliding, along an axis that is perpendicular to both said longitudinal axis "K" and said rotation axis "X", for example it is capable of sliding along an axis that is parallel to the reference plane "R", as you can see in figure 4D, where the support structure 20 is made as an articulated parallelepiped or another geometric shape.

Figure 2 schematically shows a possible embodiment of a wind tunnel 1 according to the invention. In the embodiment shown, the wind tunnel is ducted, vertical and non-recirculating.

Figures 3A, 3B schematically show the flying chamber in two different operating configurations, with different angles between the direction of the air flow "F" and the direction of the gravitational acceleration "G". In particular, figure 3A shows the flying chamber in a vertical configuration, in which a first angle "α" is approximately equal to 180°, the directions of the air flow "F" and of the gravitational acceleration "G" being substantially coinciding, but with opposite senses.

Figure 3D shows the flying chamber in an inclined configuration, in which there is a first angle "α" smaller than 180°, for example around 120°, between the direction of the air flow "F" and the direction of the gravitational acceleration "G". In the configuration shown in the drawing, the direction of the air flow "F" is no longer

equal to or substantially coinciding with the direction of the gravitational force “G”.

For the purposes of this description, said first angle “α” is the angle subtended between the direction of the air flow “F” and the direction of the gravitational acceleration “G”, taking into account the respective senses.

Figure 3B shows how the flying chamber 2 - or at least a portion thereof - immediately has an inclination relative a reference plane “R”, rotating around a rotation axis “X”, which is perpendicular to the longitudinal axis “K”. The inclination angle of the flying chamber 2 relative to said reference plane “R” is indicated by a second angle “β”.

For the purposes of this description, said second angle “β” is the angle subtended between the reference plane “R” and at least one portion of the flying chamber 2.

Figures 4A, 4B, 4C and 4D show different possible embodiments, used by mere way of example and to be considered as non-limiting, for the creation of the moving devices 3; in particular, figure 4A shows a first embodiment, in which the rotation axis “X” of the chamber is located close to an end of the flying chamber 2, in particular of the support structure 20. In this embodiment, the moving device 3 is obtained by means of a hinge. In a possible embodiment, said support element 31, by means of an actuator device 32, rotates relative to the rotation axis “X”, while the fixed structure 33 remains substantially parallel to the reference plane “R”.

In the embodiment shown in figure 4B, the rotation axis “X” is located close to a central portion of the flying chamber 2, in particular of the support structure 20. In this embodiment, the support element 31 surrounds the support structure 20 of the flying chamber 2 in a central portion thereof. Said support element 31, by means of the actuator device 32, is capable of

rotating around the rotation axis “X”, the axis along which at least part of the fixed structure 33 extends. In a possible embodiment, said support element 31, by means of an actuator device 32, is capable of rotating relative to an axis “X”, which coincides with, or is at least parallel to, the longitudinal axis of the fixed structure 33.

In the embodiment shown in figure 4C, by means of a more complex moving device 3, for example an articulated arm, the flying chamber 2 can be caused to move relative to different rotation axes. Said rotation axes can be parallel to the reference plane “R” and/or perpendicular to the reference plane “R”. In a possible embodiment, there are provided different actuator devices 32, which are adapted to move said support element 31 relative to the fixed structure 33. In particular, said actuator devices 32 are adapted to move said support element 31 relative to different rotation axes, for example for each degree of freedom of the moving device 3 there is provided a respective actuator device 32.

In the embodiment shown in figure 4D, you can see an embodiment in which said support element 31 is capable of making a linear movement relative to said fixed structure 33, for example shifting or sliding, so as to allow a wall, or at least a portion, of the support structure 20 of the flying chamber 2 to slide.

Said support element 31 is moved by means of a linear actuator device 32, such as a piston, for example a hydraulic piston.

If necessary, said support element 31, in its linear movement, is capable of moving part of the support structure 20, for example an opening between the inlet opening 21 and the outlet opening 22, thus deforming the support structure 20. A possible implementation of this embodiment could involve the creation of a flying chamber 2

shaped like an articulated parallelepiped, which is capable of having some of its corners rotate at least relative to parallel rotation axes “X”, for example in the area of the junctions between the corners of the support structure 20. In this last embodiment, it could be necessary to provide a support structure 20 with yielding and/or deformable portions and/or with hinges, so as to allow the conformation of the chamber 2 to be changed.

As already mentioned above, said flying chamber 2 is adapted to be applied to a wind tunnel 1. Hereinafter you can find a description of possible embodiments of the wind tunnel 1, used by mere way of example and to be considered as non-limiting.

In a possible embodiment of the wind tunnel 1, there are provided joining elements 5, for example yielding or supporting means, which are adapted to properly connect said flying chamber 2 and said fan device 4 even when said flying chamber 2 is moved by said moving mechanism 3.

Figure 5A shows, in a perspective view, a possible embodiment of a ducted non-recirculating wind tunnel 1, comprising a flying chamber 2 according to the invention, in a vertical configuration thereof. The flying chamber 2, which is shown by mere way of non-limiting example, has, in its upper part of the support structure 20, a substantially cylindrical conformation. Furthermore, in the end part of the chamber 2, close to the outlet opening 22, the support structure is made of a transparent material, such as for example plexiglas. In the lower part of the support structure 20 there is connected a joining element 5, which is properly shaped so as to be connected between the flying chamber 2 and the fan devices 4. In this embodiment, used

by mere way of example and to be considered as non-limiting, there are two fan devices 4, which are arranged along the same axis and are properly designed to both direct a flow of air towards the flying chamber 2. In this embodiment, the moving device 3 is adapted to only move the flying chamber 2, whereas the fan devices 4 are not subjected to the moving. In particular, the moving device 3 is adapted to move the entire support structure 20.

As you can see in figure 5B, the moving system 3 is adapted to cause the flying chamber 2 to rotate relative to a rotation axis "X", which coincides with the axis along which the fan devices 4 are arranged. In this embodiment, the support element 31 is constrained to at least one portion of said support structure 20 by means of said joining element 5. Furthermore, the actuator device 32, which is adapted to move said support element 31, is not visible, as it is hidden by the fixed structure 33. The fixed structure is further connected to the support structure, to which the fan devices 4 are fixed.

Generally speaking, a wind tunnel 1 comprises a fan device 4, which is adapted to produce an air flow to be introduced into the wind tunnel 1. The wind tunnel 1 comprises a flying chamber 2 according to the invention.

In a possible embodiment, the wind tunnel 1 is such that said flying chamber 2 is directly connected, in cascade connection, to said fan device 4, as you can see for example in figure 2. This embodiment does not comprise components such as diffusers, curved joining portions, exhaust pipe of the generating device, etc., which are instead comprised in the wind tunnel according to the prior art shown in figure 1.

In a possible embodiment, said moving device 3 is adapted to move said fan device 4 in a coordinated manner with said flying chamber 2, for example as one single piece.

Figure 6A shows an embodiment in which said moving device 3 comprises a support element 31, to which said wind tunnel 1 is fixed.

According to the embodiment shown in the drawing, the moving device 3 is made in such a way that the rotation axis “X” is located close to an end of the flying chamber 2, in particular of the support structure 20. In particular, the support element is located at an end of the support structure 20, for example close to the junction between the flying chamber 2 and the fan device 4.

The moving device 3 comprises an actuator device 32, which is capable of moving the support element 31 and, as a consequence, the entire wind tunnel 1 relative to the fixed structure 33. For example, this embodiment can have a rotation axis “X” located in an area defined between the flying chamber 2 and the fan device 4. In this embodiment, the actuator device 32 is capable of moving said support element 31, moving the flying chamber 2 and the fan device 4. In this embodiment, the flying chamber 2 and the fan device 4 are fixed to one another in a hyperstatic manner, so as to allow one single moving device 3 to move them both, together.

In a possible alternative embodiment of the wind tunnel 1, there are provided joining elements 5, for example yielding or supporting means, which are adapted to properly connect said flying chamber 2 and said fan device

4 when said flying chamber 2 is moved by said moving mechanism 3.

In a possible embodiment, said joining elements 5 are made, for example, by means of bellows portions, which are adapted to deform accordingly to the positioning variations of the flying chamber 2, relative to the fan device 4. Figure 6B shows an embodiment in which the moving device 3 is adapted to only move the flying chamber 2, whereas the fan device 4 is not subjected to the moving. According to the embodiment shown in the drawing, the moving device 3 is made in such a way that the rotation axis "X" is located close to an end of the flying chamber 2, in particular of the support structure 20. The flying chamber 2 and the fan device 4 are connected to one another by means of bellows joining elements 5. In the same embodiment, said moving device 3 comprises a support element 31, to which said flying chamber 2 is fixed, in particular the sole flying chamber 2. The same moving device 3 comprises an actuator device 32, which is capable of moving the support element 31 and, as a consequence, the sole flying chamber 2. In this embodiment, besides the fixed structure 33, also the fan device 4 is not moved relative to the flying chamber 2.

Said moving system 3 can comprise a control system. Said control system comprises at least one processing system, which is capable of controlling the position of the flying chamber 2 relative to a reference position, for example said reference plane "R". Said control system, by means of one or more sensors, is capable of determining the inclination of the flying chamber 2, for example determining said first angle "α" and/or said second angle "β". Therefore, said control system is capable of

configuring the flying chamber 2 in order to obtain the desired inclination or move it back to a vertical configuration, depending on the needs. Hence, the moving of the flying chamber 2 can be controlled by said control system by properly operating said at least one actuator device 32.

Said control system can comprise a user interface, which is capable of enabling the management of the inclination of the flying chamber 2. In a possible embodiment, said user interface allows the user to at least decide when to move the flying chamber 2 in order to incline it or take it back to a vertical configuration. In a further embodiment, the user is capable of positioning said flying chamber 2 at a desired inclination angle, through the interaction with said user interface, changing the inclination angle of the air flow “F” during the flying simulation, so as to allow people or users “U” to simulate different flying configurations during the same flying simulation.

Figure 7 shows a further embodiment of the wind tunnel 1, which is a non-ducted non-recirculating wind tunnel. In this embodiment, the fan device 4 is located in a lower position of the flying chamber 2. Said flying chamber 2 has the shape of a truncated cone, in which the inlet opening 21 has a smaller diameter than the outlet opening 22.

The flying chamber shown in figure 7 comprises a plurality of deflectors 23, which are arranged in an array, thus creating a grid, through which the air flow can flow.

Said plurality of deflectors are preferably arranged close to the inlet opening 21.

In this embodiment, the moving device 3 is capable of moving said deflectors 23 of the flying chamber 2. Said deflectors are moved accordingly to one another, so as to change the direction of the air flow "F" flowing through the flying chamber 2. In particular, said moving device 3 is capable of moving said deflectors by causing them to at least rotate around axes that are parallel to the axis "X". In a possible embodiment, used by mere way of example and to be considered as non-limiting, said moving device 3 is capable of moving said deflectors by causing them to rotate around the vertical axis, for example causing a rotation of the structure supporting them around the axis "K" of the flying chamber 2.

Generally speaking, as already mentioned above, the area in which the flying experience takes place is called flying chamber 2. According to the invention, the flying chamber 2 is free at least in a portion thereof, so that it is free at least in its rotation around at least one axis, for example perpendicular to the axis "K". As a matter of fact, in the solutions of the prior art shown in figure 1, the flying chamber is usually arranged so as to have a vertical axis, namely parallel to the direction of the gravitational acceleration, normally constrained in a hyperstatic manner to the remaining parts of a wind tunnel 1, thus not allowing any variation of the direction of the air flow "F".

Therefore, the wind tunnel 1 according to the invention, which is vertical, ducted or non-ducted and non-recirculating, is simpler compared to the solutions of the prior art, for example because of its construction.

In a possible embodiment, used by mere way of example and to be considered as non-limiting, as the wind tunnel is non-recirculating, it does not need an air conditioning system. In this last embodiment, the wind tunnel is free from systems for the recovery of the kinetic energy of the blown air, which gets lost, thus further simplifying its construction.

The flying chamber 2 according to the invention is at least capable of rotating, at least a part thereof, around an axis that is perpendicular to the vertical axis - direction of the gravitational acceleration -, for example around a rotation axis "X", thus allowing simulating and examining all those flying situations in which the direction of the air flow "F" is not parallel to the direction of the gravitational acceleration "G".

The flying chamber 2 according to the invention allows simulating, without interruptions, the transition from a pure vertical free fall simulation to a flying simulation in which the transverse speed component is other than zero, defined as tracking.

The flying chamber 2 according to the invention allows examining the interaction between the air flow "F" and the shape, size and posture of a body in order to optimize the horizontal thrust.

The flying chamber 2, according to the invention, allows simulating and examining, in a simple manner, a generic situation in which a body free falls in the atmosphere and in which the transverse component of the relative body-air speed is other than zero. This solution allows refraining from using, unlike the state of the art, larger horizontal sizes of the flying chamber.

The flying chamber according to the invention allows training one or more people or users "U" for a horizontal free fall, also known as forward tracking.

The flying chamber 2 according to the invention allows testing wingsuits and, at the same time, training people in the use of said wingsuits.

These and other numerous advantages and/or possible use applications of a flying chamber according to the invention in a wind tunnel can clearly be identified by a person skilled in the art in the light of this description and of the accompanying drawings.

Wind tunnels 1 comprising a flying chamber 2 like the one described above will have all the advantages and the applications described above.

In particular, the flying chamber 2 according to the invention can be applied to vertical wind tunnels 1 and free fall simulators for parachutists for recreational, professional or training purposes. The same solution can be applied to simulations devices known as indoor skydiving devices.

NUMERICAL REFERENCES

Wind tunnel	1
Flying chamber	2
Support structure	20
Inlet opening	21
Outlet opening	22
Deflectors	23
Moving devices	3

Support element	31
Actuator device	32
Fixed structure	33
Fan device	4
Joining elements	5
Air flow	F
Gravitational acceleration	G
Longitudinal axis	K
Reference plane	R
Person or user	U
First angle	α
Second angle	β
Rotation axis	X

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CLAIMS:

1. Flying chamber (2) for wind tunnels (1), preferably non-recirculating wind tunnels;

said flying chamber (2) comprising a support structure (20) defining an inlet opening (21) and an outlet opening (22), which allow an air flow (F) to flow between them, said inlet opening (21) and outlet opening (22) being substantially aligned along a longitudinal axis (K) of the support structure (20) itself;

said support structure (20) having an inner volume that is such as to house a person or user (U), who is going to be hit by the air flow (F);

said flying chamber (2) comprising at least one moving device (3), for moving at least one portion of said support structure (20);

said at least one moving device (3) having at least one degree of freedom, moving said at least one portion of said support structure (20) at least around a rotation axis (X);

said rotation axis (X) being perpendicular to said longitudinal axis (K) of the support structure (20).

2. Flying chamber according to claim 1, wherein said moving device (3) comprises:

- a support element (31), rigidly constrained to at least one portion of said support structure (20);
- an actuator device (32), for moving said support element (31);
- a fixed structure (33), for supporting said actuator device (32).

3. Flying chamber according to claim 2, wherein said support element (31) and said fixed structure (33) being constrained to one another by means of a hinge.

4. Flying chamber according to claim 2, wherein said support element (31) and said fixed structure (33) being constrained to one another by means of an articulated arm.

5. Flying chamber according to claim 2, wherein said support element (31) and said fixed structure (33) being constrained to one another by means of said actuator device (32).

6. Flying chamber according to claim 2 or 5, wherein said support element (31) is able to move along an axis that is perpendicular to both said longitudinal axis (K) and said rotation axis (X); wherein the support structure (20) is manufactured as an articulated parallelepiped.

7. Non-recirculating wind tunnel (1) comprising:

- a fan device (4), for producing an air flow to be introduced into the wind tunnel;

characterized in that said wind tunnel comprises a flying chamber (2) according to any of the claims from 1 to 6.

8. Wind tunnel according to claim 7, wherein said flying chamber (2) is directly connected, in cascade connection, to said fan device (4).

9. Wind tunnel according to claim 8, wherein said moving device (3) is adapted to move said fan device (4) in a coordinated manner with said flying chamber (2), for example as one single piece.

10. Wind tunnel according to claim 8, wherein there are provided joining means (5), to properly connecting said flying chamber (2) and said fan device (4) when said flying chamber (2) is moved by said moving mechanism (3).

11. Wind tunnel according to claim 10, wherein said joining means (5) are made by means of bellows portions.

12. Wind tunnel according to any of the claims 7-11, wherein said wind tunnel is ducted.

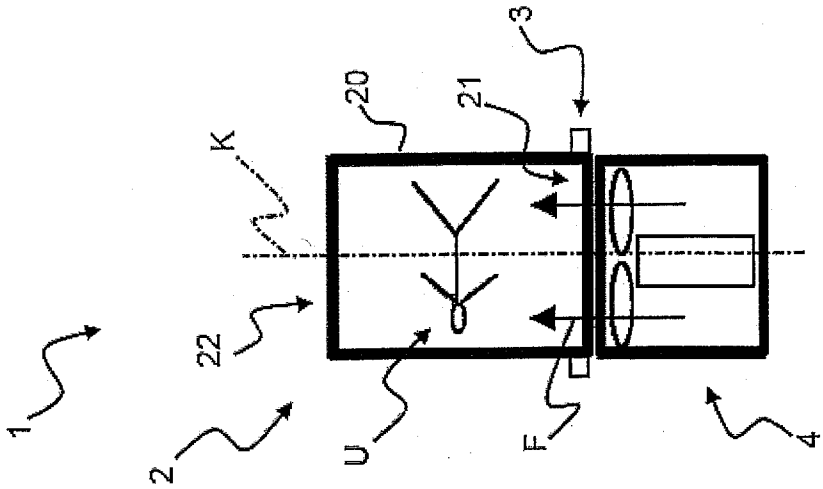

Fig.2

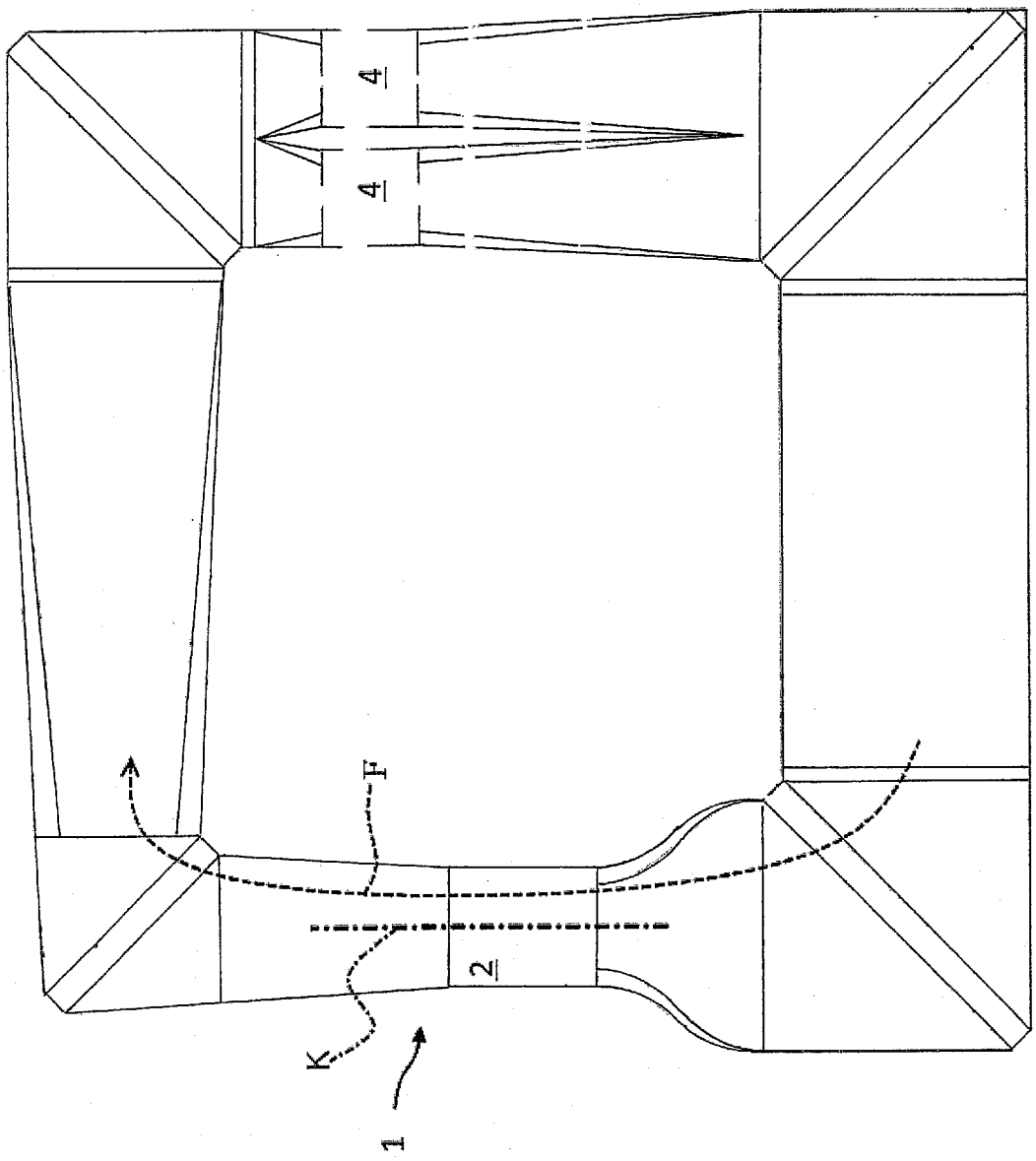

Fig.1

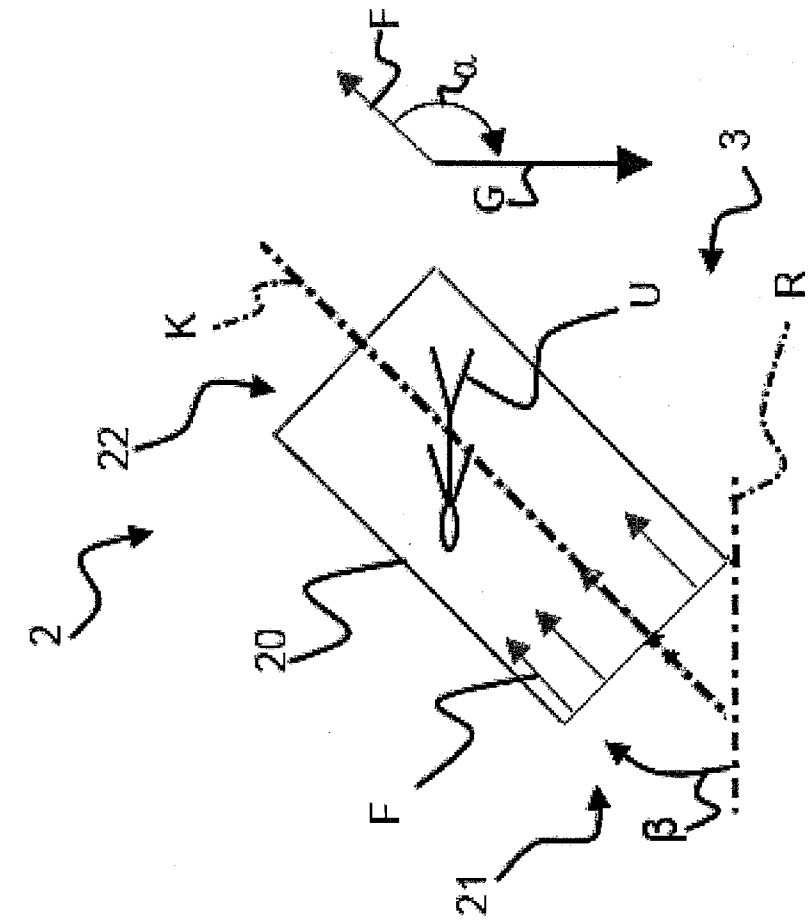

Fig.3B

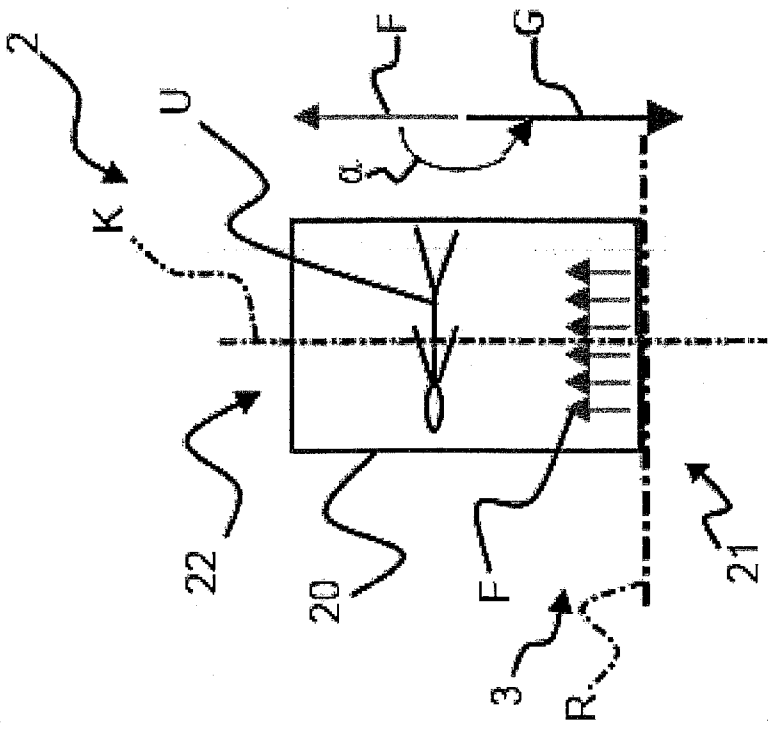

Fig.3A

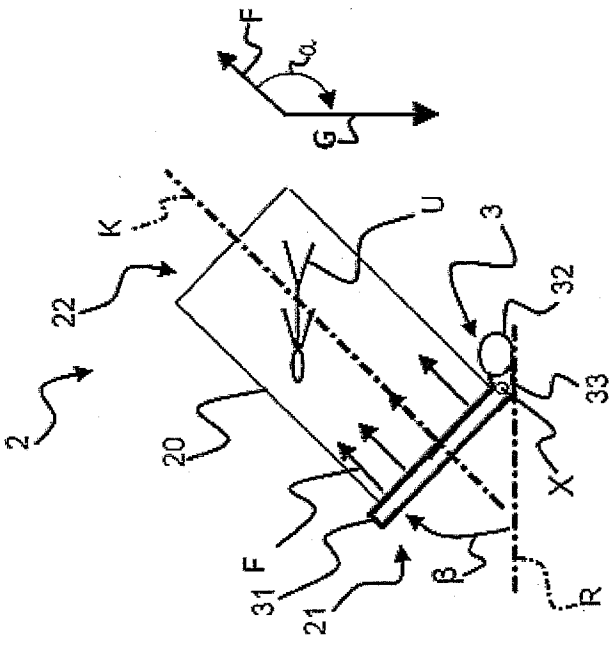

Fig.4A

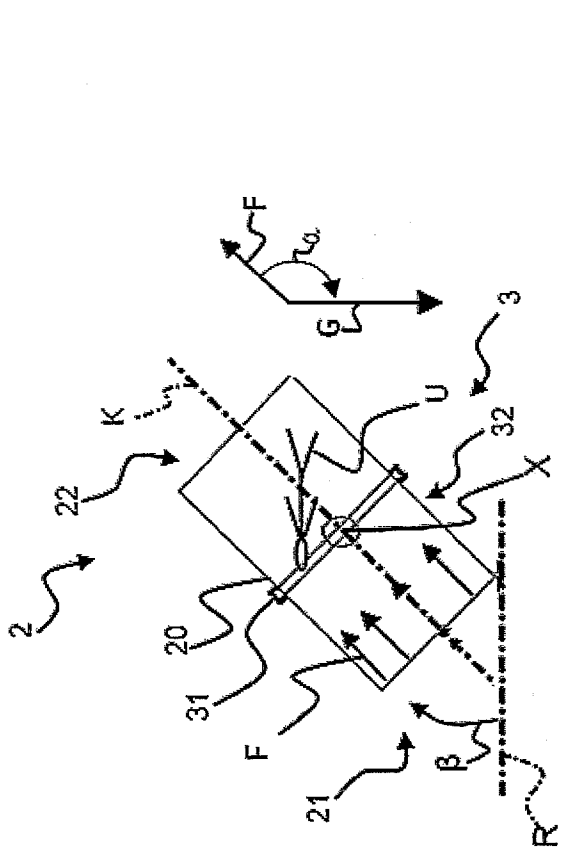

Fig.4B

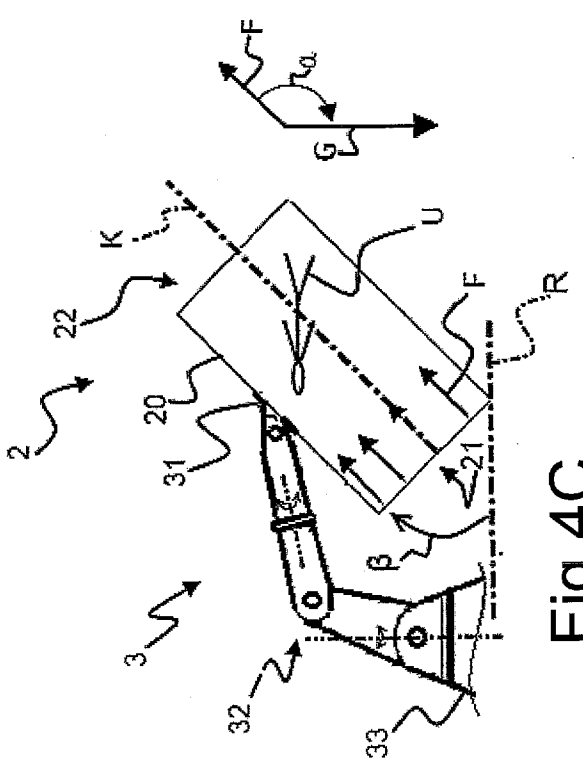

Fig.4C

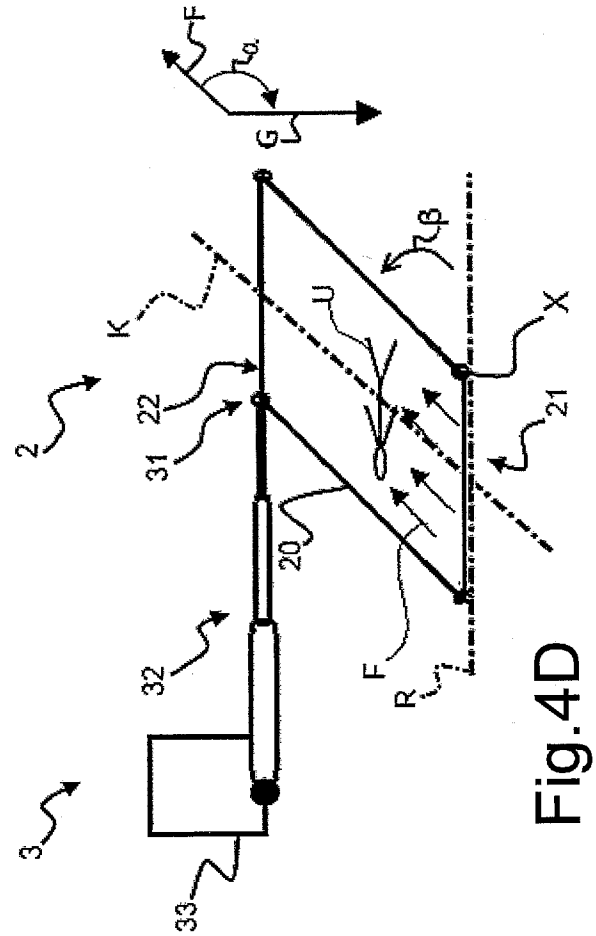

Fig.4D

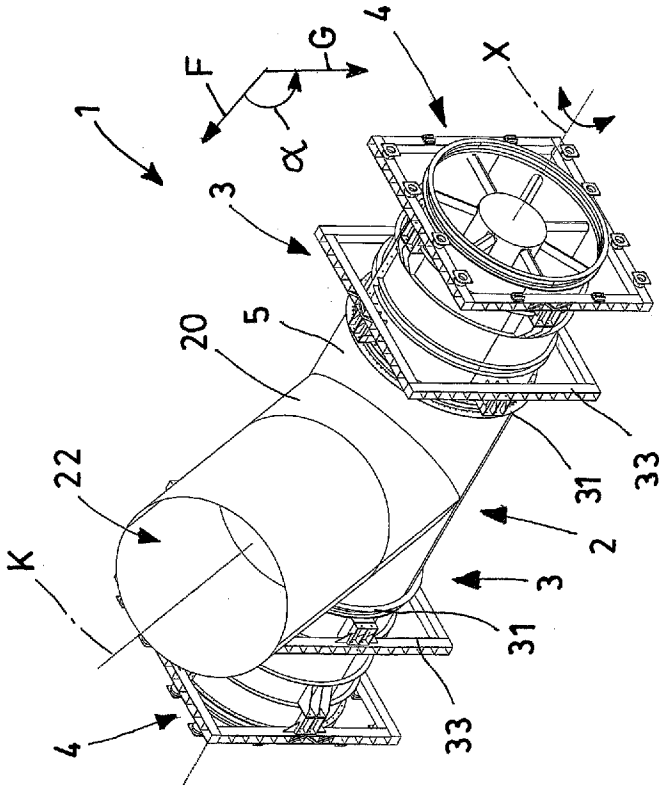

Fig.5B

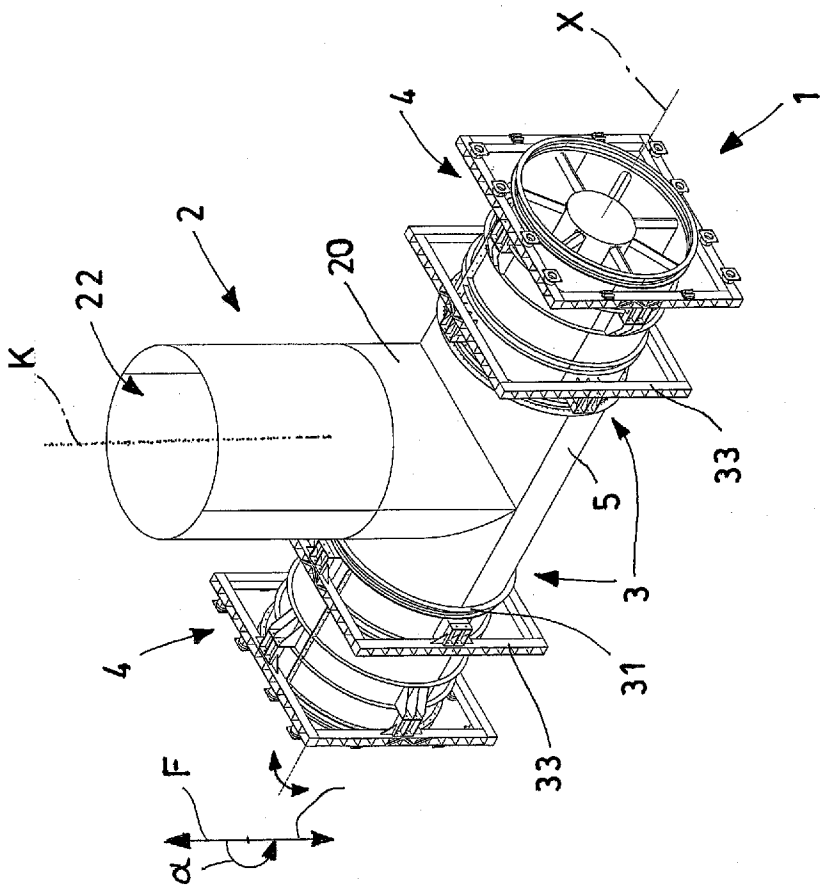

Fig.5A

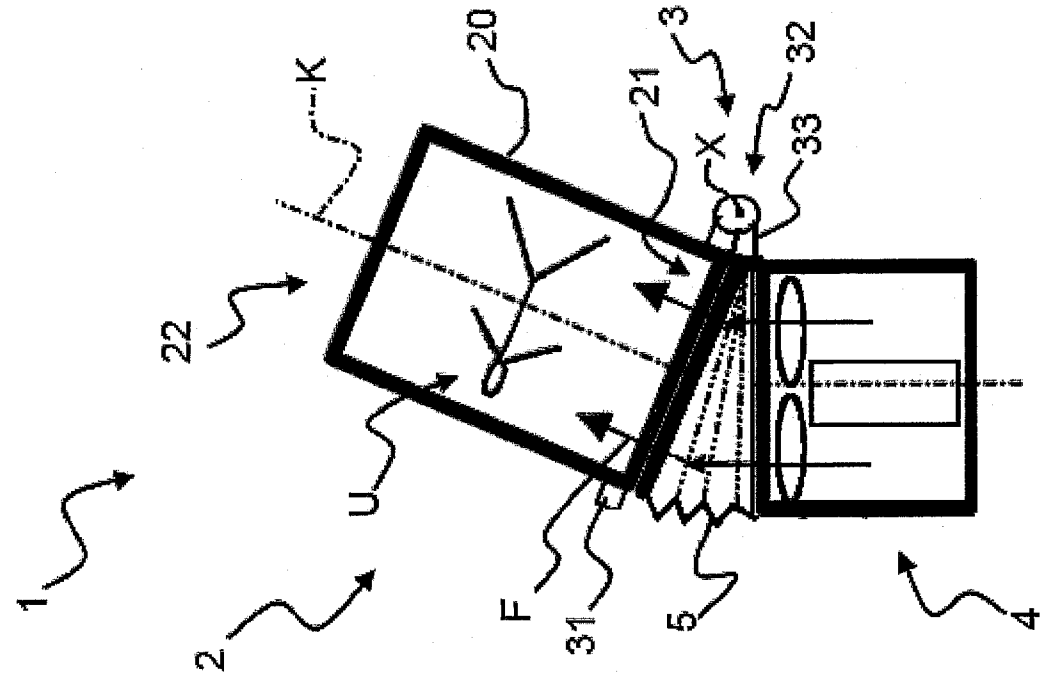

Fig.6B

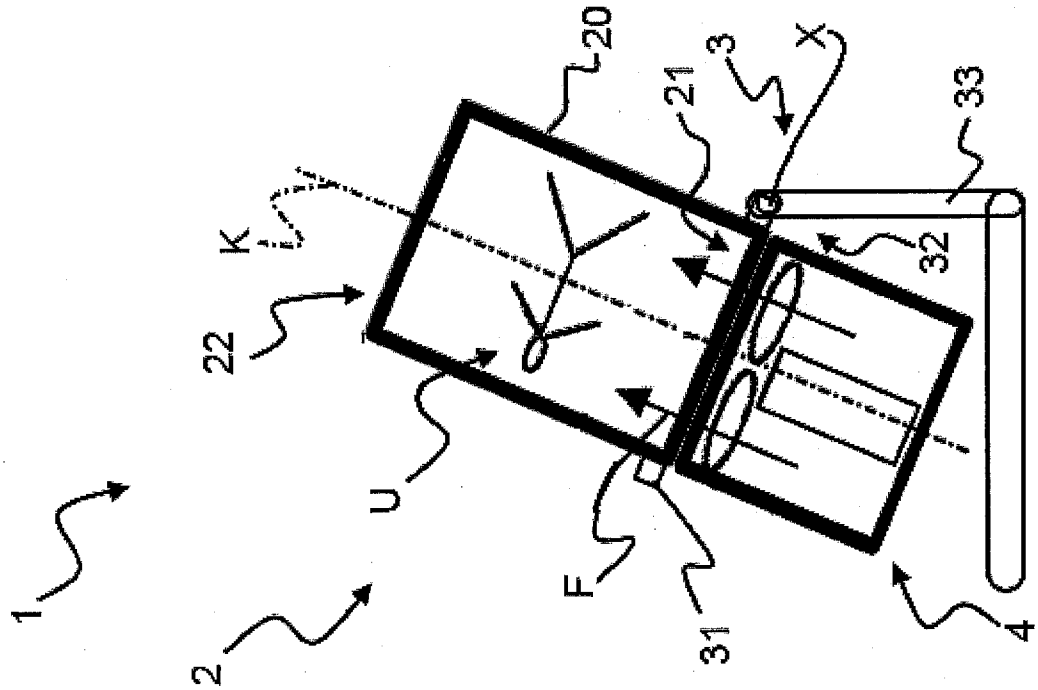

Fig.6A

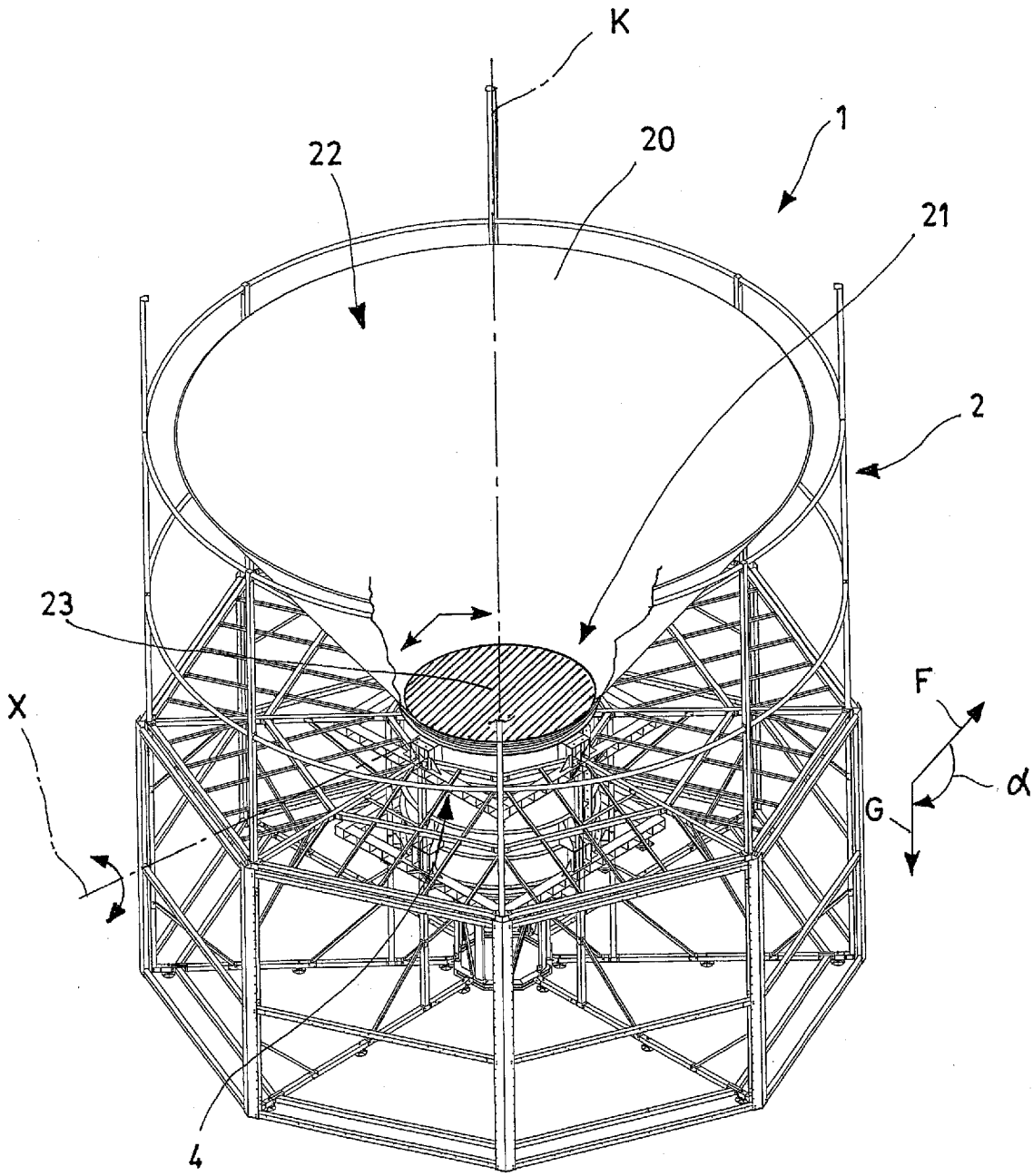

Fig.7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/057553

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01M9/04 A63G31/00 B64D23/00
ADD.

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)
G01M A63G B64D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 593 352 A (METHFESSEL HARLEY A J [US] ET AL) 14 January 1997 (1997-01-14) column 3, line 50 - column 13, line 5; figures 1-8	1-12
X	WO 2014/007600 A1 (ZVJAGINS IGORS [LV]) 9 January 2014 (2014-01-09) abstract; figures 1-6	1-12
A	DE 618 471 C (BRUNO ECK DR ING) 9 September 1935 (1935-09-09) the whole document	1-12
A	GB 2 288 772 A (HUGHES LEE [NZ]) 1 November 1995 (1995-11-01) the whole document	1-12

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 March 2017	22/03/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gruss, Christian

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/057553

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 699 278 A1 (SARDOU MAX [FR]) 17 June 1994 (1994-06-17) the whole document -----	1-12
A	WO 02/076829 A1 (LEE SUNG TAEE [KR]; PARK BYUNG HO [KR]) 3 October 2002 (2002-10-03) the whole document -----	1-12

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2016/057553

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5593352 A	14-01-1997	NONE	
WO 2014007600 A1	09-01-2014	NONE	
DE 618471 C	09-09-1935	NONE	
GB 2288772 A	01-11-1995	NONE	
FR 2699278 A1	17-06-1994	NONE	
WO 02076829 A1	03-10-2002	JP 2004519730 A	02-07-2004
		KR 20020074902 A	04-10-2002
		US 2003113695 A1	19-06-2003
		WO 02076829 A1	03-10-2002