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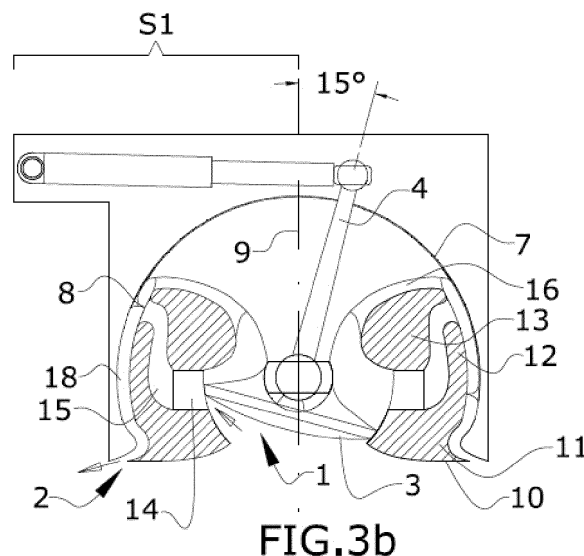
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(54) **PROPULSION DEVICE**

(57) Propulsion device comprising a rotor (14), a stator (15), an outer casing (6), a first base (10) with a central inlet opening (1) configured for fluid intake, and an outlet opening (2) configured for expulsion of propulsive fluid in the form of an outlet jet. The outlet opening (2) is located along the entire perimeter of the propulsion device, wherein the propulsion device comprises: a central valve (3) configured, by means of tilting means, to tilt with a

given direction and tilt angle, thereby regulating a flow rate of a fluid inlet jet and a direction of the fluid inlet jet towards a given sector of the propulsion device, and; a perimeter valve (7) configured, by means of tilting means, to tilt with a given direction and angle of tilt, thus regulating a flow rate of the fluid outlet jet and a direction of the fluid outlet jet towards a given sector of the perimeter outlet opening (2).



**FIG.3b**

## Description

### Purpose of the invention

[0001] The present invention has as object a propulsion device for rapidly varying the direction of thrust for the propulsion of boats.

[0002] The propulsion device subject of the present invention can facilitate the implementation of USV (*Unmanned Surface Vehicles*) in closed environments such as harbours or perform precision manoeuvres.

[0003] The propulsion device object of the present invention has application in the field of Marine Engineering and, more specifically, in the industry dealing with the design, manufacture, marketing and operation of propulsion devices for various types of vessels, both surface and underwater.

### Background of the invention and technical problem to be solved

[0004] Marine thrusters of Voith-Schneider type are known in the state of the art. These thrusters comprise a set of rotating propellers or blades mounted on a disc. Above the disc is the motor that produces the propellers' translational movement (through the rotation of the disc). Also, above the disc is a set of two perpendicular pistons, connected to a set of connecting rods that allow the coordinated turning of the propellers, allowing them to vary the angle of attack on the water in their translational movement. By varying the angle of attack, the water is propelled through the propellers in the desired direction at any angle from 0° to 360°, thus steering and propelling the ship and varying its direction by means of a single device.

[0005] The Voith-Schneider propeller has a limitation due to the cycloidal motion of the propellers. In propellers, the inboard and outboard sides of each blade reverse their position twice per revolution, going from being on the inside to the outside and vice versa; this results in a tendency to cavitation which forces the thruster to rotate with a limited RPM value and develop a slower sailing speed. This situation results in a practical limitation of the thruster rotational speed, if cavitation effects on the top surface of the downstream propeller in the direction of propulsion are to be avoided.

[0006] A thruster of the type disclosed in US 2010/0267295 A1 is also currently known. It is an azimuth thruster that allows the jet to be directed along 360° of its perimeter. A disadvantage of this type of thruster is that, in order to vary the thrust direction by 180°, the thrust jet must pass through all intermediate positions/angles. This can lead to inaccuracies when manoeuvring a boat with this type of thruster, which may call for additional manoeuvres to correct the boat's course.

## Description of the invention

[0007] In order to remedy the aforementioned drawbacks, the present invention relates to a propulsion device.

[0008] The propulsion device object of the present invention comprises a rotor, a stator, an outer casing, a first base with a central inlet opening configured for fluid intake, and an outlet opening configured for expulsion of propulsive fluid in the form of an outlet jet.

[0009] The aforementioned characteristics of the propulsion device object of the present invention are consistent with those of a propulsion device known in the state of the art such as the propulsion device disclosed in US 2010/0267295 A1.

[0010] The propulsion device object of the present invention presents a novel configuration that avoids the drawbacks mentioned with respect to the propulsion device US 2010/0267295 A1. Thus, in a novel manner, in the propulsion device object of the present invention, the outlet opening is located along the entire perimeter of the propulsion device.

[0011] Additionally, in a novel manner, the propulsion device object of the present invention comprises:

- a central valve configured, by means of tilting means, to tilt with a given direction and angle of tilt, thereby regulating a flow rate of a fluid inlet jet and a direction of the fluid inlet jet towards a certain sector of the propulsion device, and;
- a perimeter valve configured, by means of tilting means, to tilt with a given direction and tilt angle, thus regulating a flow rate of the fluid outlet jet and a direction of the fluid outlet jet towards a certain sector of the perimeter outlet opening.

[0012] Thus, as can be seen, the propulsion device object of the present invention does not need to redirect an outlet opening each time it is desired to vary the thrust/propulsion direction, passing through each and every position along the circumferential arc separating the initial propulsion direction from the desired propulsion direction.

[0013] The propulsion device of the present invention can simply swivel the central valve and the perimeter valve to regulate both the inlet and outlet flow rates, as well as the directions of the inlet and outlet jets, towards the desired sector of the propulsion device.

[0014] This allows much faster and more precise turning of the vessels, which is especially useful in closed environments of limited dimensions such as ports, places where the precision of the manoeuvres to be performed by the vessels is particularly important.

[0015] Preferably, the central valve tilting means comprise a piston mechanism configured to produce a tilt of a lever according to a given tilt angle and in a given direction, wherein the lever is connected to the central valve.

**[0016]** Preferably, the perimeter valve tilting means also comprise the aforementioned piston mechanism and lever.

**[0017]** This piston-actuated mechanism has similarities with the aforementioned "Voith Schneider propeller", where a piston mechanism is also used. However, in the case of the "Voith-Schneider propeller", this piston mechanism, which allows modifying the direction of propulsion (as in the propulsion device object of the present invention) is used to move a set of propellers, generating the disadvantages already mentioned.

**[0018]** According to possible embodiments of the propulsion device (see first and third embodiments disclosed below) the perimeter valve is connected to the lever by means of a dome-shaped structure.

**[0019]** Alternatively, according to other possible embodiments (see second and fourth embodiments disclosed below) the perimeter valve is connected by means of arms to the central valve.

**[0020]** Preferably, the propulsion device is configured so that the fluid path between the inlet opening and the perimeter outlet opening passes first through the rotor and then through the stator.

**[0021]** The stator may be arranged around the rotor, and, additionally, may also be arranged projecting in an axial direction parallel to a main longitudinal axis of the propulsion device, beyond a longitudinal dimension of the rotor.

**[0022]** Alternatively, to what is mentioned in the preceding paragraph, the stator may be arranged beyond a longitudinal dimension of the rotor, according to an axial direction parallel to a main longitudinal axis of the propulsion device. In this configuration, as shown in Figure 6, Figure 7 and Figure 8, the stator is arranged on the rotor superimposed on the rotor in the aforementioned longitudinal/axial direction. This configuration allows the rotor blades to have a larger surface area, which provides the propulsion device with greater power.

**[0023]** The rotor and/or stator may comprise variable-pitch blades.

**[0024]** Preferably, in the propulsion device object of the present invention, the perimeter valve comprises a flap arranged in a radial direction towards the inside of the propulsion device. Thus, by regulating (thanks to the tilting of the perimeter valve) the space existing between said flap and a wall of a base body of the propulsion device and an inner armature of the propulsion device, the perimeter valve is configured to regulate respectively a first percentage of stator outflow which is directed towards the perimeter outlet opening and a second percentage of stator outflow which is directed through a return cavity, back towards the rotor. By means of the mechanism disclosed here, it is possible to regulate the flow of the outlet jet, thus regulating the thrust or propulsive force of the propulsion device, and it is possible to take advantage of the flow not used for propulsion, making it recirculate towards the rotor, keeping or increasing its kinetic energy.

**[0025]** The propulsion device may comprise an annular outlet conduit connecting an outlet of the stator with the perimeter outlet opening of the propulsion device.

**[0026]** The annular outlet duct can be connected to the perimeter outlet opening by means of an elbow geometry.

**[0027]** Preferably, the outer casing of the propulsion device is flush with the first base (or lower base of the propulsion device). This configuration makes it possible to attenuate the possible dispersion of the output jet of the propulsion device.

**[0028]** Preferably, the central valve of the propulsion device has a convex curved geometry. This allows to facilitate, by Coandă effect, the directing of the inlet flow through the inlet opening directly towards the rotor inside the propulsion device, since the curvature of the central valve guides the inlet jet towards the rotor. This is an advantage over known thruster configurations (e.g., the intake device for thrusters disclosed in DE 102019106717 A1) which, in order to produce the aforementioned Coandă effect to help direct the inlet flow through the central inlet opening, resort to a convex element consisting of a protrusion ("Zustromwulst") that projects beyond the base of the thruster, which increases the draft of the thruster, increasing hydrodynamic friction and reducing its efficiency.

**[0029]** By means of the configuration of the thruster disclosed above, it is possible to direct the thrust jet only in the desired direction or to regulate its flow rate and the opening and closing time of the central valve (direction, intensity and frequency).

**[0030]** The propulsion device object of the present invention is a high precision marine thruster, specially developed to facilitate the automation of vessels (with special application for USVs (*Unmanned Surface Vehicles*) and UUVs (*Unmanned Underwater Vehicles*), which improves the operability of all types of vessels operating in the aquatic environment.

#### Brief disclosure of the figures

**[0031]** As part of the explanation of at least one embodiment of the invention, the following figures have been included.

Figure 1: It shows a simplified, schematic bottom perspective view of the propulsion device.

Figure 2: It shows a schematic section view of a first embodiment of the propulsion device, with the central valve and the perimeter valve in the idle position.

Figure 3a: It shows a schematic view of the propulsion device of Figure 2, where the central valve and the perimeter valve are shown with a minimum degree of tilt.

Figure 3b: It shows a schematic view of the propulsion device of Figure 2, where the central valve and the perimeter valve are shown with an intermediate degree of tilt.

Figure 3c: It shows a schematic view of the propulsion device of Figure 2, where the central valve and the perimeter valve are shown with a maximum degree of tilt.

Figure 4: It shows a schematic section view of a second embodiment of the propulsion device, with the central valve and the perimeter valve in the idle position.

Figure 5: It shows a simplified, lower, partially sectioned, schematic view of the rotor and stator of the propulsion device, according to the first embodiment or the second embodiment of the propulsion device.

Figure 6: It shows a schematic section view of a third embodiment of the propulsion device, with the central valve and the perimeter valve in the idle position.

Figure 7: It shows a schematic section view of a fourth embodiment of the propulsion device, with the central valve and the perimeter valve in the idle position.

Figure 8: It shows a simplified, lower, partially sectioned, schematic view of the rotor and stator of the propulsion device, according to the third embodiment or the fourth embodiment of the propulsion device.

Figure 9a: It shows a bottom view of the propulsion device, according to any of the embodiments, where fluid inlet and outlet flow lines are observed, corresponding to a minimum tilting of the lever and a minimum tilting of the central valve and the perimeter valve.

Figure 9b: It shows a bottom view of the propulsion device, according to any of the embodiments, where fluid inlet and outlet flow lines are observed, corresponding to an intermediate tilting of the lever and to an intermediate tilting of the central valve and the perimeter valve.

Figure 9c: It shows a bottom view of the propulsion device, according to any of the embodiments, where fluid inlet and outlet flow lines are observed, corresponding to a maximum tilting of the lever and a maximum tilting of the central valve and the perimeter valve.

Figure 10: It shows a simplified and schematic top view, partially sectioned, of the propulsion device where the drive mechanism of the central valve and the perimeter valve can be observed.

located on the perimeter of said first base (10) of the propulsion device.

[0036] The propulsion device comprises a mainly cylindrical geometry, with a main axis (9) of radial symmetry perpendicular to the central inlet opening (1).

[0037] Corresponding to the central inlet opening (1), there is a central valve (3) of disc-shaped geometry.

[0038] The central valve (3) is actuated by a lever (4) connected to a piston mechanism (5).

10 [0039] Figure 10 shows a top view of the propulsion device, where the outer casing (6) has been sectioned at the top, exposing the piston mechanism (5).

[0040] The lever (4) and the central valve (3) are connected through a ball joint (4') of the lever (4). This ball joint (4') is connected to a fulcrum (17) or bearing, with respect to which the lever (4) can pivot, as a hinged joint between the ball joint (4') of the lever (4) and the fulcrum (17).

[0041] By means of the movement of the pistons (5), the lever (4) is actuated in different directions, which produces the tilting of the central valve (3) in any direction, and according to different tilt degrees.

[0042] The direction and inclination according to which the central valve (3) can be tilted is determined by the length by which the pistons (5) of the piston mechanism (5) extend or retract. Preferably, the piston mechanism (5) comprises at least two pistons (5) arranged in mutually perpendicular directions.

[0043] By controlling the direction of tilt of the central valve (3), it is possible to direct the intake flow in a preferred inlet direction.

[0044] Also, by controlling the tilt degree of the central valve (3), it is possible to control the inlet flow through the inlet opening (1) of the propulsion device.

35 [0045] Figure 1 shows a simplified bottom perspective view of the propulsion device, according to any of the embodiments disclosed herein.

[0046] Figure 1 shows the propulsion device with its outer casing (6), its central inlet opening (1) (or intake zone) and its perimeter outlet opening (2) (or ejection zone). Corresponding to the inlet opening (1) the central valve (3) can be observed. Figure 1 shows flow lines schematically showing the main direction of the inflow and outflow when the piston mechanism (5) actuates the lever (4) in a certain direction and at a certain tilt angle.

45 [0047] Figure 2 schematically depicts a sectional view of the propulsion device, according to a first embodiment thereof.

[0048] Figure 2 shows the perimeter valve (7) comprising a flap (8) that projects radially towards the centre of the propulsion device. In this first embodiment, the perimeter valve (7) is attached to the upper part of the lever (4) by means of a dome-shaped structure formed by a continuous surface or a network of dome-shaped ribs.

55 [0049] Figure 2 shows the propulsion device with the lever (4), the central valve (3) and the perimeter valve (7) in the rest position, i.e., with the lever (4) tilted 0° with respect to the main axis (9) of the propulsion device. In

## Detailed Disclosure

[0032] The present invention relates, as mentioned above, to a propulsion device.

[0033] The propulsion device comprises a central fluid inlet opening (1) (or inlet zone) and a perimeter fluid outlet opening (2) (or outlet zone).

[0034] The central inlet opening (1) is located in the centre of a first base (10) (or lower base, as depicted in the Figures) of the propulsion device.

[0035] The perimeter outlet opening (2) is preferably

this position, the central valve (3) completely blocks the inlet opening (1) of the propulsion device, and the flap (8) of the perimeter valve (7) completely blocks the flow outlet through the perimeter outlet opening (2).

**[0050]** When the piston mechanism (5) starts to tilt the lever (4), the central valve (3) starts to swing, causing the inlet opening (1) to be open to the passage of fluid (typically water) towards a certain inner sector of the propulsion device.

**[0051]** Figure 3a shows the situation in which the central valve (3) of the propulsion device (according to the first embodiment) starts to swing, allowing the fluid inlet to pass through the inlet opening (1).

**[0052]** When the fluid enters the interior of the propulsion device through the inlet opening (1), it first passes through the rotor (14) and then through the stator (15).

**[0053]** In both this first embodiment of the propulsion device and the second embodiment of the propulsion device, the stator (15) is placed around the rotor (14), projecting above the rotor (14) away from the first base (10) of the propulsion device.

**[0054]** Both the rotor (14) and the stator (15) are located between a base body (11) of the propulsion device and an inner armature (13) of the propulsion device. The first base (10) of the propulsion device is an outer face of said base body (11) of the propulsion device.

**[0055]** At the outlet of the stator (15), the fluid flow may be directed to a return cavity (16), back towards the rotor (14), or to an annular outlet conduit (18) connected to the perimeter outlet opening (2). The annular outlet duct (18) runs between a wall (12) of the base body (11) and the outer casing (6) of the propulsion device. The annular outlet duct (18) has a geometry substantially in the form of a spherical or ellipsoidal crown truncated by two parallel planes. The connection area between the annular outlet duct (18) and the perimeter outlet opening (2) has a geometry that forms an elbow which forces the outflow of the propulsion device to be directed centrifugally with respect to the main axis (9) of the propulsion device.

**[0056]** However, according to alternative embodiments (not shown in the figures) of the propulsion device object of the present invention, the propulsion device lacks the annular outlet conduit (18) and the elbow-shaped connection area with the perimeter outlet opening (2). In these alternative embodiments, the outlet opening (2) perimeter is directly the area between the flap (8) of the perimeter valve (7) and the wall (12) of the base body (11), the outlet jet of the propulsion device being then directly the radial outlet of the stator (15).

**[0057]** In the situation shown in Figure 3a, the central valve (3) has started to tilt with a minimum tilt angle (which, in this case as an example is assumed to correspond to a 10° tilt of the lever (4) with respect to the main axis (9) of the propulsion device). A small amount of fluid flow begins to access the interior of the propulsion device, towards a certain first sector (S1) of the propulsion device (see left area of Figure 3a), towards the rotor (14) of the propulsion device. After passing through the rotor (14),

the fluid is ejected in all directions towards the stator (15). However, since the central valve (3) determines a main direction of the inlet flow towards the first sector (S1) of the propulsion device, also the most of the rotor (14) outlet flow is directed towards the outside of the rotor (14) and towards the stator (15) in correspondence with said first sector (S1) of the propulsion device.

**[0058]** After its passage through the stator (15), in correspondence with the first sector (S1) of the propulsion device, a small part of the outflow of the stator (15) enters the annular outlet duct (18) through the gap between the flap (8) of the perimeter valve (7) and the wall (12) of the base body (11). Subsequently, this small part of the flow exits in the form of an outlet jet from the propulsion device through the perimeter outlet opening (2), in an area corresponding to the first sector (S1) of the propulsion device. However, since the tilt angle of the perimeter valve (7) with its flap (8) is minimal, most of the outflow of the stator (15) in said first sector (S1) is directed through the area located between the flap (8) of the perimeter valve (7) and the inner armature (13), towards the return cavity (16), back towards the rotor (14). Also, in sectors away from or opposite to the first sector (S1), the flap (8) of the perimeter valve (7) blocks the passage of fluid through the annular outlet conduit (18) towards the perimeter outlet opening (2), so that in said sectors away from or opposite to the first sector (S1), the flow at the outlet of the stator (15) is directed through the return cavity (16) back towards the rotor (14).

**[0059]** A situation is thus obtained where, with a minimum degree of tilting of the lever (4), the central valve (3) leaves a minimum fluid passage towards the inside of the propulsion device, and the perimeter valve (7) leaves a minimum fluid passage towards the outside of the propulsion device, thus having a minimum output jet that produces a low thrust by the propulsion device.

**[0060]** Figure 9a shows schematically by means of flow lines the minimum outlet jet (corresponding to the minimum tilting of the lever (4) in Figure 3a) through the outlet opening (2) perimeter, in an area corresponding to the first sector (S1) of the propulsion device.

**[0061]** When the magnitude or intensity of the thrust produced by the propulsion device is to be increased, the intake and expulsion in the propulsion device must be increased, thereby increasing the inflow and outflow. This requires that the piston mechanism (5) produces a greater tilting of the lever (4) with respect to the main axis (9) of the propulsion device, which produces a greater tilting of the central valve (3) and the perimeter valve (7).

**[0062]** Figure 3b represents a situation of intermediate opening or tilting of the central valve (3) and the perimeter valve (7) (which, in this case as an example, is assumed to correspond to a 15° tilt of the lever (4) with respect to the main axis (9) of the propulsion device). This situation causes that, in the area of the propulsion device corresponding to the first sector (S1), a greater proportion of the outgoing flow from the stator (15) accesses, through the gap between the flap (8) of the perimeter valve (7)

and the wall (12) of the base body (11), to the annular outlet duct (18) and to the outside of the propulsion device through the perimeter outlet opening (2). In contrast to this, in the area of the propulsion device corresponding to the first sector (S1), a smaller proportion of the outgoing flow from the stator (15) enters the return cavity (16) via the area between the flap (8) of the perimeter valve (7) and the inner armature (13), as the lever (4) is more tilted and thus the perimeter valve (7) is more tilted, the space between the flap (8) and the inner armature (13) is reduced in the area corresponding to the first sector (S1) of the propulsion device.

**[0063]** As was the case when the tilting of the lever (4) with respect to the main axis (9) was minimal (Figure 3a), also in this situation of intermediate tilting of the lever (4), in sectors away from or opposite to the first sector (S1) of the propulsion device, the flap (8) of the perimeter valve (7) blocks the flow from the annular outlet (18) to the perimeter outlet opening (2), so that in such sectors away from or opposite to the first sector (S1) of the propulsion device, the outgoing flow from the stator (15) is directed through the return cavity (16) back to the rotor (14).

**[0064]** Figure 9b shows schematically by means of flow lines the intermediate outlet jet (corresponding to the intermediate lever tilt (4) in Figure 3b) through the perimeter outlet opening (2), in an area corresponding to the first sector (S1) of the propulsion device.

**[0065]** When the magnitude or intensity of the thrust produced by the propulsion device is to be increased as much as possible, the intake and expulsion in the propulsion device must be increased as much as possible, thereby maximizing the inflow and outflow. This requires that the piston mechanism (5) produces a maximum tilting of the lever (4) with respect to the main axis (9) of the propulsion device, which produces a maximum tilting of the central valve (3) and the perimeter valve (7).

**[0066]** Figure 3c represents a situation of maximum opening or tilting of the central valve (3) and the perimeter valve (7) (which, in this case as an example, is assumed to correspond to a 20° tilt of the lever (4) with respect to the main axis (9) of the propulsion device). This situation causes that, in the area of the propulsion device corresponding to the first sector (S1), practically the entire outgoing flow of the stator (15) accesses, through the existing gap between the flap (8) of the perimeter valve (7) and the wall (12) of the base body (11), to the annular outlet duct (18) and to the outside of the propulsion device through the perimeter outlet opening (2). In contrast to this, in the area of the propulsion device corresponding to the first sector (S1), a practically zero proportion of the outgoing flow from the stator (15) enters the return cavity (16) through the area between the flap (8) of the perimeter valve (7) and the inner armature (13), since, when the lever (4) is tilted to the maximum and the perimeter valve (7) is thus tilted to the maximum, the space between the flap (8) and the inner armature (13) in the area corresponding to the first sector (S1) of the propulsion device is reduced to the maximum.

**[0067]** As it happened when the tilting of the lever (4) with respect to the main axis (9) was minimum (Figure 3a) or intermediate (Figure 3b), also in this situation of maximum tilting of the lever (4), in sectors far away or opposite to the first sector (S1) of the propulsion device, the flap (8) of the perimeter valve (7) blocks the flow from the annular outlet (18) to the perimeter opening (2), so that in such sectors away from or opposite to the first sector (S1) of the propulsion device, the outgoing flow from the stator (15) is directed through the return cavity (16) back to the rotor (14).

**[0068]** Figure 9c shows schematically by means of flow lines the maximum outlet jet (corresponding to the maximum tilting of the lever (4) in Figure 3b) through the outlet opening (2) perimeter, in an area corresponding to the first sector (S1) of the propulsion device.

**[0069]** As can be seen in Figure 9a, Figure 9b and Figure 9c, in sectors adjacent to the first sector (S1) of the propulsion device, there is also a small dispersion of the outlet jet of the propulsion device through the perimeter outlet opening (2). However, thanks to the tilting of the perimeter valve (7) with its flap (8), most of the outgoing flow from the stator (15) is directed outward from the propulsion device through the annular outlet duct (18) and the perimeter outlet opening (2), only in the area corresponding to the first sector (S1), since the perimeter valve (7) with its flap (8) blocks the outflow through the perimeter outlet opening (2) in sectors away from the first sector (S1) of the propulsion device. In order for this minimal dispersion of the outflow jet to occur, it is also desirable that the outer casing (6) of the propulsion device be flush with the first base (10) of the propulsion device, so that the annular outlet duct (18) forces the flow exiting the stator (15) in sectors adjacent to the first sector (S1) to mix with the flow exiting the stator (15) in the first sector (S1), thereby correcting or attenuating the dispersion in the outflow jet.

**[0070]** Figure 4 shows a second embodiment of the propulsion device that is the object of the present invention. This second embodiment differs from the first embodiment in that the perimeter valve (7), instead of being attached to the upper part of the lever (4) by means of a dome-shaped structure, is attached by means of arms (19) to the central valve (3). Thus, when the piston mechanism (5) produces the tilting of the lever (4) and, in turn, the tilting of the central valve (3), this tilting of the central valve (3) also produces the tilting of the perimeter valve (7).

**[0071]** Figure 5 shows a sectional bottom view of the rotor (14) and stator (15) of the propulsion device, according to the first embodiment and the second embodiment of the propulsion device. It can be seen that the rotor (14) is arranged on the inside of the stator (15).

**[0072]** Figure 6 shows a third embodiment of the propulsion device that is the object of the present invention. This third embodiment is analogous to the first embodiment, but where the stator (15) is not placed around the rotor (14), but only above the rotor (14).

**[0073]** Figure 7 shows a fourth embodiment of the propulsion device that is the object of the present invention. This fourth embodiment is analogous to the second embodiment, but where the stator (15) is not placed around the rotor (14), but only above the rotor (14).

**[0074]** Figure 8 shows a sectional bottom view of the rotor (14) and stator (15) of the propulsion device, according to the third embodiment and the fourth embodiment of the propulsion device. It can be seen that the rotor (14) is superimposed on the stator (15).

**[0075]** In the third embodiment and in the fourth embodiment of the propulsion device, this arrangement of the rotor (14) with its blades having a larger surface area than in the first and second embodiments, and superimposed on the stator blades (15) in the longitudinal/axial direction, gives the propulsion device greater power.

**[0076]** In the third and fourth embodiments of the propulsion device, the flux leaving the rotor (14) and entering the stator does so in the longitudinal/axial direction of the propulsion device (in the direction of the main axis (9) of the propulsion device). In contrast to this, in the first and second embodiments of the propulsion device, the flux leaving the rotor (14) and entering the stator does so in the radial direction of the propulsion device (in the direction perpendicular to the main axis (9) of the propulsion device).

**[0077]** Preferably, the central valve (3) has a convex curved geometry, so as to favour the admission of fluid towards the interior of the propulsion device by the Coandă effect it produces in the intake jet, which tends to reproduce the curved geometry of the central valve (3), heading towards the rotor (14) of the propulsion device. This Coandă effect is produced in the 360° of the central valve (3) so that, whatever the direction and angle of tilt of the central valve (3), this Coandă effect is produced on the intake flow, favouring the entry of fluid directly to the rotor (14) of the propulsion device.

**[0078]** The propulsion device object of the present invention allows to vary the direction and frequency of opening/closing (opening and closing lapse) of the central valve (3), as well as the intensity of the propulsion jet (by regulating the rotational speed (RPM) of the rotor (14) and the opening of the perimeter valve (7)).

**[0079]** Preferably, the rotor (14) is configured with variable-pitch blades.

## Claims

1. A propulsion device comprising a rotor (14), a stator (15), an outer casing (6), a first base (10) with a central inlet opening (1) configured for fluid intake, and an outlet opening (2) configured for expulsion of propulsive fluid in the form of an outlet jet, **characterized in that** the outlet opening (2) is located along the entire perimeter of the propulsion device, wherein the propulsion device comprises:

- a central valve (3) configured, by means of tilting means, to tilt with a given direction and tilt angle, thus regulating a flow rate of a fluid inlet jet and a direction of the fluid inlet jet towards a certain sector of the propulsion device, and;  
- a perimeter valve (7) configured, by means of tilting means, to tilt with a given direction and tilt angle, thus regulating a flow rate of the fluid outlet jet and a direction of the fluid outlet jet towards a certain sector of the perimeter outlet opening (2).

2. Propulsion device as claimed in claim 1, **characterized in that** the means for tilting the central valve (3) comprise a piston mechanism (5) configured to produce a tilt of a lever (4) according to a given tilt angle and in a given direction, wherein the lever (4) is connected to the central valve (3).
3. Propulsion device as claimed in claim 2, **characterized in that** the means for tilting the perimeter valve (7) comprise the piston mechanism (5) and the lever (4).
4. Propulsion device as claimed in claim 3, **characterized in that** the perimeter valve (7) is connected to the lever (4) by means of a dome-shaped structure.
5. Propulsion device as claimed in claim 3, **characterized in that** the perimeter valve (7) is connected by means of arms (19) to the central valve (3).
6. Propulsion device according to any of the preceding claims, **characterized in that** it is configured so that the fluid path between the inlet opening (1) and the perimeter outlet opening (2) passes first through the rotor (14) and then through the stator (15).
7. Propulsion device as claimed in claim 6, **characterized in that** the stator (15) is arranged around the rotor (14).
8. Propulsion device as claimed in claim 7, **characterized in that** the stator (15) is arranged projecting in an axial direction parallel to a main (9) longitudinal axis of the propulsion device, beyond a longitudinal dimension of the rotor (14).
9. Propulsion device as claimed in claim 6, **characterized in that** the stator (15) is arranged beyond a longitudinal dimension of the rotor (14), according to an axial direction parallel to a main (9) longitudinal axis of the propulsion device.
10. Propulsion device according to any of the preceding claims, **characterized in that** the rotor (14) and the stator (15) comprise variable-pitch blades.

11. Propulsion device according to any one of claims 6 to 10, **characterized in that** the perimeter valve (7) comprises a flap (8) arranged in a radial direction towards the inside of the propulsion device, wherein by regulating the space between said flap (8) and a wall (12) of a base body (11) of the propulsion device and an inner armature (13) of the propulsion device, the perimeter valve (7) is configured to regulate respectively a first percentage of stator outflow (15) that is directed towards the perimeter outlet opening (2) and a second percentage of stator outflow (15) that is directed through a return cavity (16) back towards the rotor (14). 5 10
12. Propulsion device according to any one of claims 6 to 11, **characterized in that** it comprises an annular outlet conduit (18) connecting a stator outlet (15) with the outlet opening (2) perimeter of the propulsion device. 15 20
13. Propulsion device as claimed in claim 12, **characterized in that** the annular outlet duct (18) connects to the perimeter outlet opening (2) by means of an elbow-shaped geometry. 25
14. Propulsion device according to any of the preceding claims, **characterized in that** the outer casing (6) is flush with the first base (10). 30
15. Propulsion device according to any of the preceding claims, **characterized in that** the central valve (3) has a convex curved geometry. 35 40 45 50 55

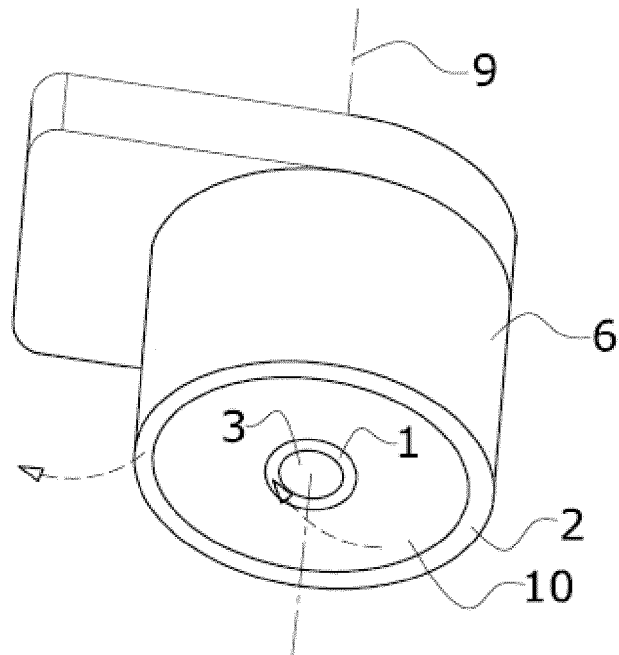


FIG.1

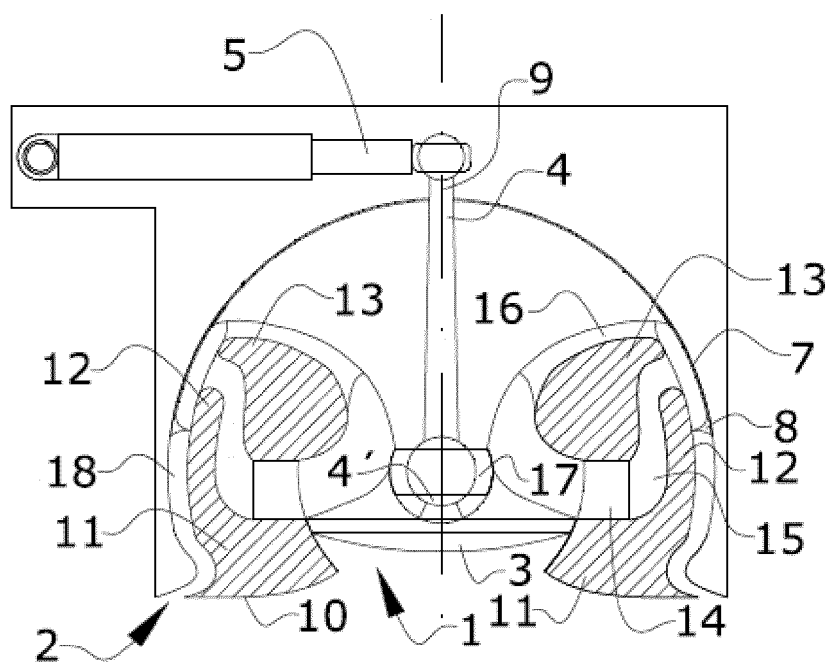
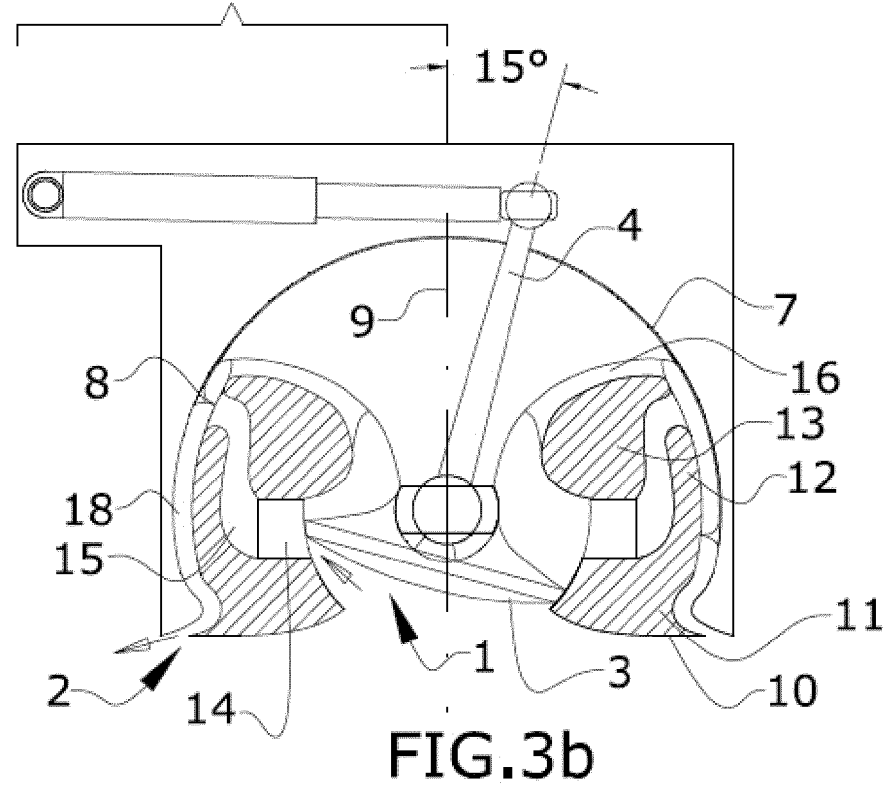
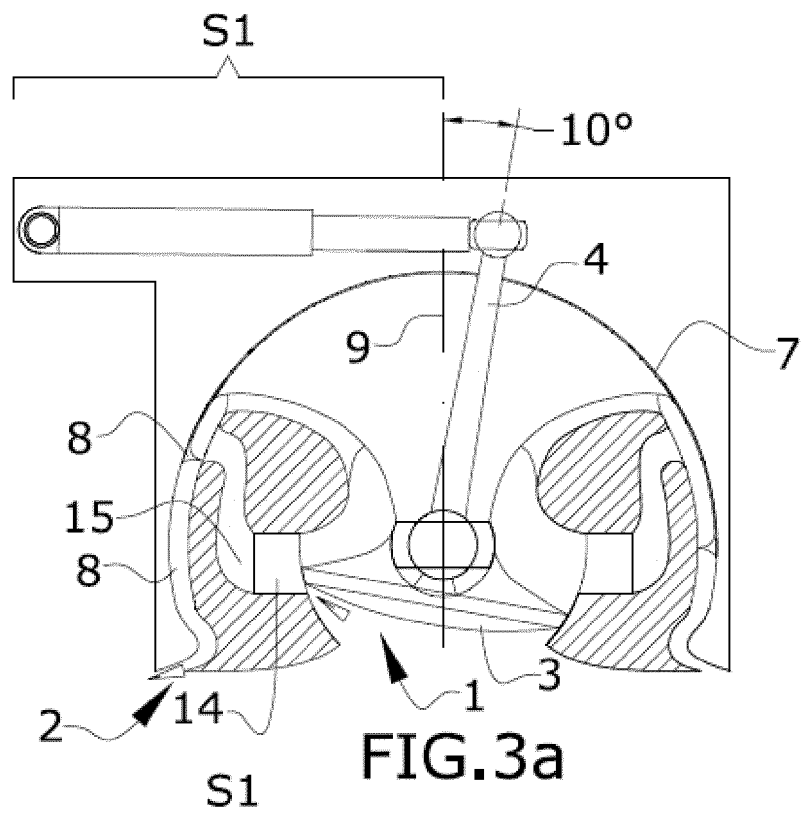
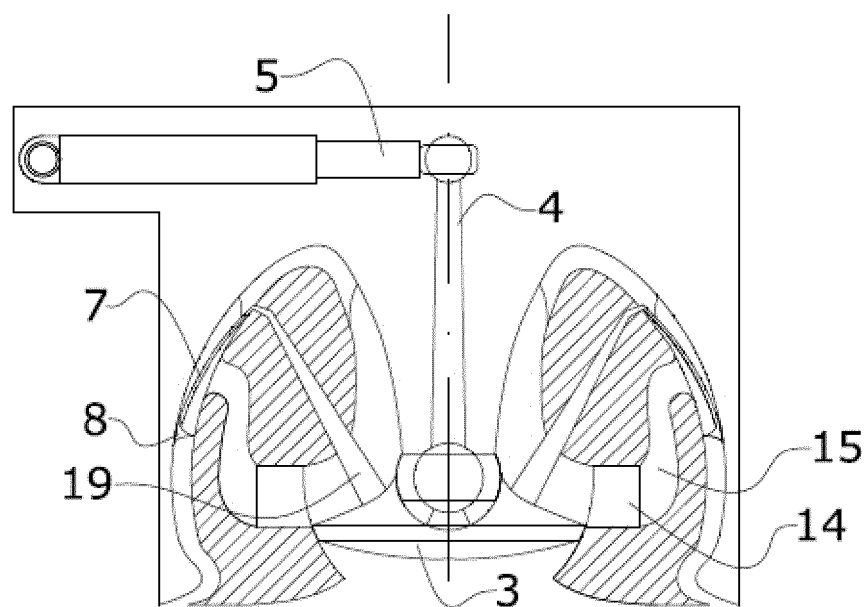
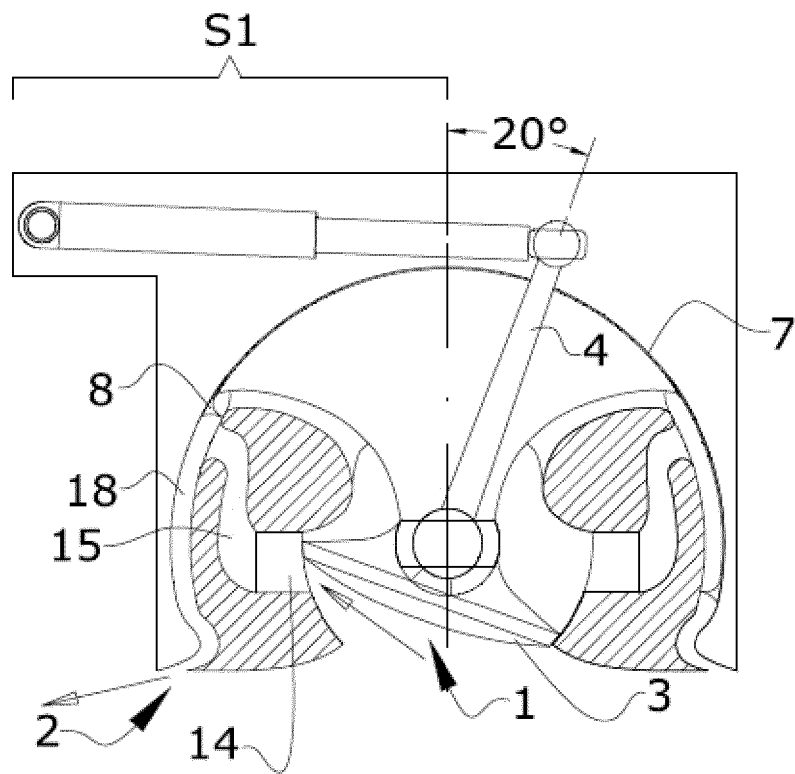


FIG.2





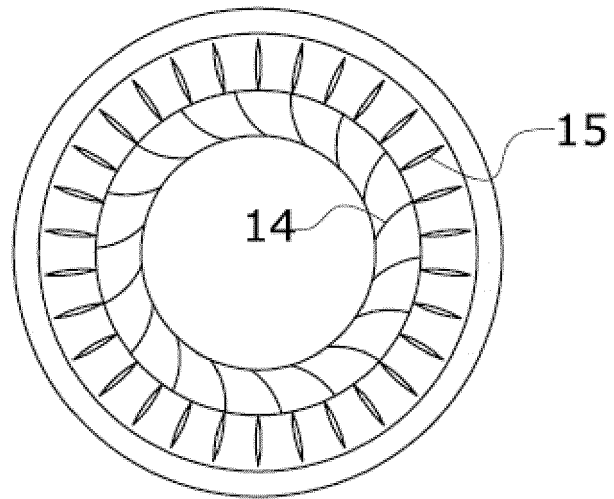


FIG. 5

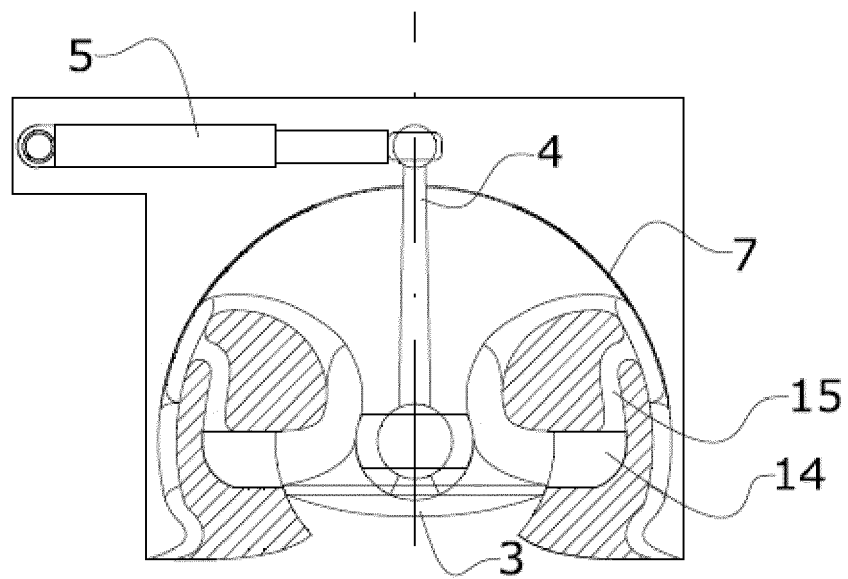


FIG. 6

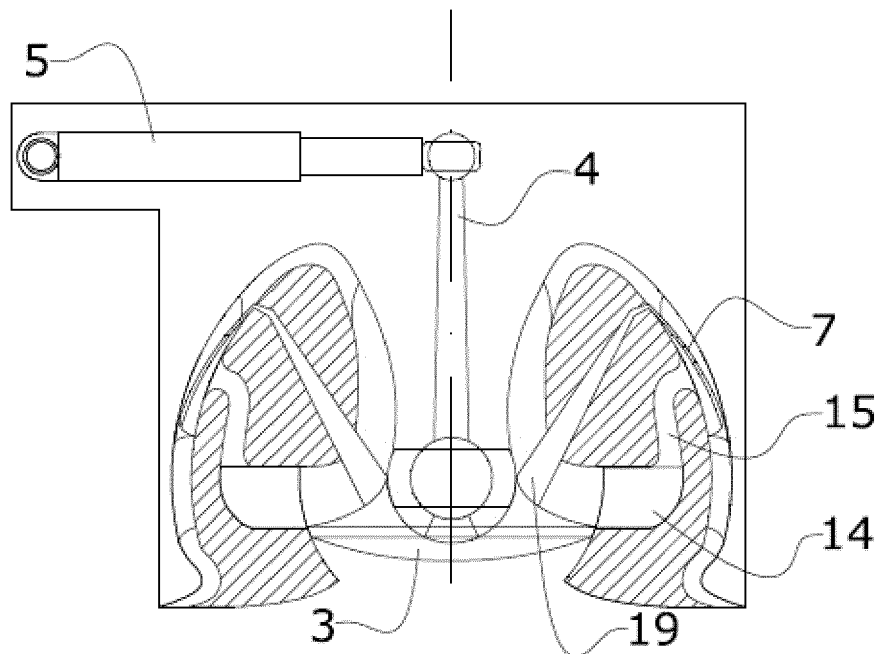


FIG. 7

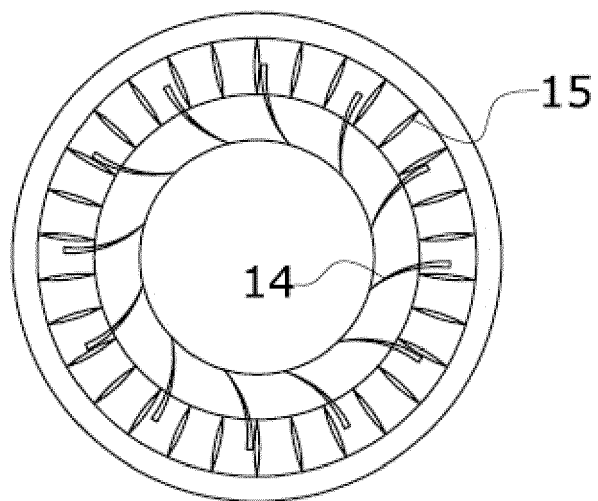


FIG. 8

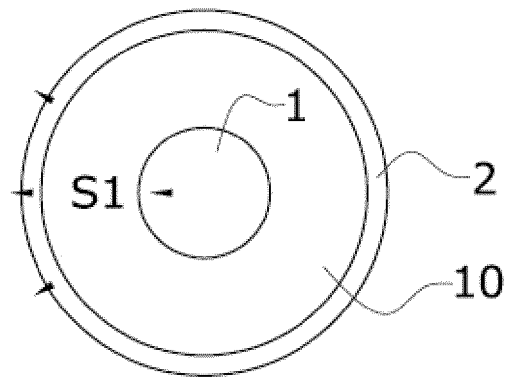


FIG. 9a

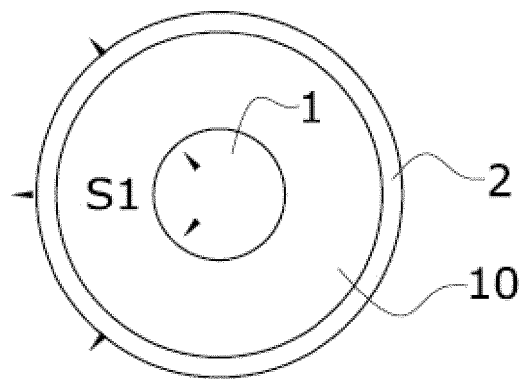


FIG. 9b

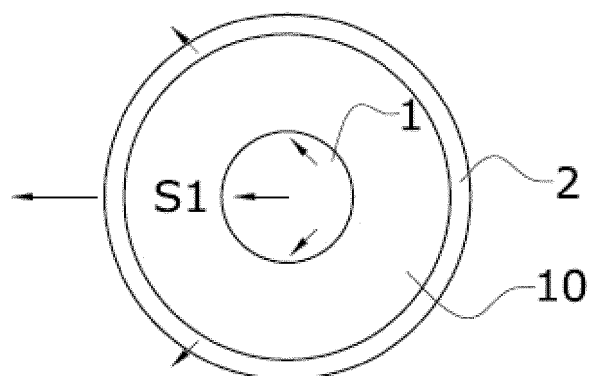


FIG. 9c

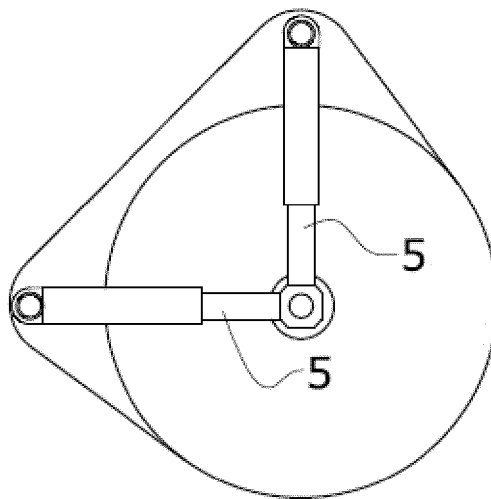


FIG.10

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/ES2022/070686

## A. CLASSIFICATION OF SUBJECT MATTER

**B63H11/08** (2006.01)**B63H11/10** (2006.01)

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)

**B63H**

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)

EPODOC, INVENES, WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages      | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------|-----------------------|
| A         | US 2010267295 A1 (KRAUTKRAEMER GERD) 21/10/2010, Par.0022-0050. Figure: 1-6             | 1-15                  |
| A         | US 5520557 A (KAUL STEFAN ET AL.) 28/05/1996, Col.1, lin.63 – Col.4, lin.2. Figure: 1-2 | 1-15                  |
| A         | JP 2001039389 A (KAWASAKI HEAVY IND LTD) 10/07/2000, Description. Figure: 1-3           | 1-15                  |
| A         | WO 9605098 A1 (SCHOTTEL WERFT ET AL.) 22/02/1996, Pag.7-14. Figure: 1,1A                | 1-15                  |

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

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Date of the actual completion of the international search

31/01/2023

Date of mailing of the international search report

(01/02/2023)

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2022/070686

Information on patent family members

| Patent document cited<br>in the search report | Publication<br>date | Patent family<br>member(s)                                                                                                                                                                                                                                  | Publication<br>date                                                                                                                                                                                                          |
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