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(54) **BOAT**

(57) Boat comprising a hull (2), at least two appendages (3), projecting from the hull (2) and intended to be immersed in water in order to generate a lift in navigation. Each appendage (3) comprises a support portion (31), mechanically connected to the hull (2), a hydrodynamic portion (32) which is extended along at least one main extension axis (X) and defines, at its own interior, at least one housing seat (S). The hydrodynamic portion (32) is rotatably connected to the support portion (31) around a first rotation axis (Z) substantially orthogonal to the main extension axis (X), and around a second rotation axis (Y) substantially orthogonal to the first rotation axis (Z) and to the main extension axis (X).

The boat (1) also comprises propulsion means (4), housed at least partially within the housing seat (S) of the hydrodynamic portion (32), first movement means (5), placed in mechanical connection between the hydrodynamic portion (32) and the support portion (31) in order to rotate the hydrodynamic portion (32) around the first rotation axis (Z), and second movement means (6), placed in mechanical connection between the hydrodynamic portion (32) and the support portion (31) in order to rotate the hydrodynamic portion (32) around the second rotation axis (Y).

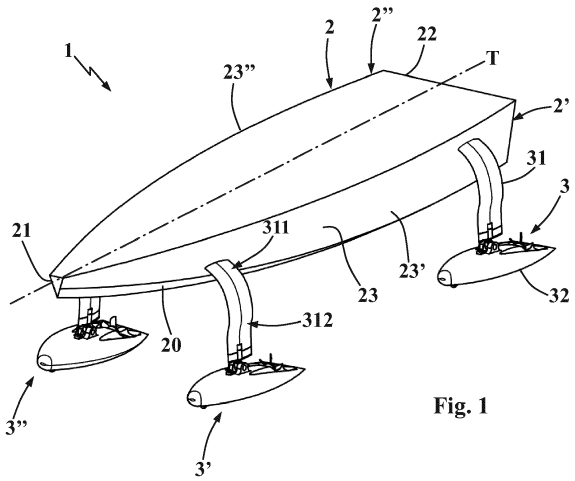

Fig. 1

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Description

Field of application

[0001] The present invention regards a boat according to the preamble of the independent claim number 1.

[0002] The present boat is intended to be advantageously employed for navigation, preferably at high speeds, on a body of water.

[0003] More in detail, the boat, object of the present invention, is advantageously employable in those contexts where a high maneuverability and a high control of the position of the boat are requested.

[0004] The invention is therefore inserted in the scope of the nautical industry, in the scope of making and assembling boats and in particular hydrofoils.

State of the art

[0005] Known on the market are boats, e.g. the trimarans described in the documents FR 2451312 and DE 10300599, which are provided with a hull and with multiple masts which project below the hull and carry mounted, on their lower ends, floating appendages adapted to float on the body of water during navigation.

[0006] Such floating appendages are rotatable connected to the corresponding masts in order to be free rotate around a first rotation axis (yaw) and a second rotation axis (pitch).

[0007] In particular, such boats provide for controlling the rotation of the appendages around the yaw axis, so as to control the turn of the boat, while they provide for leaving the appendage free to rotate around the pitch axis moved by the wavy motion of the body of water on which the boat navigates.

[0008] Such boats nevertheless do not allow reaching high speed, in particular in rough sea conditions. In such conditions, in fact, the floating appendages generate a high movement resistance, since as stated above they are configured for following the wavy motion.

[0009] In order to overcome such drawbacks, boats have been developed that are arranged for navigating at high speeds, which are also termed hydroplaning boats, or "hydrofoils", and are provided with a hull, with appendages mounted on the hull and projecting below the latter, for the purpose of being at least partially immersed in water.

[0010] During use, such appendages are capable of interacting with a water flow on which they advance, converting the pressure resulting from the relative speed between that of advancement of the hydrofoil and that of the water flow into a lift force directed upward. In particular, the greater the advancing speed of the hydrofoil on which such appendages are mounted, the greater the resulting lift force applied to the appendages, which lifts the hull from the free surface of the water.

[0011] More in detail, once a predetermined value of advancing speed has been exceeded, the generated lift force exceeds the weight force of the hydrofoil and the hull of the latter is lifted from the free surface of the water up to completely emerging and obtaining a navigation condition termed "foilborne".

[0012] Such foilborne navigation allows numerous advantages. In particular, during foilborne navigation, only the appendages are immersed in water and the hydrofoil navigates with a smaller surface area with respect to a "conventional" navigation, in which also the hull is at least partially immersed in water.

[0013] The aforesaid smaller immersed surface involves a lower hydrodynamic resistance of the water on the hydrofoil and allows the hydrofoil to reach higher navigation speeds, given the same installed motor power.

[0014] Examples of hydrofoils of known type are described in the documents US 4862820, DE 102018127650 and GB 785900. The hydrofoils described in the aforesaid patents are provided, in a per se conventional manner, with a hull intended to advance on the water in a first navigation condition of conventional type, i.e. with at least one portion of such hull immersed in water.

[0015] The aforesaid hydrofoils of known type also comprise three appendages, intended to be immersed in water in order to allow the hydrofoil to navigate also in a second condition, i.e. in foilborne condition.

[0016] More in detail, such hydrofoils are provided with a bow appendage and with two stern appendages, which are mounted on the hull so as to project below the hull itself in order to be immersed in water and they are spaced from each other along a main extension direction of the hull itself.

[0017] Each appendage comprises a support portion rotatably connected to the hull and a hydrodynamic portion which is extended orthogonal with respect to the support portion.

[0018] In addition, such hydrofoils described in the aforesaid patents comprise propulsion means, which are provided with a tapered body fixed to the support portion of the appendage, at a lower end thereof, and they are placed to intercept the hydrodynamic portion.

[0019] In particular, the hydrodynamic portion comprises a first wing and a second wing, which are extended on opposite sides of the tapered body of the propulsion means.

[0020] As described above, the support portion is rotatably mounted on the hull and is susceptible of being moved with respect to the hull itself.

[0021] More in detail, the support portion is movable around a rotation axis orthogonal to the main extension axis of the hull itself and substantially horizontal.

[0022] Therefore the support portion is movable between a lifted position, in which it is substantially side-by-side the hull and the hydrofoil is susceptible of navigating in a conventional manner, and a lowered position, in which it projects below the hull and the hydrofoil is susceptible of navigating, once the speed threshold value has been exceeded, in foilborne condition.

[0023] In order to allow a greater control of the position of the hydrofoil, i.e. so as to maintain it substantially always horizontal during the entire navigation, the hydrofoil described in the aforesaid patents are also provided with movable fins mounted on the hydrodynamic portions of the appendages.

[0024] More in detail, each hydrodynamic portion has substantially flat form, and is placed horizontal when the appendage is immersed in water. The aforesaid movable fins are plates mounted below the hydrodynamic portions of the appendages at a rear edge thereof, that is directed towards the stern, i.e. in opposite direction from the advancing direction. In addition, the aforesaid fins are hinged to the corresponding hydrodynamic portion and are susceptible of being moved in order to vary an incidence profile (i.e. the profile, substantially horizontal, of the appendage that interacts with the water flow in order to convert the water pressure into the aforesaid lift force) of the hydrodynamic portion itself with the water flow lines.

[0025] In particular, the variation of the incidence profile involves a different interaction of the hydrodynamic portion with the water and thus involves a different lift force developed by the appendage itself.

[0026] Such hydrofoils of known type also comprise a first apparatus for moving the support portion (as described above in order to lift the appendage) and a second apparatus for moving the fins of the appendages.

[0027] More in detail, the apparatus of known type comprises at least one linear actuator mechanically connected to each fin and actuatable in order to be moved between a retracted configuration, in order to move the fin into a configuration coplanar with the hydrodynamic portion and an extended configuration, in order to move the mobile termination into a tilted configuration with respect to the corresponding hydrodynamic portion so as to increase or decrease the lift force imparted to the hull.

[0028] As mentioned above, each fin is connected to the corresponding hydrodynamic portion by means of a hinge which allows the movement thereof between the coplanar configuration and the tilted configuration by rotating around a substantially horizontal rotation.

[0029] The hydrofoils of known type briefly described up to now have in practice shown that they do not lack drawbacks.

[0030] The main drawback lies in the fact that such boats require a conventional helm so as to execute the normal turn operations, therefore requiring a further element projecting from the hull which must be immersed in water.

[0031] A further drawback lies in the fact that such boat does not allow a sufficient control of the pitch phenomenon. More in detail, the fins of the appendages allow a limited variation of configuration, in particular only around a single rotation axis and extended for a reduced extension of the hydrodynamic portions.

[0032] In this situation, the appendages of the hydrofoils of known type allow a limited adaptive capacity at the various situations of progression of the hydrofoil and consequently they have shown in practice to be incapable of meeting sudden turn requests or adverse water conditions. A further drawback lies in the fact that in such boats the adjustment of the lift depends on the speed at which the boat is navigating, therefore resulting impossible to adjust the lift when the boat is traveling at reduced speed or is stopped.

[0033] A further drawback lies in the fact that the propulsion means placed to separate the two wings of the hydrodynamic portion are impacting from a fluid-dynamic standpoint, reducing the efficiency in terms of consumptions and performances of the hydrofoil, and the presence of the same fins on the hydrodynamic portion is also impacting from the hydrodynamic standpoint.

Presentation of the invention

[0034] In this situation, the problem underlying the present invention is therefore that of overcoming the drawbacks manifested by the boats of known type, by providing a boat which is provided with a reduced number of appendages projecting from the hull and intended to be immersed in water.

[0035] A further object of the present invention is to provide a boat which is provided with appendages which are little impacting on the hydrodynamic profile of the boat, allowing the boat to reach high speeds.

[0036] A further object of the present invention is to provide a boat which is provided with an improved control of the position thereof, and in particular of the turn angle and of the pitch angle.

[0037] A further object of the present invention is to provide a boat which allows adjusting, in an efficient manner, the lift even when the boat is traveling at reduced speed or is stopped.

[0038] A further object of the present invention is to provide a boat that has reduced weight, and in which several of the mechanical and electronic components are immersed in water.

[0039] A further object of the present invention is to provide a boat that is simple to attain.

[0040] A further object of the present invention is to provide a boat which is entirely efficient and reliable.

Brief description of the drawings

[0041] The technical characteristics of the invention, according to the aforesaid objects, are clearly seen by the contents of the below-reported claims and the advantages thereof will be more evident in the following detailed description, made with reference to the enclosed drawings, which represent a merely exemplifying and non-limiting embodiment, in which:

- Fig. 1 shows a perspective view of a boat, object of the present invention, in accordance with the preferred embodiment;

- Fig. 2 shows a side view of the boat of figure 1;
- Fig. 3 shows a perspective view of a detail of the boat of figure 1, relative to an appendage of the boat;
- Fig. 4 shows a side view of the appendage of figure 3;
- Fig. 5 shows a rear view of the appendage of figure 3;
- Fig. 6 shows a section view of the appendage of figure 3, attained along trace VI-VI of figure 5;
- Fig. 7 shows a section view of the appendage of figure 3, attained along the section line VII-VII of figure 4;
- Fig. 8 shows a detail of the appendage, relative to first movement means inserted in an insertion seat of the appendage, with several parts removed in order to better illustrate other parts;
- Fig. 9 shows a rear view of the first movement means of figure 8;
- Fig. 10 shows a section view of the first movement means of figure 10, attained along the section line X-X of figure 9;
- Fig. 11 shows a section view of the first movement means of figure 9, attained along the section line XI-XI of figure 9;
- Fig. 12 shows a section view of the first movement means of figure 10, attained along the section line XII-XII of figure 10;
- Fig. 13 shows a perspective view of a detail of the first movement means, relative to a first rotation body mounted on a fixed body, in accordance with the preferred embodiment;
- Fig. 14 shows a side view of the detail of figure 13;
- Fig. 15 shows a section view of the detail of figure 15, attained along the section line XV-XV of figure 14;
- Fig. 16 shows a section view of the detail of figure 15, attained along the section line XVI-XVI of figure 14;
- Fig. 17 shows a detail of figure 14, relative to a fixed body;
- Fig. 18 and 19 show two details of figure 13, respectively relative to a first fixing plate and to a second fixing plate;
- Fig. 20 shows a detail of figure 14, relative to a first rotation body.

Detailed description of a preferred embodiment

[0042] With reference to the enclosed drawings, reference number 1 overall indicates a boat according to the present invention.

[0043] The boat 1 according to the invention, during use, is advantageously intended to navigate on a body of water and comprises a hull 2 which, during use, is preferably at least partially lifted from the water surface.

[0044] Advantageously, with the term "boat" it will be intended hereinbelow any one floating unit, such as for example a watercraft, a ship or even a jet ski, regardless of its shape, size and type of navigation that this is intended to allow. Preferably, the boat 1 is of hydroplaning type, in particular a hydrofoil, which is intended to navigate at high speeds with the hull 2 lifted from the water surface.

[0045] In accordance with the invention the boat comprises a hull 2, which is extended advantageously along a main extension axis T between a bow end 21 and a stern end 22.

[0046] In the following present description, reference will always be made to a boat 1 provided with only one hull 2; nevertheless an alternative embodiment of the boat 1 is also intended as being possible, provided with two or more hulls 2, without departing from the protective scope of the present patent.

[0047] Advantageously, the main extension axis T defines an advancing direction of the boat 1 itself along a navigation course thereof.

[0048] The boat also comprises at least two projecting appendages 3 which project, preferably on the lower part, from the hull 2 and are intended to be immersed in water in order to generate a lift during navigation of the hydrofoil 1.

[0049] In accordance with the preferred embodiment illustrated in the enclosed figures, the hull 2 is advantageously provided with a median plane, comprising the aforesaid main extension axis T and defining a port half-hull 2' and a starboard half-hull 2". Advantageously, with the hydrofoil 1 at rest, the median plane is a substantially vertical plane that defines the aforesaid two half-hulls 2', 2" preferably mirrored and congruent with respect to each other.

[0050] Advantageously, the aforesaid at least two appendages 3 comprising at least one port appendage 3' mounted on the port half-hull 2' and susceptible of generating a first lift force and at least one starboard appendage 3" mounted on the starboard half-hull 2" and susceptible of generating a second lift force.

[0051] In accordance with the preferred but non-limiting embodiment of the present invention illustrated in the enclosed figures, the hydrofoil 1 comprises four appendages 3 mechanically connected to the hull 2, and in particular comprises two port appendages 3' connected to the port half-hull 2' and spaced from each other parallel to the main extension axis T, and two starboard appendages 3" connected to the starboard half-hull 2" and spaced from each other parallel to the main extension axis T and substantially opposite the port appendages 2' with respect to the median plane.

[0052] Advantageously, the hull 2 comprises a keel portion 20, at the median plane and two lateral sides 23, opposite with respect to the median plane itself including a port lateral side 23' and a starboard lateral side 23".

[0053] Preferably, in accordance with the preferred embodiment, the two port appendages 3' project from the port lateral side 23' and the two starboard appendages 3" project from the starboard lateral side 23".

[0054] Each appendage 3 comprises a support portion 31, mechanically connected to the hull 2 of the boat 1, and a hydrodynamic portion 32 which is extended along at least one main extension axis X and defines, at its own

interior, at least one housing seat S.

[0055] The hydrodynamic portion 32 is also rotatably connected to the support portion 31 around a first rotation axis Z substantially orthogonal to the main extension axis X, and around a second rotation axis Y substantially orthogonal to the first rotation axis Z and to the main extension axis X.

[0056] The support portion 31 is extended advantageously protruding from the hull 2, along a direction that is transverse, preferably orthogonal, to the main extension axis T of the hull 2.

[0057] In accordance with the preferred embodiment in which the appendages 3 project from the lateral sides 23 of the hull 2, the support portions 31 have a substantially J-shaped form and are preferably provided with a first connector section 311, connected to the corresponding lateral side 23 of the hull 2 and extended along a direction substantially parallel to the main extension axis X of the hydrodynamic portion 32, and a second connector section 312, extended along a direction transverse to the main extension axis X.

[0058] In this manner it is possible to place the appendages 3 laterally with respect to the hull 2, simultaneously allowing to maintain the hydrodynamic portions 32 sufficiently spaced from the hull 2 itself, preventing turbulences due to the water flow during navigation.

[0059] Advantageously, the hydrodynamic portion 32 is extended along a direction that is transverse, preferably substantially orthogonal to the support portion 31 and is therefore intended to be placed substantially parallel to the water surface during navigation.

[0060] In particular, it is the hydrodynamic portion 32 of each appendage 3 which is intended, during use, to be at least partially immersed in water in order to generate a lift force and to lift the hull 2 from the free surface of water, allowing the hydrofoil 1 to navigate in foilborne condition. With the term "lift", a lifting force must be intended in the present text, which is substantially directed upward, resulting from the fluid-dynamic forces that the water imparts on the aforesaid appendages 3 and in particular on the respective hydrodynamic portions 32.

[0061] For such purpose each hydrodynamic portion 32 is advantageously provided with a hydrodynamic profile which is shaped in order to allow generating a lift in navigation. Advantageously, the aforesaid profile in such a manner allows making a hydrodynamic portion which does not require wings or fins that project laterally from the latter, as in the above-described hydrodynamic appendages of known type.

[0062] The boat 1 also comprises propulsion means 4, housed at least partially within the housing seat S of the hydrodynamic portion 32.

[0063] Advantageously, the hydrodynamic portion 32 of each appendage 3 defines, at its own interior, at least one housing seat S, at whose interior a corresponding propulsion means 4 is placed. Therefore, in accordance with the preferred embodiment, the boat 1 comprises four propulsion means 4, one for each appendage 3.

[0064] In this manner it is possible to reach high speeds and ensure a high maneuverability and stability of the boat 1.

[0065] The boat 1 also comprises first movement means 5, placed in mechanical connection between the hydrodynamic portion 32 and the support portion 31 in order to rotate, in particular in order to drive in rotation, the hydrodynamic portion 32 around the first rotation axis Z and second movement means 6 placed in mechanical connection between the hydrodynamic portion 32 and the support portion 31 in order to rotate, in particular in order to drive in rotation, the hydrodynamic portion 32 around the second rotation axis Y.

[0066] Advantageously, therefore, with such configuration, the propulsion means 4 are rotated, together with the hydrodynamic portion 32, around the first rotation axis Z and around the second rotation axis Y, respectively by the first movement means 5 and by the second movement means 6.

[0067] In this manner the hydrodynamic portion 32, in addition to generating a lifting force (lift), allows controlling the position of the boat 1.

[0068] More in detail, in this manner the hydrodynamic portion 32 simultaneously allows the turn control, acting as helm by means of the rotation around the first rotation axis Z, and the control of the pitch, by means of the rotation around the second rotation axis Y.

[0069] In addition, the placement of the propulsion means 4 directly on the hydrodynamic portion 32 of the appendage 3 (within a housing seat) allows considerably increasing the control of the boat, allowing combining the abovementioned lift generated by the hydrodynamic portion 32 also with a propulsion thrust generated by the propulsion means 4 themselves.

[0070] For example, it is possible to rotate the hydrodynamic portion 32 around the second rotation axis Y in order to orient the propulsion means 4 selectively towards the bottom of the body of water (obtaining an upward propulsion thrust) or towards the surface of the body of water (obtaining a downward propulsion thrust).

[0071] In addition, in this manner it is possible to considerably reduce the weight of the boat since the propulsion means 4, being completely housed in water, undergo an Archimedes' thrust which allows reducing the impact on the hydrofoil, increasing the efficiency and the performances thereof.

[0072] Advantageously, the first and the second movement means 5, 6 are configured for controlling the angular position of the hydrodynamic portion 32, respectively, around the first rotation axis Z and the second rotation axis Y.

[0073] Preferably, the first movement means 5 comprise a first actuator member mechanically connected to the hydrodynamic portion 32 and adapted to actuate the latter to rotate around the first rotation axis Z.

[0074] Preferably, the second movement means 6 comprise a second actuator member 62 mechanically connected to the hydrodynamic portion 32 and adapted

to actuate the latter to rotate around the second rotation axis Y.

[0075] Advantageously, the first movement means 5 comprise a first rotation body 51, rotatably engaged with the support portion 31 around the first rotation axis Z and integral in rotation with respect to the hydrodynamic portion 32, and the aforesaid first actuator member, which acts on the first rotation body 51 in order to rotate it around the first rotation axis Z.

[0076] The support portion 31 is extended advantageously between an upper end 31' and a lower end 31" and, in accordance with the preferred embodiment, is provided with an insertion seat 310, made at the lower end 31" and within which the first rotation body 51 is at least partially inserted, free to rotate.

[0077] Advantageously, the insertion seat 310 is partially extended along the support portion 31 and is preferably accessible from a window, not represented in the enclosed figures, made laterally on the support portion 31.

[0078] In this manner the operations of mounting and dismounting, together with possible control operations, are facilitated by the presence of a window communicating with the aforesaid insertion seat 310.

[0079] More in detail, the first rotation body 51 is extended between an upper end 51', housed within the aforesaid insertion seat 310, and a lower end 51", projecting from the insertion seat 310 itself and comprises a cylindrical rotor shaft 511 and a guide element 512, which projects radially from the rotor shaft 511, preferably in proximity to the upper end 51".

[0080] More in detail, the guide element 512 has a semi-circular shape and is extended circumferentially from the rotor shaft 511 along an arc of circumference defined by a first angle comprised between 60° and 120°, preferably about 90°.

[0081] The guide element 512 is advantageously provided with a first slide surface, preferably substantially parallel to the lateral surface of the rotor shaft 511, and with two first stop walls, which are extended substantially radially from the rotor shaft 511 and define two shoulders 513 of the guide element 512.

[0082] Advantageously, in accordance with the preferred embodiment, the first movement means 5 comprise a fixed body 53, which is housed within the insertion seat 310 and is constrained to the latter in order to be prevented from rotating around the first rotation axis Z.

[0083] More in detail, the fixed body 53 comprises advantageously an engagement element 531, and preferably two engagement elements 531, which are housed in corresponding engagement seats made on the support portion 31 of the appendage 3, in order to render the fixed body 53 and the support portion 31 integral in rotation.

[0084] The fixed body 53 is advantageously mechanically connected to the first rotation body 51 in order to support it in position during the rotation around the first rotation axis Z.

[0085] In particular, the fixed body 53 internally defines a guide seat 530, within which the first rotation body 51 is at least partially housed, at least with the guide element 512 thereof, in order to guide the first rotation body 51 during its rotation around the first rotation axis Z.

[0086] More in detail, the guide seat 530 of the fixed body 53 comprises a second slide surface, which is placed facing and preferably in abutment against the first slide surface of the guide element 512.

[0087] Advantageously, the first movement means 5 comprise a device for feeding a pressurized fluid, preferably oil, and a circuit for feeding the aforesaid pressurized fluid.

[0088] More in detail, advantageously the guide seat 530 is placed to intercept the feed circuit and the fixed body 53 is for such purpose provided with two feed openings 532, placed in communication with the guide seat 530 in order to allow pumping the pressurized fluid within the guide seat 530 itself, inducing the rotation of the rotor shaft 511.

[0089] In particular, the guide element 512 of the first rotation body 51 defines, in the guide seat 530, two half-chambers S1, S2, each of which provided with one of the aforesaid feed openings 532. More in detail, the pressurized fluid pumped into one of the two half-chambers S1, S2 by means of one of the two feed openings 532 exerts a pressure on the guide element 512, rotating it around the first rotation axis Z, in particular towards the other feed opening 532, through which meanwhile the excess fluid is advantageously suctioned.

[0090] In this manner it is therefore possible to vary the angular position of the first rotation element 51 around the same first rotation axis Z and, by interrupting the pumping of the pressurized fluid, maintain the above-reached angular position, allowing a safe and stable orientation of the first rotation body 51 and of the hydrodynamic portion 32.

[0091] Therefore, in accordance with the above-described embodiment, the first actuator member comprises the pressurized fluid (preferably oil) which, when pumped within the guide seat 530, allows rotating the first rotation body 51.

[0092] Of course, without departing from the protective scope of the present invention, it is also possible to employ actuator members of different type, such as pneumatic or mechanical actuator members, well known to the man skilled in the art and therefore not described in detail hereinbelow. The aforesaid actuator members can also be advantageously placed directly on the hull 2.

[0093] The fixed body 53 also comprises preferably a stop element 533, which is extended projecting from an internal surface of the same fixed body 53 to partially intercept the guide seat 530 and is extended between a first stop wall 533' and a second stop wall 533", angularly spaced from each other by an angle comprised between 60° and 120°, and preferably 90°.

[0094] More in detail, the first and the second stop walls 533', 533" are arranged for cooperating with the shoulders 513 of the guide element 512, in order to prevent

further rotations of the latter around the first rotation axis Z.

[0095] Advantageously, moreover, the stop element 533 is provided with a face, directed towards the center of the guide seat 530, which has semi-cylindrical form and is preferably counter-shaped with respect to the profile of the rotor shaft 511.

[0096] The aforesaid semi-cylindrical face of the stop element 533 is advantageously arranged for being placed in abutment against the external surface of the rotor shaft 511 in order to support and guide the latter during the rotation around the first rotation axis Z, in particular preventing the rotor shaft 511 from being tilted with respect to the first rotation axis Z.

[0097] Advantageously, the two feed openings 532 are each provided with a feed hole, which is extended substantially parallel to the stop walls 533', 533".

[0098] Preferably, the aforesaid feed openings 532 are made on the upper part of the fixed body 53, each at a distinct stop wall 533', 533", in order to allow pumping the pressurized fluid as close as possible to the stop walls 533', 533", against which it is susceptible of abutting against the guide element 512.

[0099] Advantageously, the first and the second stop walls 533', 533" of the stop element 533 are each provided with a groove 534 substantially aligned with the corresponding feed opening 532 and preferably semicircular, so as to allow the pumping of the pressurized fluid even when the guide element 512 is placed in abutment against one of the aforesaid stop walls 533', 533".

[0100] The fixed body 53 comprises two fixing plates 54 fixed to each other, preferably by means of a bolted connection, and a central body 55, interposed between the aforesaid fixing plates 54 in order to be retained in position on the first rotation body 51.

[0101] More in detail, the fixed body 53 comprises a first fixing plate 54', placed in abutment against a lower wall of the guide element 512, and a second fixing plate 54", placed in abutment against an upper wall, opposite the aforesaid lower wall of the guide element 512. In this manner, with the first and the second fixing plate 54', 54" placed in abutment against the respective lower and upper walls of the guide element 512 and fixed together, the central body 55 is integral in translation with respect to the first rotation element 51.

[0102] Advantageously, the two engagement elements 531 are extended projecting from the central body 55.

[0103] Preferably, the first rotation body 51 comprises, at the lower end 51", a first hinging eyelet 510, provided with a through hole oriented along the second rotation axis Y.

[0104] Advantageously, the second movement means 6 comprise a second rotation body 61, rotatably engaged with the first rotation body 51 around the second rotation axis Y, and the aforesaid second actuator member 62, interposed between the hydrodynamic portion 32 and the first rotation body 51 in order to rotate the hydrodynamic portion 32 around the second rotation axis Y.

[0105] Preferably, the second rotation body 61 is integral in rotation with respect to the hydrodynamic portion 32.

[0106] Advantageously, in accordance with the preferred embodiment, the second rotation body 61 comprises a pin, inserted within the through hole of the hinging eyelet 510 and rotatable with respect to the latter around the aforesaid second rotation axis Y.

[0107] Preferably, the hydrodynamic portion 32 comprises an attachment element, projecting above and comprising two second hinging eyelets that are spaced from each other.

[0108] More in detail, the two second hinging eyelets are placed with the respective through holes aligned with the through hole of the first hinging eyelet 510, with the latter interposed between the two second hinging eyelets, and the pin is placed to traverse the through hole of the first hinging eyelet 510 and the through holes of the two second hinging eyelets.

[0109] Otherwise, in accordance with an embodiment variant not illustrated in the enclosed figures, the pin of the second rotation body 61 is directly fixed to the hydrodynamic portion 32, for example by means of two connection arms and is therefore integral in rotation with the latter.

[0110] Of course, without departing from the protective scope of the present invention, it is also possible to provide that the attachment element of the hydrodynamic portion 32 comprises only one second hinging eyelet, while the first rotation body 51 comprises, at the lower end 51", two first hinging eyelets 510, substantially reversing the mechanism of coupling between first rotation body 51 and hydrodynamic portion 32.

[0111] Advantageously, the second actuator member 62 comprises a piston 620, preferably oil-pressure, which is extended between a head end 62', mechanically connected to the first rotation body 51, and a bottom end 62", mechanically connected to the hydrodynamic portion 32.

[0112] In this manner it is possible at the same time to rotate the hydrodynamic portion 32 (and the second actuator member 62 therewith) around the first rotation axis Z, by means of the first rotation body 51 actuated by the first actuator member, and around the second rotation axis Y, by means of the second rotation body 61 actuated by the second actuator member 62. Advantageously, the second actuator member 62 is mechanically connected to the first rotation body 51 and with the hydrodynamic portion 32 by means of suitable articulation elements, which can for example in turn comprise eyelet elements, ball articulations or any other articulation element which allows obtaining a degree of freedom for the second actuator member 62, preventing the sum of the aforesaid rotations from being able to damage it. Advantageously, the first rotation body 51 comprises a connection flange 514, which is extended projecting from the rotor shaft 511, transverse with respect to the first rotation axis Z.

Preferably the connection flange 514 is made in proximity to the first hinging eyelet 510 and still more preferably at the insertion seat 310.

[0113] Advantageously, the connection flange 514 is also substantially counter-shaped with respect to the plan shape of the support portion 31, at the lower end 31" thereof, so as to reduce to the minimum the hydrodynamic impact of the flange 514 during navigation. For such purpose, the same connection flange 514 is extended only from one side of the rotor shaft 511, in order to prevent impacting against elements interposed between the support portion 31 and the hydrodynamic portion 32.

[0114] Advantageously, the hydrodynamic portion 32 is extended, along the main extension axis X, between a rear widened portion 321 and a front tapered portion 322 and the housing seat of the hydrodynamic portion is preferably made in the rear widened portion 321.

[0115] Advantageously, the widened portion 321 is extended between a front section, directed towards the tapered portion 322, and a rear section, opposite the front section.

[0116] Preferably, the widened portion 321 is extended with a tapering between a front section and the rear section in order to obtain a shape with reduced hydrodynamic impact.

[0117] In this manner it is possible to house, in the housing seat S, propulsion means 4 provided with a main extension along a direction substantially orthogonal to the main extension axis X of the hydrodynamic portion 32, hence allowing the attainment of a hydrodynamic portion 32 with reduced size during navigation.

[0118] Advantageously, in accordance with the preferred embodiment illustrated in the enclosed figures the propulsion means 4 comprise a motor 41, housed in the housing seat S and provided with an outlet shaft 411, which projects at least partially from the housing seat S, and at least one propeller 42, placed outside the hydrodynamic portion 32, at the rear widened portion 321 and fixed to the outlet shaft 41 in order to be rotated by the latter.

[0119] In accordance with a non-illustrated embodiment variant of the boat the propulsion means 4 are of the type with tube propeller or alternatively of the type with hydrojet or with turbine, which are well known to the man skilled in the art and therefore they will not be described in detail hereinbelow.

[0120] Preferably, the propeller 42 is placed at the rear section of the widened portion 321 of the hydrodynamic portion 32.

[0121] More in detail, the hydrodynamic portion 32 is advantageously provided with a housing pocket 323, which is extended through, along a direction substantially orthogonal to the main extension axis X, at the rear section of the widened portion 321 and the propeller is housed at least partially within the aforesaid housing pocket.

[0122] Advantageously, the motor 41 is a combustion motor and the propulsion means 4 comprise a tank intended to contain fuel for the combustion motor, and such tank is housed within a seat thereof or within the housing seat where the motor 41 is installed.

[0123] More in detail, in accordance with the preferred embodiment illustrated in figure 7, the motor 41 is a motor with opposite cylinders, preferably a boxer motor, which comprises a motor body 410 provided with an outlet shaft 411, and two cylinders 412 opposite each other with respect to the motor body 410, preferably at 180°.

[0124] Advantageously, each of the two opposite cylinders 412 is mechanically connected to a distinct cam, each of which in turn integral in rotation with the outlet shaft 411 such that the cylinder 412 during its movement rotates (by means of the corresponding cam) the outlet shaft 411. The operation of the boxer motor is well known to the man skilled in the art and therefore will not be described in detail hereinbelow.

[0125] The use of a motor 41 of boxer allows considerably reducing the vibrations imparted by the motor 41 to the hydrodynamic portion 32, allowing a greater stability of the entire the boat 1.

[0126] In accordance with the preferred embodiment, in which the motor 41 is a combustion motor, this is provided with at least one duct for expelling the exhaust gases, at least one for for feeding air and at least one duct for feeding fuel.

[0127] Advantageously, the support portion 31 is extended between an upper end 31', mechanically connected to the hull 2, and a lower end 31", rotatably connected to the hydrodynamic portion 32.

[0128] Advantageously, the support portion 31 is provided with at least one through transport channel 313, which is extended inside the support portion 31 between the upper end 31' and the lower end 31" and at its interior houses at least the aforesaid air feed duct and at least one duct for discharging exhaust gas from the motor 41.

[0129] In accordance with the preferred embodiment illustrated in figure 5, the support portion 31 is provided with two transport channels 313, in which a first transport channel houses the air feed duct and a second transport channel houses the exhaust duct of the motor 41.

[0130] Of course, without departing from the protective scope of the present invention, the motor 41 can be a motor of different type, for example a V-shaped internal combustion motor, a rotary motor of turbine type or an electric motor, for example of the type with permanent magnets. Advantageously, in the event in which the motor 41 is an electric motor (e.g. of the type with permanent magnets), the propulsion means 4 comprise at least one supply device, preferably one or more batteries, and at least one inverter, interposed between the supply device and the electric motor in order to convert the direct current entering from the supply device into direct current exiting towards the electric motor 41.

[0131] Advantageously, the inverted is housed within the housing seat S and the at least one transport channel 313 houses the supply cables which are connected on one side to the supply device, preferably placed on board

the hydrofoil 1, and on the other side to the inverter placed within the housing seat S. In this manner, in addition to saving on the overall weight supported by the hydrofoil, it is also possible to quickly and efficiently cool the motor and the inverter due to the same water in which they are immersed, as is better specified hereinbelow.

[0132] Advantageously, the hydrodynamic portion 32 comprises a cooling circuit which is extended inside the hydrodynamic portion 32 itself, next to the housing seat S, in order to cool the propulsion means 4.

[0133] Advantageously, the cooling circuit is extended between an inlet mouth, made at the front tapered portion 322 of the hydrodynamic portion 32 in order to allow the entrance of water during navigation, and a discharge mouth in order to allow the discharge of water from the cooling circuit.

[0134] Advantageously, the hydrodynamic portion 32 comprises a hydrodynamic body and introduction lip, which projects below the latter and at least partially defines the inlet mouth of the cooling circuit.

[0135] The boat thus conceived therefore achieves the pre-established objects.

Claims

1. Boat comprising:

- a hull (2);
- at least two appendages (3), projecting from said hull (2), intended to be immersed in water in order to generate a lift in navigation;
each said appendage (3) comprising:

  - a support portion (31), mechanically connected to said hull (2);
  - a hydrodynamic portion (32) which is extended along at least one main extension axis (X) and defines, at its own interior, at least one housing seat (S);

said hydrodynamic portion (32) being rotatably connected to said support portion (31) around a first rotation axis (Z) substantially orthogonal to said main extension axis (X), and around a second rotation axis (Y) substantially orthogonal to said first rotation axis (Z) and to said main extension axis (X);
- propulsion means (4), housed at least partially within the housing seat (S) of said hydrodynamic portion (32);

said boat being **characterized in that** it comprises:

- first movement means (5), placed in mechanical connection between said hydrodynamic portion (32) and said support portion (31) in order to drive the rotation of said hydrodynamic portion (32) around said first rotation axis (Z);
- second movement means (6), placed in mechanical connection between said hydrodynamic portion (32) and said support portion (31) in order to drive the rotation of said hydrodynamic portion (32) around said second rotation axis (Y).

2. Boat according to claim 1, **characterized in that** said first movement means (5) comprise:

- a first rotation body (51) rotatably engaged with said support portion (31) around said first rotation axis (Z) and integral in rotation with respect to said hydrodynamic portion (32);
- a first actuator member which acts on said first rotation body (51) in order to rotate it around said first rotation axis (Z).

3. Boat according to claim 2, **characterized in that** said second movement means (6) comprise:

- a second rotation body (61) rotatably engaged with said first rotation body (51) around said second rotation axis (Y);
- a second actuator member (62), interposed between said hydrodynamic portion (32) and said first rotation body (51) in order to rotate said hydrodynamic portion (32) around said second rotation axis (Y).

4. Boat according to claims 2 and 3, **characterized in that** said first rotation body (51) comprises a connection flange (514), said second actuator member (62) comprises a piston (620), which is extended between a head end (62') connected to the connection flange (514) of said first rotation body (51), and a second end (62") connected to the hydrodynamic portion (32).

5. Boat according to any one of the preceding claims, **characterized in that** said hydrodynamic portion (32) is extended, along said main extension axis (X), between a rear widened portion (321) and a front tapered portion (322);
the housing seat (S) of said hydrodynamic portion (32) being made in said rear widened portion (321).

6. Boat according to claim 5, **characterized in that** said propulsion means (4) comprise:

- a motor (41), housed in said housing seat (S) and provided with an outlet shaft (411), which projects at least partially from said housing seat (S);
- at least one propeller (42), placed outside said hydrodynamic portion (32) at said rear widened portion (321) and fixed to said outlet shaft (411)

in order to be actuated in rotation by said motor (41).

7. Boat according to claim 6, **characterized in that** said motor (41) is a combustion motor and said propulsion means (4) comprise a tank intended to contain a fuel fluid for said combustion motor (41), said tank being housed within said housing seat (S).

8. Boat according to claim 7, **characterized in that** said support portion (31) is extended between an upper end (31'), mechanically connected to said hull (2), and a lower end (31"), rotatably connected to said hydrodynamic portion (32);
said support portion (31) being provided with at least one through transport channel (313), which is extended inside said support portion (31) between said upper end (31') and said lower end (31") and at its interior houses at least one duct for loading the supply air of said combustion motor (41), and at least one duct for discharging the combustible gases from said combustion motor (41).

9. Boat according to any one of the preceding claims, **characterized in that** said hydrodynamic portion (32) comprises a cooling circuit which is extended inside said hydrodynamic portion, next to said housing seat (S), in order to at least partially cool said propulsion means (4);
said cooling circuit being extended between an inlet mouth, made at the front tapered portion (322) of said hydrodynamic portion (32) in order to allow the entrance of water during navigation, and a discharge mouth in order to allow the discharge of water from said cooling circuit.

10. Boat according to claims 8 and 9, **characterized in that** said hydrodynamic portion (32) comprises a hydrodynamic body and an introduction lip, which projects below said hydrodynamic body and at least partially defines the inlet mouth of said cooling circuit.

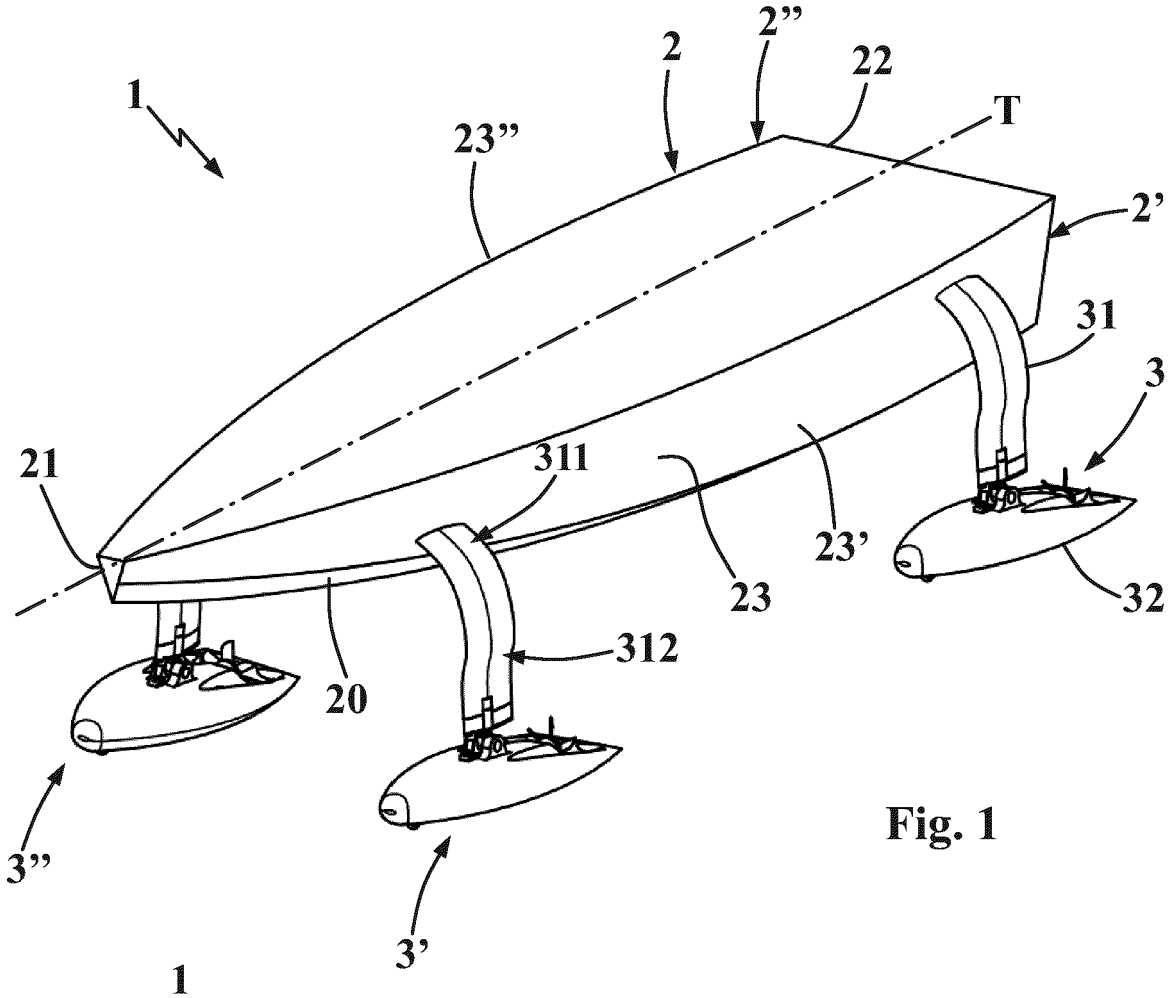

Fig. 1

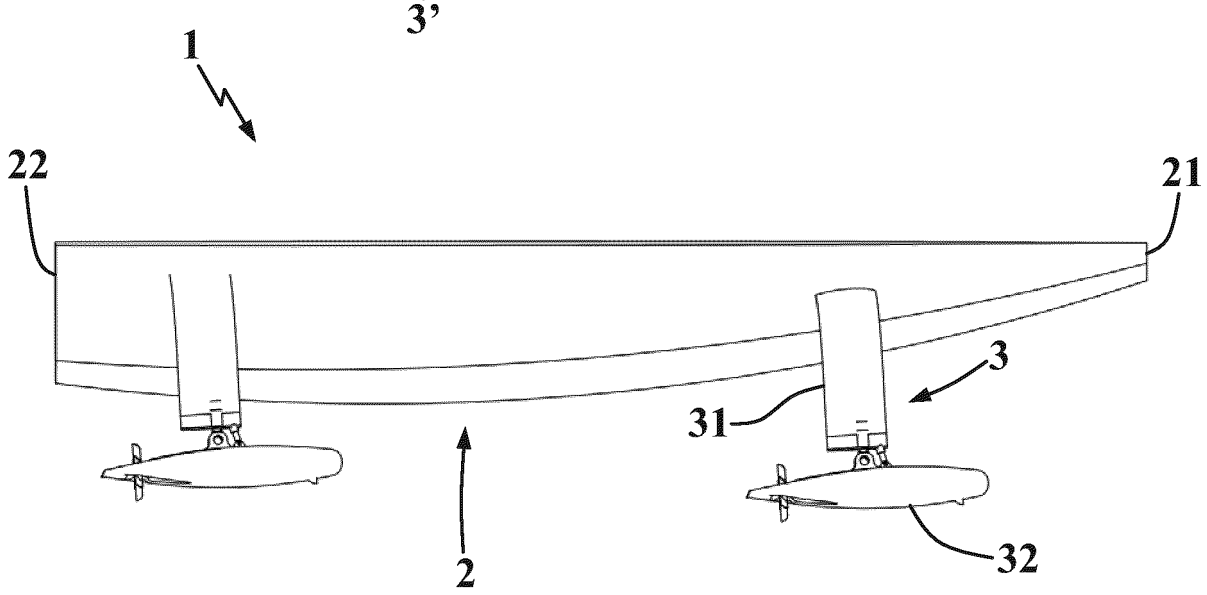

Fig. 2

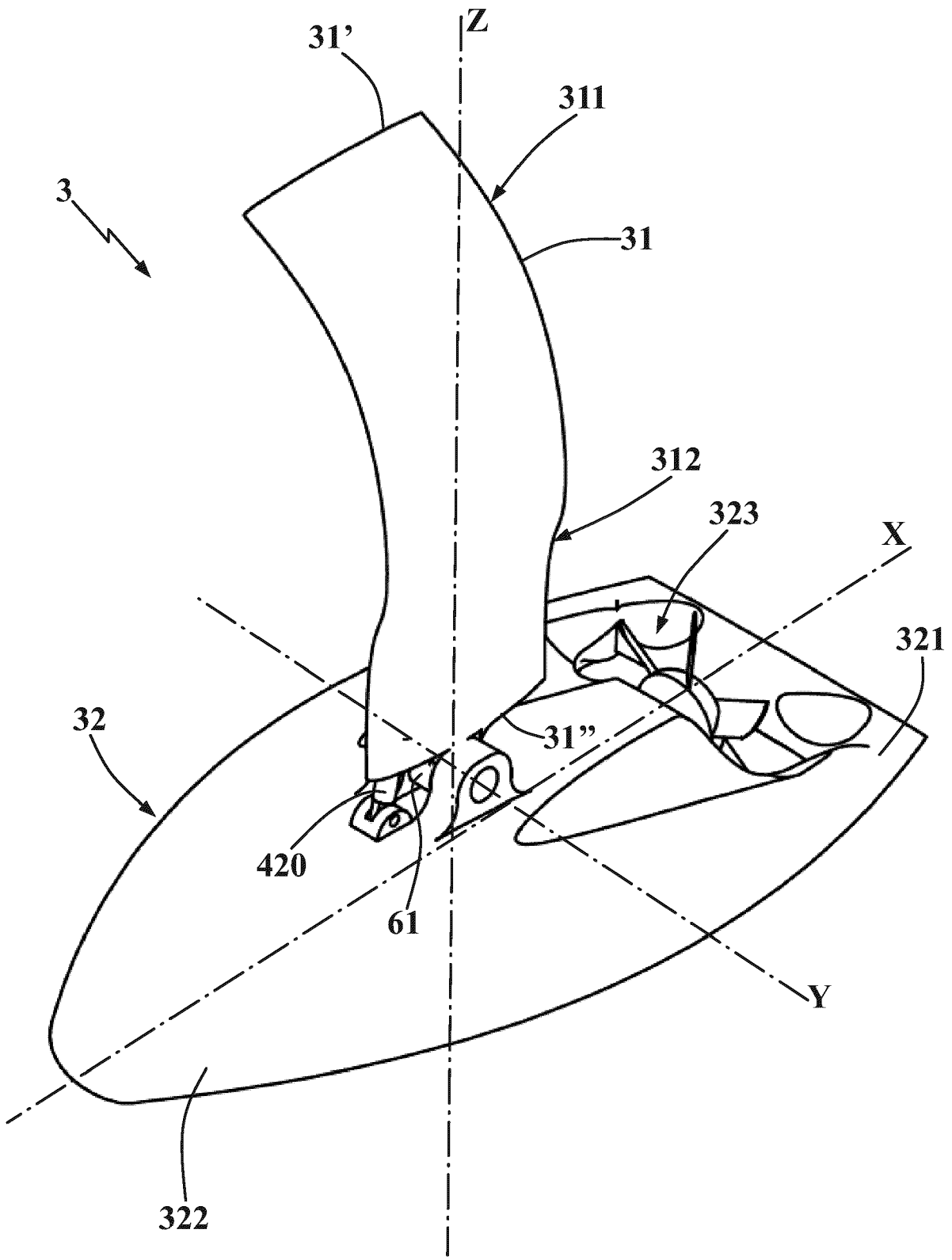

Fig. 3

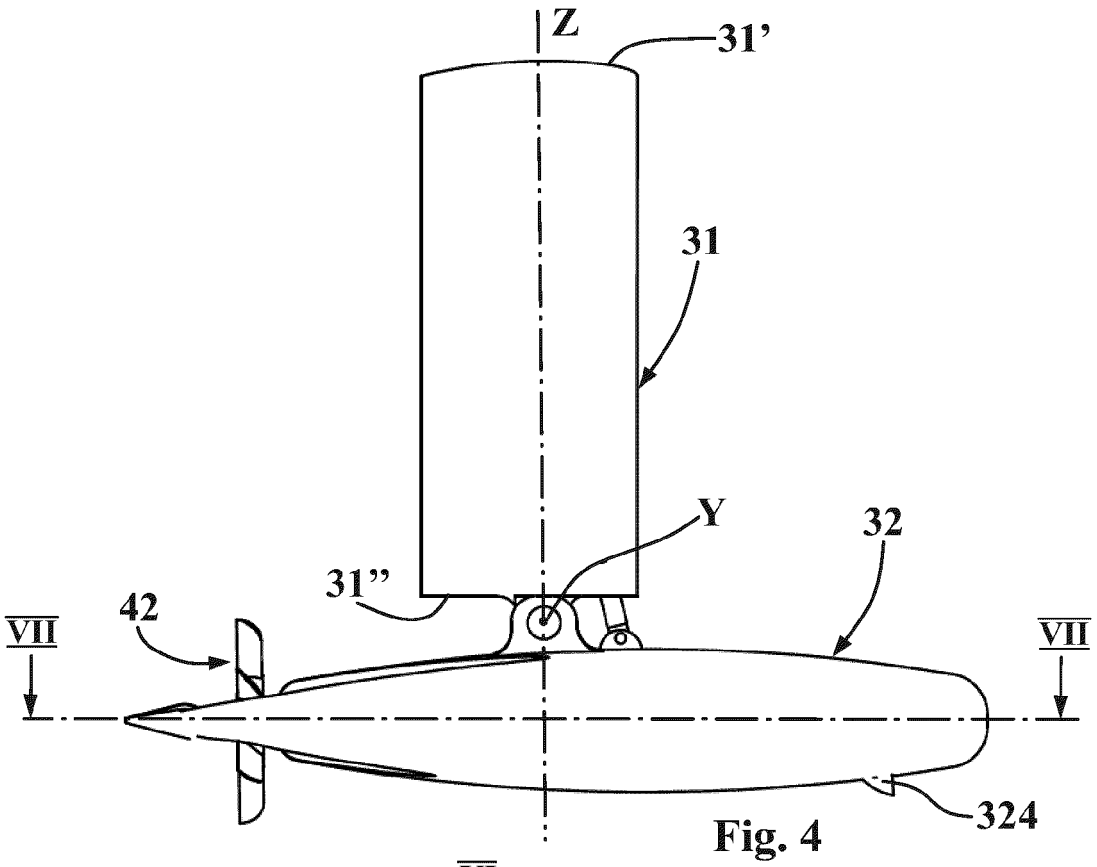

Fig. 4

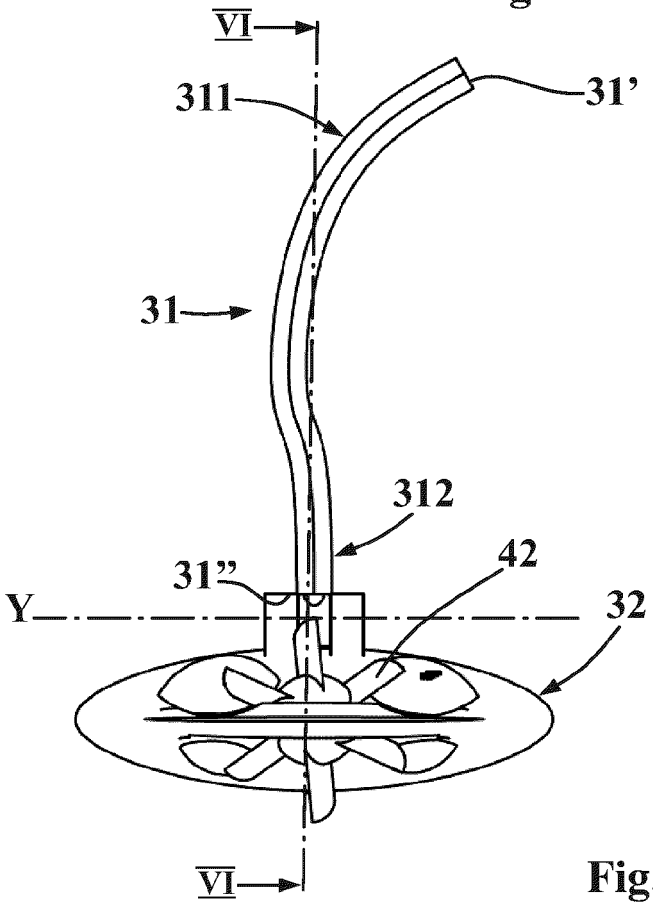

Fig. 5

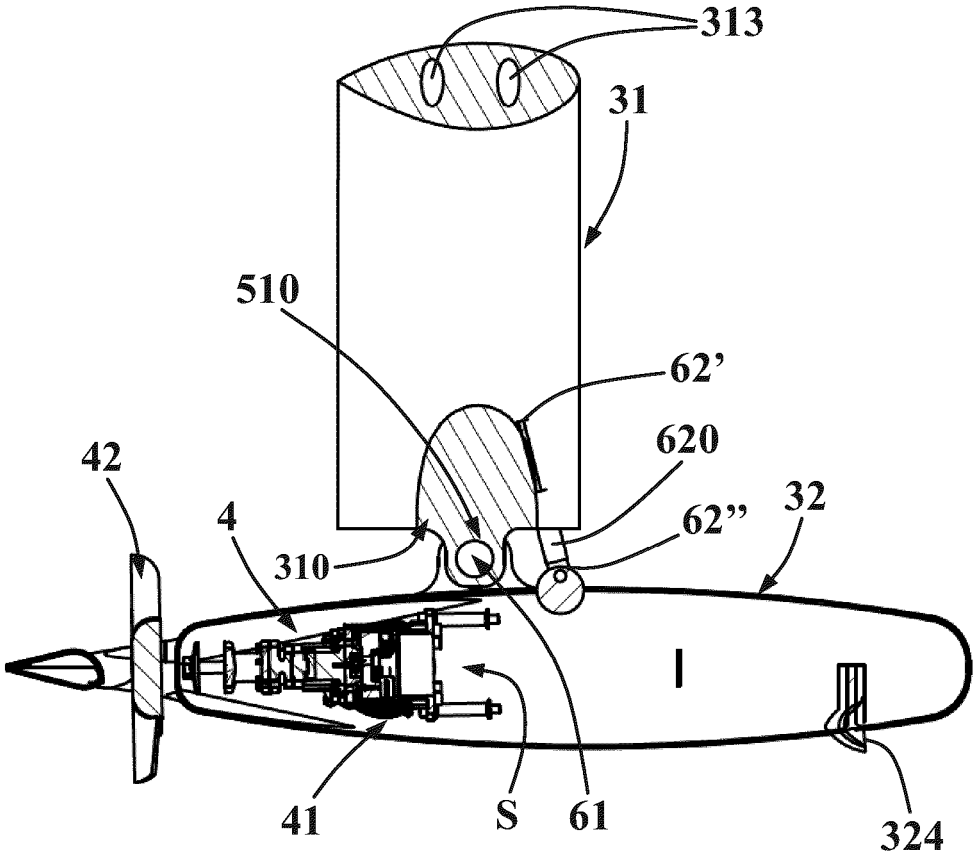
313
31
510
62'
620
42
62"
32
4
310
41
S
61
324

Fig. 6

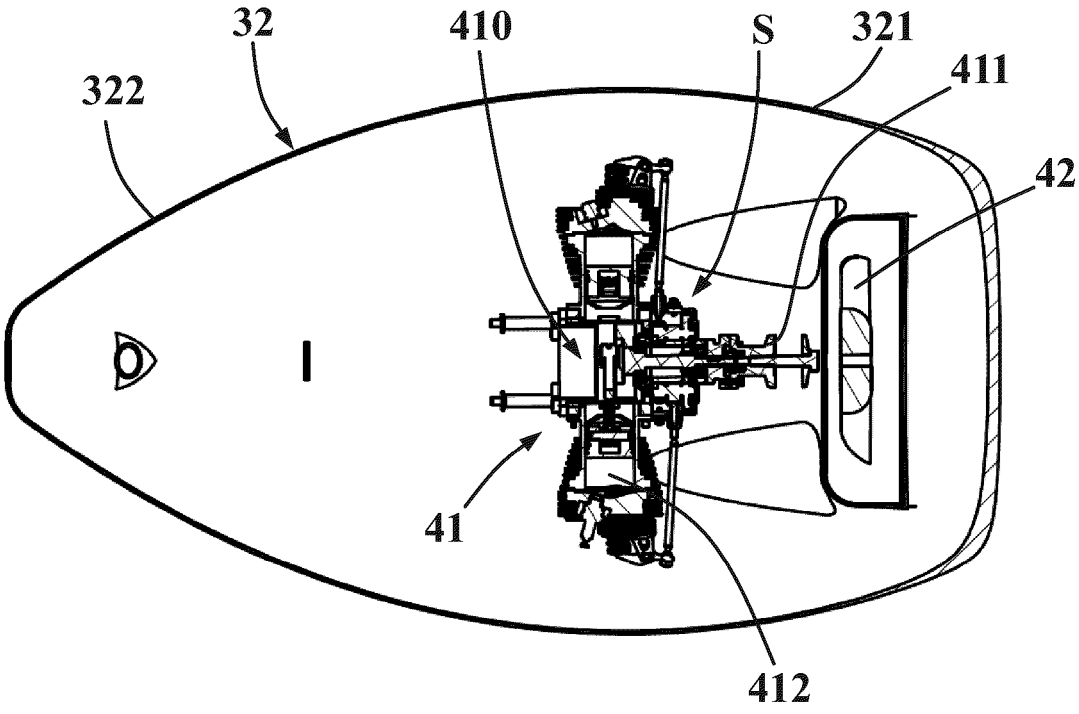
32
410
S
321
322
411
42
41
412

Fig. 7

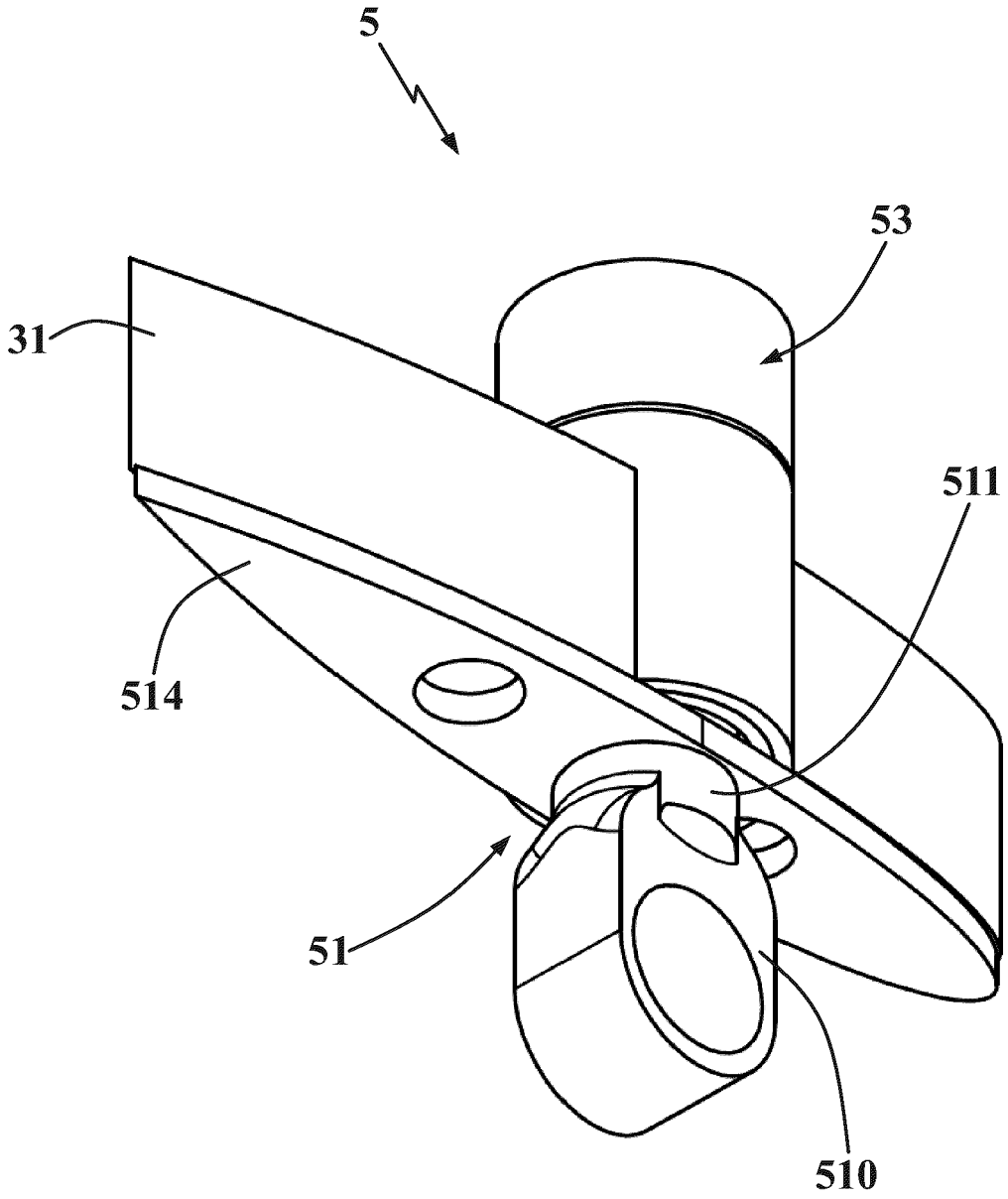

Fig. 8

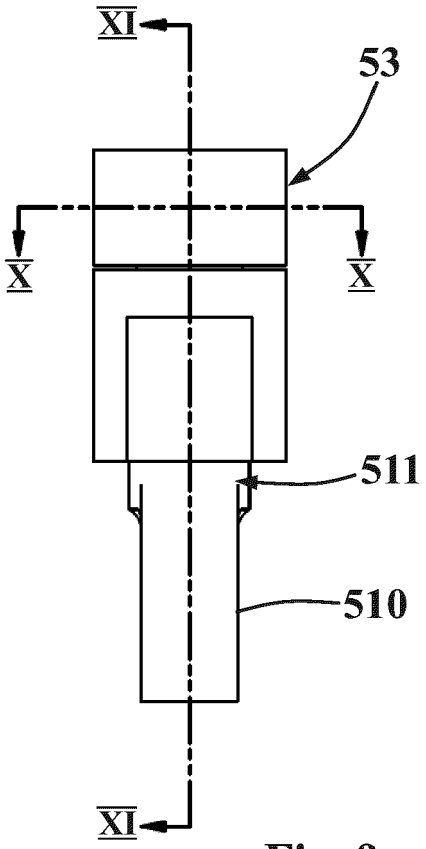

Fig. 9

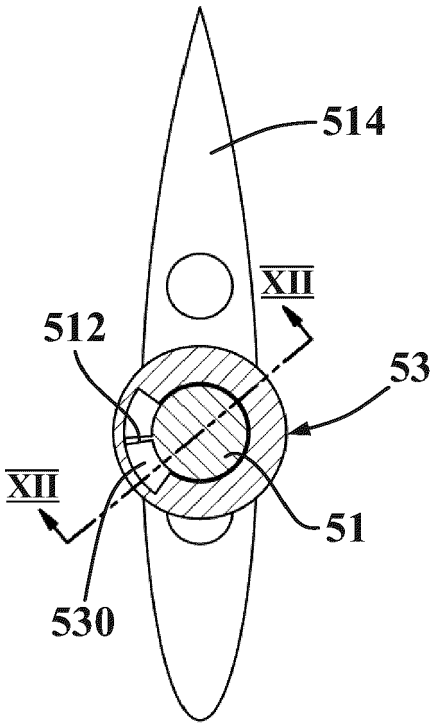

Fig. 10

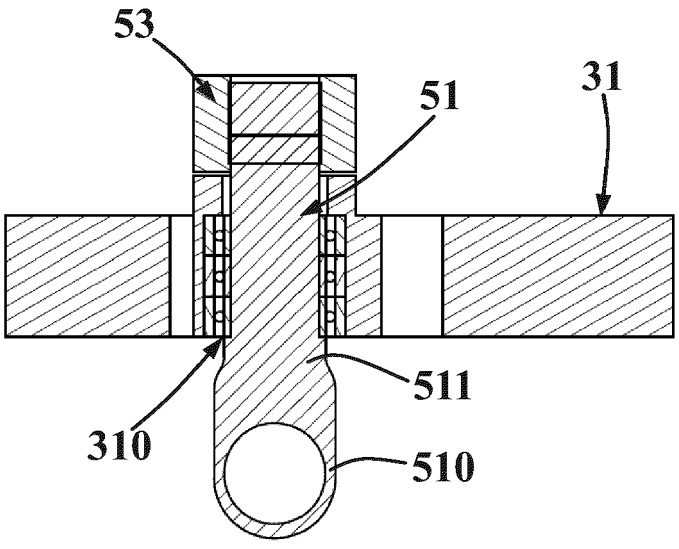

Fig. 11

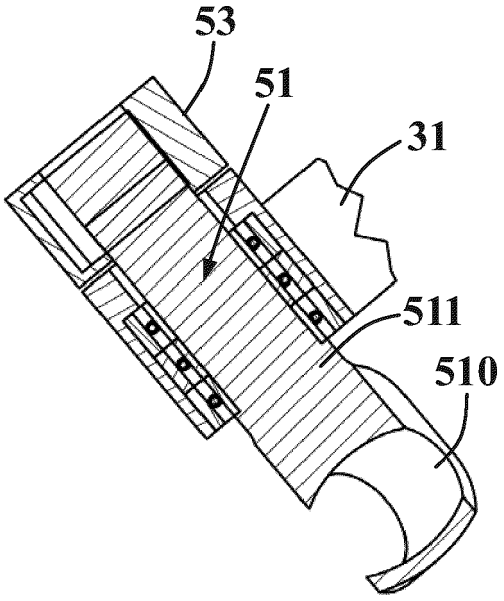

Fig. 12

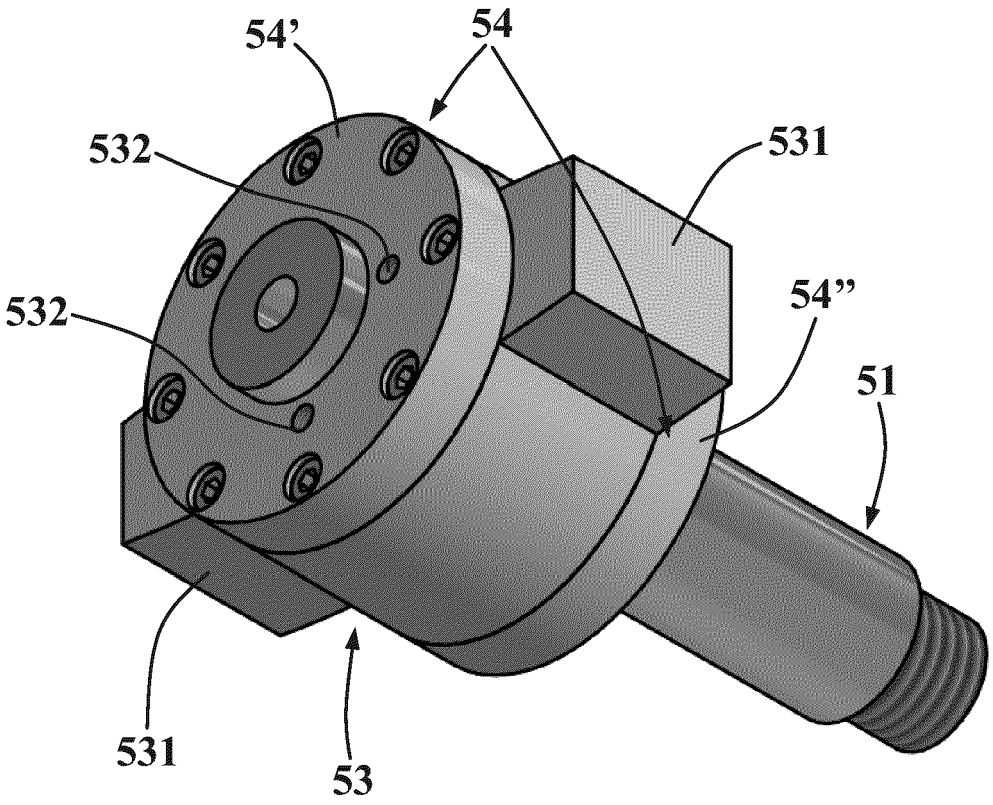

Fig. 13

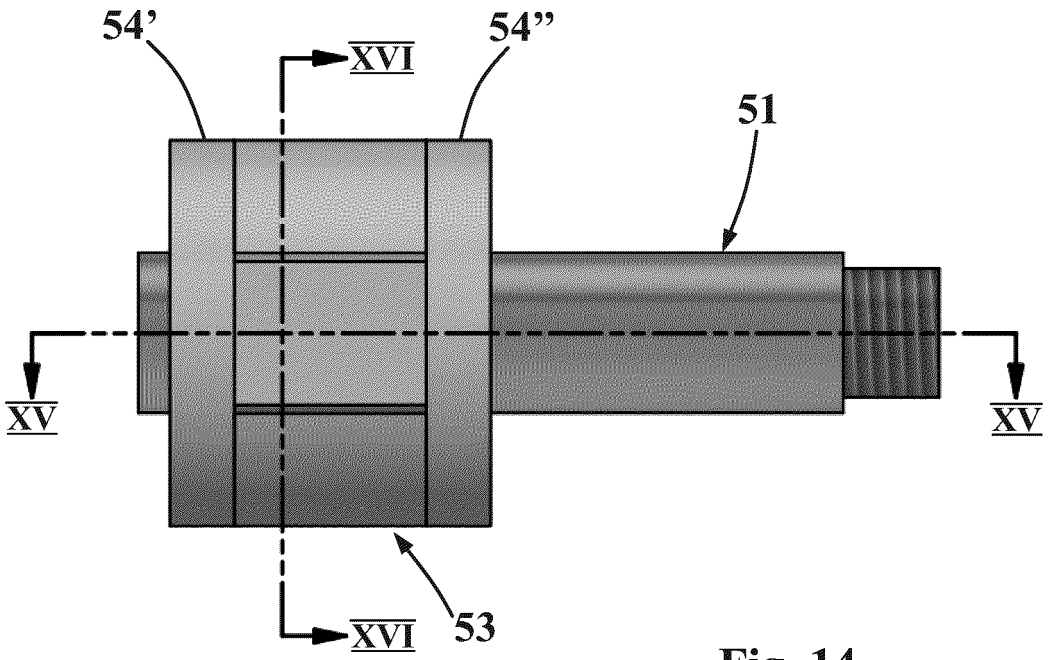

Fig. 14

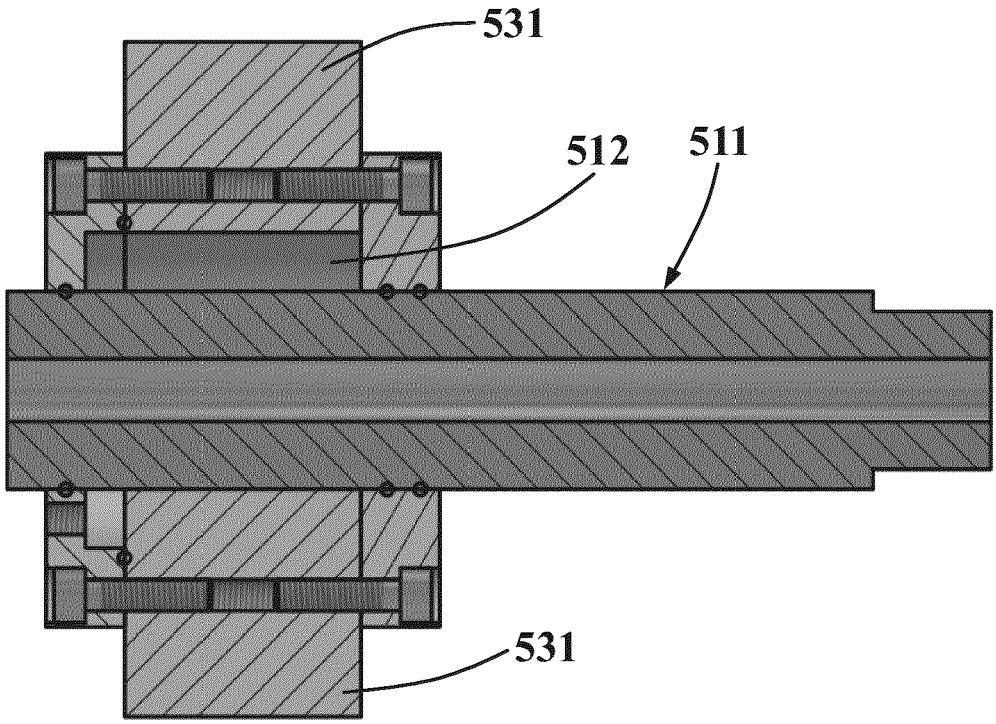

Fig. 15

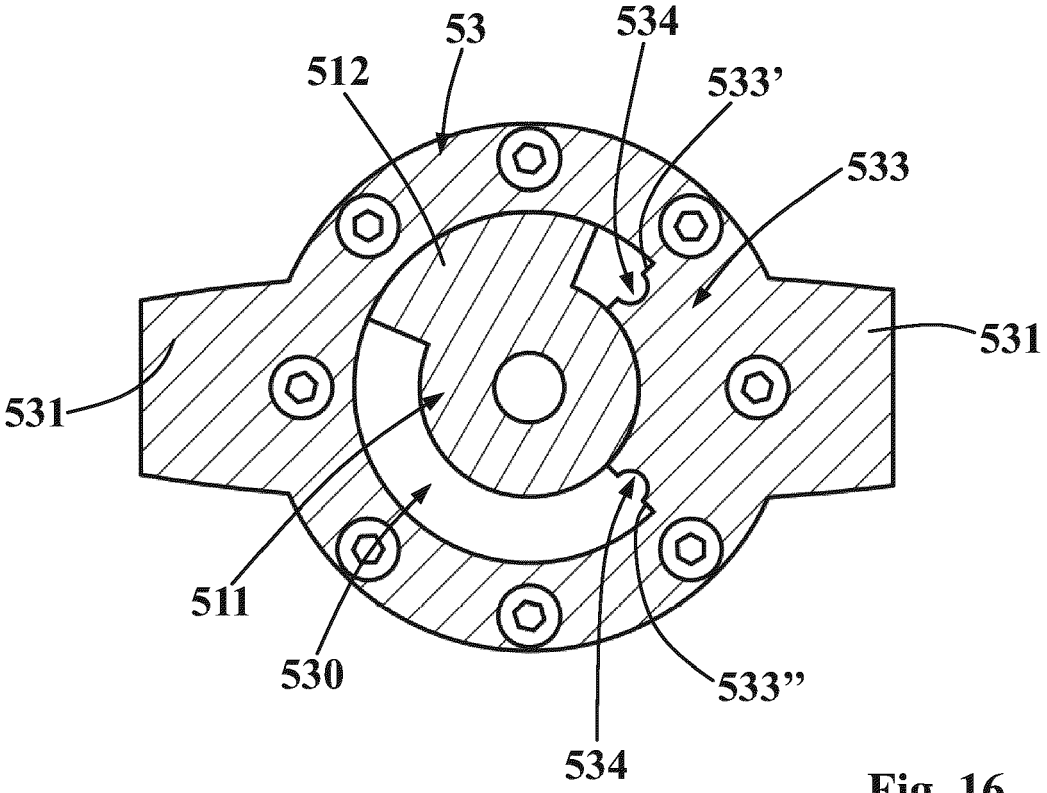

Fig. 16

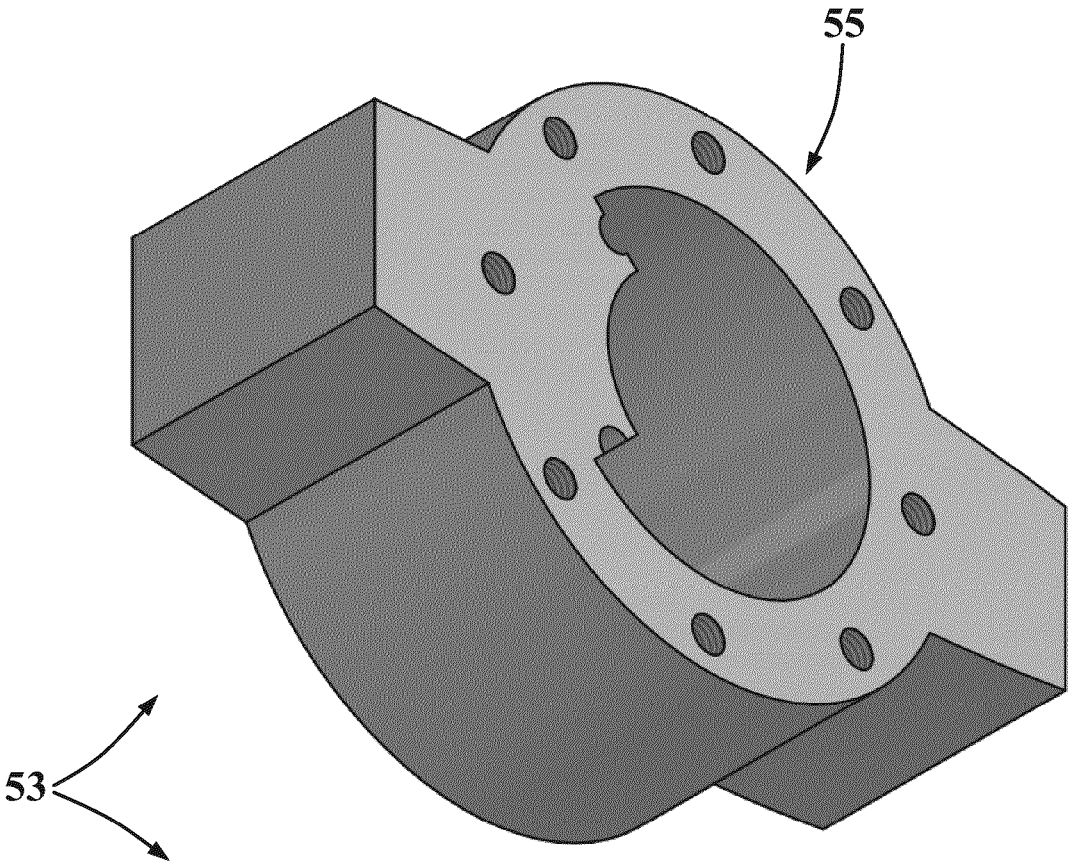

Fig. 17

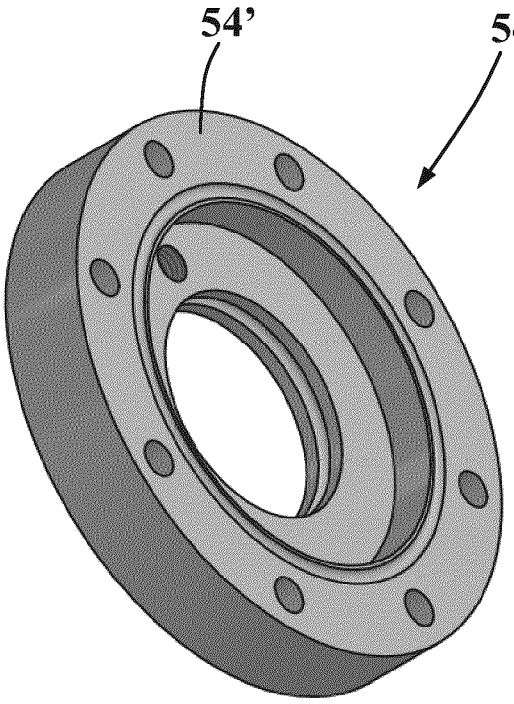

Fig. 18

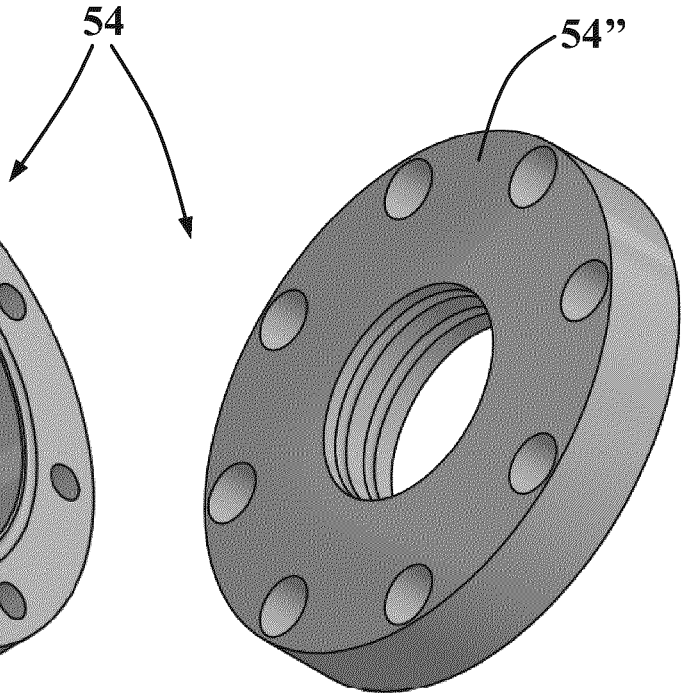

Fig. 19

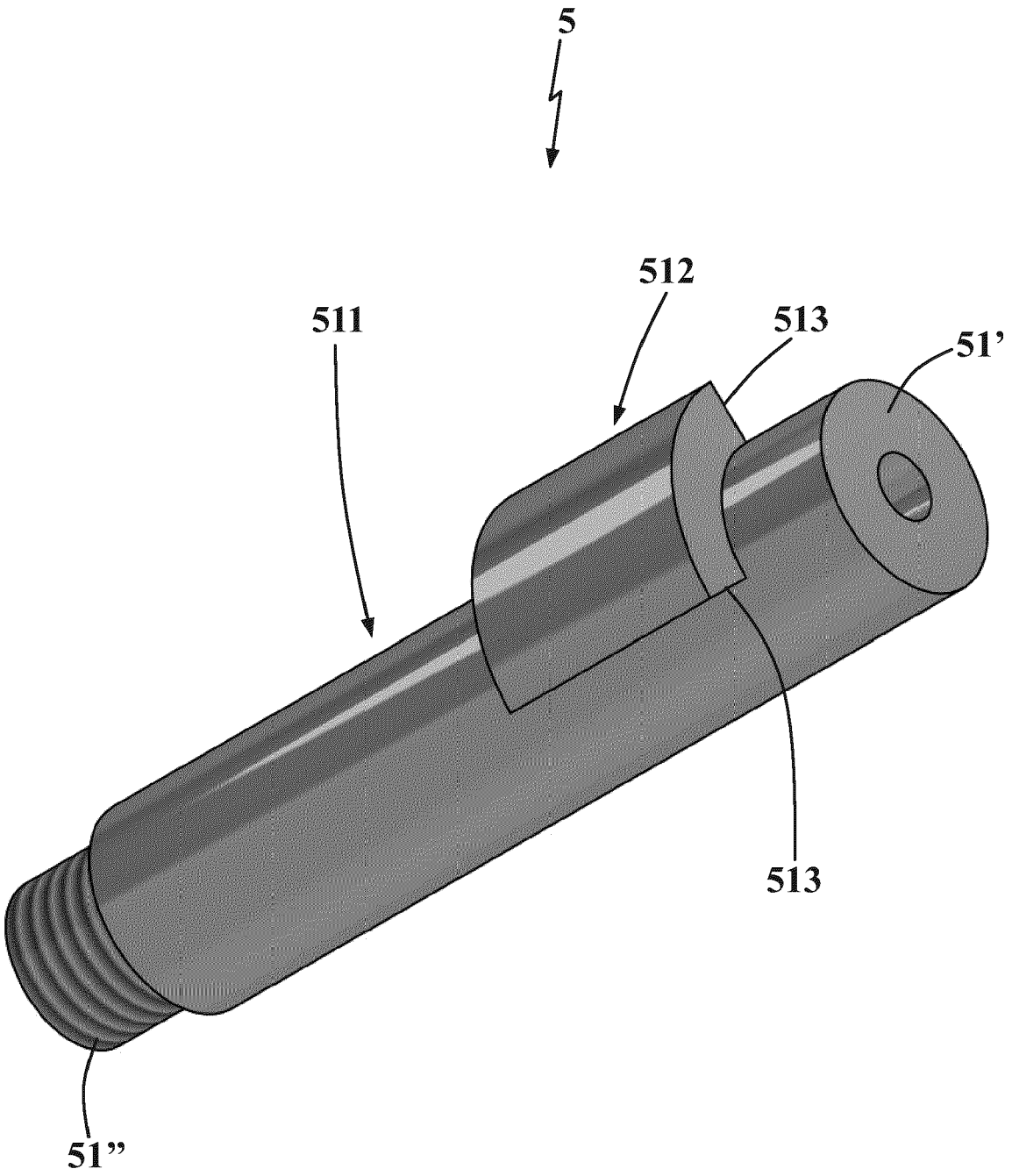

Fig. 20

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European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 3436

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 451 312 A1 (VERNIER GABRIEL) 10 October 1980 (1980-10-10) * figures 1, 2, 3, 6-9, 15 * * page 2, lines 32-34, 54-57 * * page 4, lines 14-18 *	1-10	INV. B63B1/22 B63B1/26 B63B1/28 B63H5/08 B63H21/38
X	DE 103 00 599 A1 (SOMMER JOERG [DE]) 22 July 2004 (2004-07-22) * figures 1-4 *	1-10	
X	DE 10 2018 127650 A1 (INNOGY SE) 7 May 2020 (2020-05-07) * figures 1-4 * * paragraph [0086] *	1-10	
X	GB 785 900 A (FRIEDRICH HERMANN WENDEL) 6 November 1957 (1957-11-06) * figures 1, 7-10 *	1-10	
			TECHNICAL FIELDS SEARCHED (IPC) B63B B63H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 August 2022	Freire Gomez, Jon

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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22-08-2022

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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