



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.07.2020 Bulletin 2020/30

(51) Int Cl.:
B63B 41/00 (2006.01)

(21) Application number: **20151468.4**

(22) Date of filing: **13.01.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **PS Indus BVBA**
1500 Halle (BE)

(72) Inventor: **STEVERING, Philippus Theodorus Cordula**
1500 HALLE (BE)

(74) Representative: **Philippaerts, Yannick et al Arnold & Siedsma**
Bezuidenhoutseweg 57
2594 AC The Hague (NL)

(30) Priority: **17.01.2019 NL 2022413**

(54) **KEEL ASSEMBLY CONFIGURED FOR MOUNTING IN A HULL OF A SAILING BOAT FOR PROVIDING STABILITY AND DIRECTIONAL GUIDANCE TO SAID SAILING BOAT**

(57) A keel assembly configured for mounting in a hull of a sailing boat for providing stability and directional guidance to said sailing boat, wherein the keel assembly comprises: a keel mounted on a keel shaft such that the keel is rotatable through a keel opening between a re-

tracted position and an extended position wherein the keel protrudes substantially downward from the hull, a keel opening cover configured such that it covers, in a cover position, at least part of the keel opening when the keel is in the extended position.

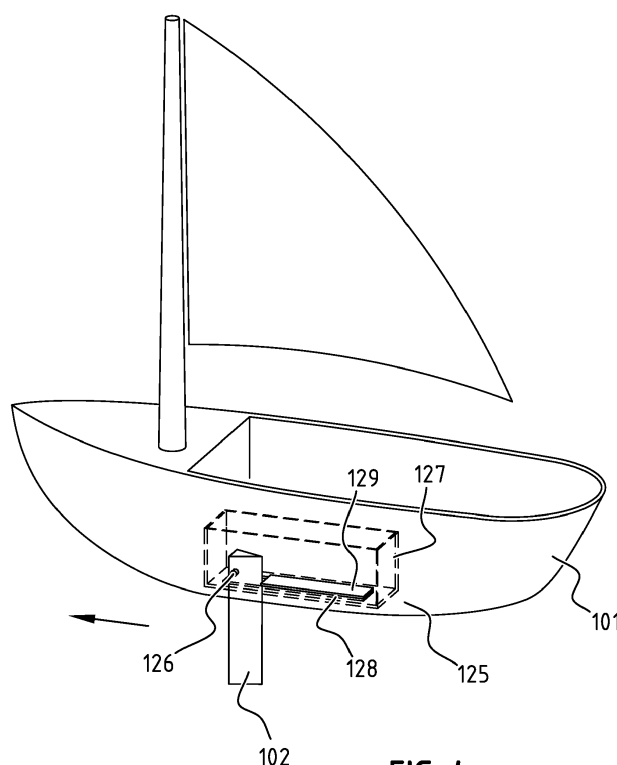


FIG. 4

Description

[0001] The present invention relates to a keel assembly configured for mounting in a hull of a sailing boat for providing stability and directional guidance to said sailing boat. In addition, the invention relates to a boat comprising such keel assembly.

[0002] Sailing yachts and boats employ the wind, acting on the sails, to propel the sailing yacht on the surface of the water. The direction of sailing can be determined based on a balance of forces between the wind acting on the sails and forces acting on a structural element of the yacht protruding below the surface of the water. The wind causes an aerodynamic sail force on the sails, comprising of a sail side force component and a sail thrust component. The sail thrust component causes the sailing boat to propel forward. The sail side force component causes the boat to drift downwind, this is typically known as the leeward direction. Thus the boat tends to drift off a course set by the captain. The water causes a hydrodynamic force on the structural element, comprising a hydrodynamic lift force component and a board drag component. The hydrodynamic lift force component aims to counteract the aerodynamic sail side force. In other words, the structural element counteracts the leeward force of the wind acting on the sails, such that a sideways motion of the sailing yacht is minimized. A secondary purpose of the structural element is to provide ballast, such that the stability of the yacht is improved whilst sailing. Such structural elements are typically known as keels.

[0003] Keels are typically bolted to the hull of the yacht or may be integrated in the hull of a yacht, such that they are formed in a single piece together with the hull. They are typically formed with a higher weight than necessary for the construction of such keels. In the context of the application the wording heavy and/or higher weight is defined as comprising more weight than necessary for the construction of an element. For example, a heavy keel is a keel having more weight than necessary for the construction of said keel. Because the yacht comprises a heavy keel, the centre of gravity of the yacht is relatively low, which improves the stability of the yacht. Therefore the yacht is allowed to carry more sail, this improves the performance of the sailing yacht. In practice such keels have a weight dependent on the size of the yacht. A yacht of 10m has a fixed keel with a weight of about 1650kg, a yacht of 14m has a keel with a weight of about 3875kg, etc. In other words, a ratio of the weight of the yacht to the weight of the fixed keel, i.e. a ballast ratio, varies from 20% to 45%. The ballast ratio is typically about 30%.

[0004] A disadvantage of a fixed keel is that the fixed keel increases the draft of the hull of the yacht. In other words, a yacht with a fixed keel protrudes much deeper in the water than a yacht without a fixed keel. This reduces the sailing area in which a yacht may sail. In practice, a yacht with a fixed keel may not sail or moor in shallow areas.

[0005] A centreboard is a structural element which is typically retractable and which serves a similar purpose, i.e. limiting drift, as a keel. The retractability of the centreboard allows the centreboard to be raised, such that the sailing boat may sail or moor in shallow waters. A centreboard typically comprises a limited width and a high aspect ratio, which is the ratio of the length of the centreboard to its mean chord. In other words, a centreboard typically has an elongated shape. The centreboard is typically a slim element in order to reduce drag in the water. Because the centreboard has an elongated shape and is typically slim, the centreboard does not comprise a weight higher than necessary for the construction of the centreboard.

[0006] A disadvantage of a centreboard is that the centre of gravity of the sailing boat with a centreboard is relatively high compared to the centre of gravity of a comparable sailing boat with a keel. Because the centre of gravity is relatively high, the righting effect - the effect which keeps the boat substantially upright - is sub-optimal. Therefore more internal ballast is needed to obtain a similar stability compared to a boat with a fixed keel. The extra weight reduces the performance of the yacht.

[0007] US1118360 describes a retractable keel. Said retractable keel is mounted at least partially in the hull of the yacht and may be lowered and raised from the hull into or from the water. A sailing yacht or boat with a retractable keel has a suboptimal performance.

[0008] It is an object of the present invention to improve the performance of a sailing yacht or boat with a retractable keel.

[0009] The invention provides for this purpose a keel assembly configured for mounting in a hull of a sailing boat for providing stability and directional guidance to said sailing boat, wherein the keel assembly comprises:

- a keel mounted on a keel shaft such that the keel is rotatable through a keel opening between a retracted position and an extended position wherein the keel protrudes substantially downward from the hull,
- a keel opening cover configured such that it covers, in a cover position, at least part of the keel opening when the keel is in the extended position.

[0010] The invention is based on the insight that a large opening in hull affects the performance of the sailing boat. However the skilled person will appreciate that the length and weight of a keel otherwise positively effect the performance of a sailing boat. A keel opening provided in the hull of a boat allows a keel to rotate through the keel opening. The keel opening is situated at the bottom of the hull. By covering the keel opening with a keel opening cover, the hydrodynamic streamline of the hull is improved, thereby reducing drag and turbulence. Hence the performance of the ship, when sailing with extended keel, is improved. In other words, water is no longer allowed to enter the hull of the ship which would substantially slow down the movement of the sailing boat. An

additional advantage is that by providing a keel which is retractable, the draft of a sailing boat may be reduced or increased depending on the location where the yacht is sailed. For example, the sailing yacht may be sailed or moored in shallow areas as well as deep areas of a sea or lake. It is a further additional advantage of the assembly of the invention that the stability of the sailing boat is increased by providing a substantially heavy keel, thereby allowing the sailing yacht to carry more sail thus improving performance. Yet another advantage is based on the insight that the stability that is required when sailing, is much higher than the stability that is required when the yacht is motoring towards a port. Hence the sailing yacht with the assembly of the invention may moor in a shallow port and sail in the deep waters around the port. Yet another advantage of the assembly according to the invention is that a longer and thus deeper keel has proven to be more optimal for the performance of the yacht. This is due to the improved hydrodynamic performance of a yacht with a long keel. In other words, the keel assembly according to the invention combines the advantages of a fixed keel with the advantages of a centreboard, without performance reduction.

[0011] Preferably, the keel opening cover is moveably coupled to the keel by a connection, the connection being configured such that the rotation of the keel to said extended position causes the keel opening cover to be moved to said cover position. By coupling the keel to the keel opening cover, via a connection, the keel opening cover is moved to its cover position along with the movement of the keel. Thereby the amount of additional structural and actuating means needed is reduced in order to move the keel opening cover.

[0012] Preferably, the connection comprises a cover shaft and wherein an upper end of the keel is coupled to a front portion of the keel opening cover via the cover shaft. Because only a small portion of the keel is connected inside the hull, a substantially larger portion of the keel is allowed to rotate in and out of the hull. Thus, when the keel is in the extended position, said substantially larger portion of the keel protrudes from the hull, thereby providing a large contact surface upon which the hydrodynamic forces may act. This improves the performance of the sailing yacht.

[0013] Preferably, the connection is further configured such that the rotation of the keel from the extended to the retracted position moves the keel cover from the cover position to an open position. When the keel of the sailing yacht hits a shallow area or a rock protruding from the sea bottom, the keel is rotated in the direction of the keel opening cover, towards the retracted position of the keel. The keel induces the keel opening cover, via the connection, to move away from the cover position. In this way, the keel opening cover is moved out of the way of the rotating keel in order to prevent damages to the keel and the keel opening cover.

[0014] Preferably, when the keel is in the retracted position, the keel is substantially enclosed by the hull. When

the sailing yacht is sailing downwind, which is the term used when the sailing yacht is sailing at 180° of the direction of the wind, a centreboard would typically be retracted. Otherwise the centreboard would only cause a board drag force in the water, thereby reducing the performance of the sailing yacht. By retracting the keel to the retracted position, wherein it is substantially enclosed by the hull, the keel is at least partly removed from the water. Thereby substantially reducing the board drag force component or even completely eliminating said board drag force component. Thus the performance of the sailing yacht is improved. Another advantage is that the draft of the sailing boat is reduced. Because the draft of the sailing boat is reduced, the depth of the water in which a sailing boat may sail is reduced. Therefore the sailing yacht with a retracted keel can sail in shallower water than a sailing boat with a fixed keel. This increases the area in which a sailing boat may sail. Yet another advantage is that when a sailing boat runs dry - which is the term used when the sailing yacht hits a sand bank or rests on the sea floor when the tide is out, i.e. the water level is low - a sailing boat with a fixed keel would by tipped on its side. When the tide comes back in, i.e. the water starts to rise again, the boat might not set it self upright anymore and sink or the tipping might even have caused irreparable damage. Because the keel is substantially enclosed by the hull a sailing boat substantially rests on the sea floor with its hull rather than the keel. Therefore the tendency of the boat to tip is reduced when the boat runs dry and damage is prevented.

[0015] Preferably, the keel assembly further comprises a keel housing which encloses the keel at least partly in the retracted position. By enclosing at least part of the keel in the retracted position, water, which would otherwise splash upwardly into the hull of the boat when sailing, is not allowed to enter the hull. Thereby the intake of water is reduced when sailing, maintaining the performance of the sailing boat during sailing.

[0016] Preferably, the keel housing comprises said keel opening. By providing the keel housing with the keel opening, the keel is allowed to rotate between the retracted position and the extended position.

[0017] Preferably, the keel shaft is arranged at a front segment of the keel housing. In this way, the keel shaft is automatically rotated to a retracted position, or there in between, when the keel hits sediment or the sea bottom. Thus permanent damage is avoided or the sailing speed is maintained.

[0018] Preferably, a slot is provided in the keel housing and guiding pins are mounted on the keel opening cover, wherein the slot is configured for guiding the guiding pins such that the keel opening cover is controllably moved between said open and cover position. The orientation of the keel opening cover, relative to the sailing boat, is maintained even in rough conditions. This ensures to always cover the keel opening in a sufficient way. The keel opening cover sufficiently closes the keel opening, even when the sailing boat is rocking heavily. This improves

the reliability of the assembly.

[0019] Preferably, the keel assembly further comprises an actuator being connected to the keel and wherein the actuator is configured for rotating the keel between said retracted and extended position. The keel is rotated between the retracted and extended position by the actuator. This allows a user to position the keel in a desired position via the actuator, without manually lifting or positioning the keel.

[0020] Preferably, the keel opening cover is arranged above an upper end of the keel when the keel is in the retracted position. Tests have shown that this arrangement allows the keel to be accommodated in a simple manner.

[0021] Preferably, a surface area of the keel opening cover is substantially the same as a remaining surface area of the keel opening when the keel is in the extended position. The streamline of the hull is maintained and performance is improved by covering substantially the same surface area as the remaining surface area. In other words, only a small portion of surface area, not covered by the keel opening cover, causes drag in the water.

[0022] Preferably, the keel has a weight greater than 1500kg, preferably greater than 2500kg, more preferably greater than 3000kg, most preferably greater than 5000kg. The stability of the boat with a heavy keel is improved, such that it may carry additional sail. This improves the performance of the sailing boat.

[0023] The invention further provides a sailing boat comprising a keel assembly as described above.

[0024] Preferably, the sailing boat comprising the keel assembly has a ballast ratio preferably larger than 15%, more preferably larger than 20%, most preferably larger than 25%. The ballast ratio is preferably smaller than 55%, more preferably smaller than 48%, most preferably smaller than 40%.

[0025] The advantages of the keel assembly apply, mutatis mutandis, to the sailing boat comprising the keel assembly.

[0026] The accompanying drawings are used to illustrate presently preferred non-limiting exemplary embodiments of devices of the present invention. The above and other advantages of the features and objects of the invention will become more apparent and the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic representation of a known sailing yacht;

Figure 2 is a top view representation of a sailing boat wherein a force equilibrium is shown;

Figure 3 is a rear view representation of a sailing boat wherein a force equilibrium acting on the sailing boat is shown;

Figure 4 is a schematic representation of an embodiment of the keel assembly according to the invention in a longitudinal section along the longitudinal direc-

tion of a sailing yacht, wherein the retractable keel is in an extended position;

Figure 5 is a schematic representation of an embodiment of the keel assembly according to the invention in a longitudinal section along the longitudinal direction of a sailing yacht, wherein the retractable keel is in a retracted position;

[0027] For the sake of argument, portions of elements from the invention defined in the description are defined relative to a longitudinal section of the boat when the keel is in the extended position.

[0028] Figure 1 shows a sailing yacht 100 comprising a hull 101. The hull 101 is a watertight body of the sailing yacht 100. The line where the hull meets the water surface is defined as the water line. The yacht 100 comprises a fixed keel 137, wherein the fixed keel 137 is integrated in the hull 101. The yacht 100 may also comprise a fixed keel 137 that is bolted to the hull 101. In this case, the design of the fixed keel 137 may be so that the fixed keel is compatible with the streamline of the yacht 100. The fixed keel 137 is positioned in a central position of the hull and is integrated in a bottom portion of the hull 101. The hull 101 is substantially streamlined and comprises a bottom portion which is substantially flat, such that the sailing boat 100 may glide on the water. The bottom portion of the hull is defined as the portion of the hull of the boat below by the water line excluding the keel. The fixed keel 137 projects from the hull 101, substantially downward in the water. The fixed keel has a surface relative to the surface area of a sail 103 such that an aerodynamic leeward force caused by the wind acting on the sails 103 of the sailing boat 100 is at least partially compensated by the hydrodynamic lift force caused by the pressure difference across a leeward and windward surface area of the fixed keel.

[0029] Figure 2 shows a top view of a sailing boat. The arrows 104 indicate an apparent wind direction acting on the sails 103 of the yacht. The arrows 105 indicate the relative flow of water. The boat 100 comprises a centre line 107, indicating the centre of the sailing boat, seen in a longitudinal direction of the boat. The boat 100 sails in a direction 106. The sailing direction 106 is defined by a leeway angle, γ , between the centre line 107 of the sailing boat and the sailing direction 106. The wind 104 acting on the sails 103 generates an aerodynamic sailing force 108. The aerodynamic sailing force 108 decomposes in a sail side component 109, substantially perpendicular to the sailing direction 106, and an aerodynamic sail trust component 110. The figure furthermore shows a hydrodynamic force 111 acting on the keel 102 of the yacht 100. The hydrodynamic force 111 decomposes in a hydrodynamic lift component 113 and a hydrodynamic board drag component 112. As for an airplane wing, the difference of pressure resulting from unequal velocity of the water 105 circulating on each side of the keel creates a hydrodynamic lift component 113. The hydrodynamic board drag component 112 is perpendicular to the hy-

hydrodynamic lift component and is opposite to the sailing direction 106. The hydrodynamic lift component 113 aims to counteract the sail side component 109, such that the leeward motion of a yacht is substantially countered. For example, the boat will drift slightly in the leeward direction, at the leeway angle, γ . This leeward motion of the yacht is defined by the movement from the yacht, from a first location to a second location in the direction of the wind. The boat will also sail substantially forward because the aerodynamic sail thrust component 110 is larger than the hydrodynamic board drag component 112. The shape and size of the keel has an effect on the performance of the sailing boat. The size is determined by the length and the chord of the keel. This is typically defined by an aspect ratio, i.e. the ratio of the length and the chord. Preferably the aspect ratio is high, in other words, the aspect ratio is more than 2/1, preferably more than 4/1, preferably more than 6/1. This is based on the insight that the chord, i.e. the width of the keel, is directly related to the hydrodynamic board drag component. The keel typically has a profiled cross-section, this term will be discussed in a further figure, in order to reduce drag and increase lift. A keel with a small chord and a long length has a more pronounced curvature compared to a keel with a large chord and a small length. Because the lift of the keel is produced by a high pressure on the leeward side and the low pressure of the windward side, the pressures will meet at a trailing edge. The high pressure will leak to the low pressure side and cause turbulence. Thus the trailing edge creates less lift and creates drag. A keel with a long chord and a small length will leak more than a keel with a small chord and a long length. In other words, a keel with a larger chord compared to a keel with a smaller chord causes more drag in the water than the keel with the smaller chord. It will be clear to the skilled person, that in order to achieve a size of the keel relative to the size of the sail, it must comprise a length proportionate to the width. Thus the aspect ratio is high in order to obtain a good performance.

[0030] Figure 3 shows a rear view of a sailing boat 100. Wherein the aerodynamic sailing force 108 acts on the sail 103 and the hydrodynamic sailing force 111 acts on the keel 102. The aerodynamic sailing force 108 acts on the sails 103 at a centre of effort 116 and causes a heeling force 121. The heeling force 121 causes a heeling moment 135 around the centre line 107 of the boat. The heeling force 121 is situated at a point, located at a distance D, from the centre of gravity 117 of the sailing boat. A centre of hydrodynamic forces 118 is situated at a point, located at a distance d from the centre of gravity 117 of the sailing boat. Because the distance D is larger than the distance d, the boat is heeled at an angle, α , between a sailing mast axis 119 and a vertical axis 120. In other words, the sailing boat does not sail upright. The heeling effect, wherein the heeling force 121 causes the yacht to not sail upright, negatively impacts the performance of the sailing yacht 100 because the rounded edge portion of the hull is immersed in the water. The effect is that

the hull causes more drag in the water. While certain hull designs take this effect into account, an additional effect is that because the sailing boat 100 is inclined the thrust of sailing boat is reduced because the effective area of the sails upon which the wind may act is reduced. The weight of the keel 102 aims to counteract said heeling effect by substantially counteracting it with a righting effect. In an embodiment the keel 102 may also swing round an axis (not shown), which is oriented in a longitudinal direction of the sailing boat. In this way, the keel 102 may be swung in a direction such that the heeling effect is countered.

[0031] The keel 102 comprises a heavy weight, which, together with the weight of the sailing boat forms a centre of gravity 117 of the sailing boat. A buoyancy force 115 is situated substantially offset from the vertical axis 120. It will be clear that the buoyancy force 115 may be located at different offsets from the vertical axis 120, depending on the heeling angle, α . For example, a boat sailing perpendicular to the wind will have heeling force 121 acting on the sailing boat which is higher than a heeling force acting on a boat sailing downwind from the wind. The larger heeling force, when sailing perpendicular to the wind, will cause the boat to heel more than when the sailing boat is sailing downwind from the wind. Therefore the boat sails at a larger heeling angle, i.e. more inclined. Because the boat sails at a larger heeling angle, the buoyancy force 115 when sailing perpendicular to the wind will be situated more to the side of the hull, seen in a lateral direction of the sailing boat. When the sailing boat is sailing downwind from the wind the buoyancy force 115 will be situated close to or even on the mast axis 119. The buoyancy force 115 and the weight force 114 acting on the centre of gravity 117 form a force couple. The force couple causes a righting effect 136, countering the heeling effect 135, such that a smaller portion of the rounded edge portion of the hull is immersed in the water, thereby reducing drag caused by the immersed rounded edge portion of the hull. Thus the boat is inclined upward. In this way, the performance of the yacht is improved. In other words, the keel 102 improves the stability of the sailing boat 100, such that it can sail closer to its upright position, wherein the bottom portion of the hull glides more optimal in the water, thereby improving the performance of the sailing boat. Preferably, the centre of gravity of the sailing boat is situated below the bottom portion of the sailing boat.

[0032] Figure 4 shows a schematic perspective view of an embodiment of the keel assembly according to the invention. The figure shows particularly a cross-section of the keel assembly 125 wherein the keel 102 is positioned in the extended position.

[0033] The keel assembly 125 is mounted in the bottom portion of the hull 101 of a sailing boat 100, wherein the keel 102 is mounted to a keel shaft 126, such that the keel is rotatable. The keel comprises a leading edge, said leading edge is the bottommost edge of the keel, when the keel is in the retracted position. In other words, the

leading edge is the part of the keel which first contacts the water when sailing forward with the keel in the extended position. The keel furthermore comprises a trailing edge, wherein said trailing edge is the uppermost edge of the keel, when the keel is in the retracted position. The keel 102 is shown as an object with an aerofoil shaped cross-section. It will be clear to the skilled person that any shape of the keel can be opted for depending on the practical situation. For example, a wing keel or bulb keel may be used. Typically a keel is symmetrical, seen in a longitudinal direction of the cross-section of the keel, such that forces acting on a keel are substantially similar in a starboard tack position and a port tack position. The skilled person will appreciate that, for example when sailing with a catamaran, the keels may also be non-symmetrical or that multiple keel assemblies may be used. In said example each hull of the catamaran may be fitted with a keel assembly comprising a keel. The keel assembly 125 is preferably mounted in a central position in the hull 101 of the sailing boat 100.

[0034] The keel shaft is mounted in a keel housing 127 at a front segment of the keel housing 127, such that the keel shaft is rotatable. The front segment of the keel housing is defined as the first 25% of the keel housing 127 seen in the longitudinal direction of the sailing boat. The skilled person will appreciate that different embodiments are possible. For example, the keel shaft 126 may be mounted on bearings comprised in the keel housing 127. Alternatively, the skilled person will appreciate that, in the embodiment shown in the figure, the keel 102 is mounted in a keel housing 127, and that all manner of practical embodiments can be opted for depending on the practical situation. For example, the keel 102 may also be mounted on a keel shaft 126, wherein said shaft is mounted directly in the hull 101.

[0035] The keel 102 is shown in the extended position, wherein the keel protrudes substantially downward from the hull 101 through a keel opening 128. The keel opening 128 allows the keel 102 to rotate through the keel opening 128, when it is moved between the extended position to the retracted position, as shown in figure 5, or vice versa. The keel opening 128 furthermore allows the keel to protrude from the hull 101. For example, when the boat hits the sea bed, with the keel 102 in the extended position, the keel 102 may at least partially rotate through keel opening 128. The keel opening 128 is schematically shown to be rectangular. It will be clear to the skilled person that the keel opening 128 may have any form. The keel opening 128 may, for example, be shaped such that the keel 102 only narrowly passes through the opening. In another example, the keel opening 128 may be formed such that it substantially replicates the shape of the keel. This would advantageously influence the streamline of the bottom of the hull since the gap between the keel and the hull would be smaller and narrower, thus reducing the chance that water may slow down the boat. The keel 102 may also be configured such that at least a portion of the keel is rotatable along a longitudinal di-

rection of the sailing boat, in order to counter the heeling effect.

[0036] A keel opening cover 129 is shown to cover at least part of the keel opening 128 when the keel 102 is in the extended position. The keel opening cover 129 may be formed to narrowly fit in the keel opening 128 or the shape of the keel opening cover 129 may substantially replicate the shape of the keel opening. The figure shows that a front portion of the keel opening cover 129 is situated close to the top portion of the keel 102, seen in a longitudinal direction of the sailing boat. However it will be clear to the skilled person that the keel opening cover 129 may also be shaped to at least partially encompass the keel 102 when it is positioned in the retracted position. Preferably, the keel opening cover 129 is formed of a single part, however depending on the application, may comprise a plurality of interconnected parts forming the keel opening cover 128. The movement of the keel opening cover 129 is described here below. The keel 102 may also comprise a cover part such the keel cover part (not shown) and the keel opening cover 129 cooperate to completely cover the keel opening 128.

[0037] The keel housing 127 is shown to be integrated in the hull 101 of the sailing boat 100. The skilled person will appreciate that the form of the keel housing 127 may be adapted so that it saves space on the inside of the hull 101. The keel housing 127 furthermore comprises the keel opening 128, through which the keel 102 may rotate and protrude. The keel opening 128 provided in the keel housing 127 is considered to be indirectly a keel opening 128 in the hull 101. In other words, the keel housing 127 comprises an open side. In an alternative embodiment (not shown) the keel assembly 125 is installed in the hull 101 of a boat without the keel housing 127, a keel opening 128 is to be provided in the hull 101. The keel housing 127 is configured to be mounted in the hull 101 of the sailing boat 100.

[0038] It will be clear to the skilled person that the weight of the keel 102 is relative to the total weight of the sailing boat 101. For example, a small yacht may have a keel of 500kg whilst a larger luxury sailing yacht may have a keel of 1000kg. Preferably the weight of the keel is more than 10% of the total weight of the sailing boat, more preferably more than 20%, most preferably more than 30% of the total weight of the sailing boat. In other words, the sailing boat comprising the keel assembly may have a ballast ratio preferably larger than 15%, more preferably larger than 20%, most preferably larger than 25%. The ballast ratio is preferably smaller than 55%, more preferably smaller than 48%, most preferably smaller than 40%.

[0039] Figure 5 shows a schematic perspective view of an embodiment of the keel assembly according to the invention..

[0040] In particular figure 5 shows that the keel 102 is positioned in the retracted position. The keel 102 is enclosed by the keel housing 127. In other embodiments (not shown), the keel 102 is at least partly enclosed by

the keel housing 127. Preferably more than 50% of the keel is enclosed by the keel housing 127, more preferably more than 75%, most preferably more than 90%. In other words, the keel housing 127 encloses at least part of the keel 102. It will be clear to the skilled person, that when the keel 102 is in the retracted position, the leading edge of the keel may also protrude from the keel opening.

[0041] The keel 102 is moveably coupled to the keel opening cover 129 by a connection 134. The connection 134 is embodied by an intermediate element. The connection 134 couples the keel opening cover 129 to the keel 102. When the keel 102 rotates, from the position wherein it is retracted to a position wherein it is extended, the keel opening cover 129 moves from an open position to a closed position wherein the keel opening cover 129 covers the keel opening 128. The connection 134 is coupled to an upper portion of the keel via a cover shaft 130. The connection 134 is connected to a front portion of the keel opening cover 129.

[0042] During the rotation of the keel 102, the keel opening cover 129 is controllably moved between the open and closed position by a slot 132 wherein guiding pins 132, which are mounted to the keel opening cover 129, are guided. The guiding of the cover, in between positions, ensures that the keel opening cover 129 is lying, relative to the hull, during the movement. Because the keel opening cover 129 is connected on two positions, the interaction between the connection 134 and the guiding pins 132 causes the keel opening cover 129 to be controllably lowered to the cover position, wherein it covers the keel opening cover. In this way, misalignment of the keel opening cover 129 on the keel opening 128 is avoided and the performance of the sailing boat 100 is guaranteed. For example, the sea may be wild due to an upcoming storm, wherein the waves may increase, rocking the boat heavily. Even in such a scenario, the cover may easily be moved to the closed position without the need of additional means.

[0043] When the keel 102 of the sailing boat hits the seabed, the keel 102 rotates, by the force exerted on the keel 102 by the seabed, from the extended position to a retracted position. The rotation of the keel 102 causes, via the interaction of the connection 134 and the guiding pins 132, the keel opening cover 129 to move to its open position.

[0044] The keel assembly 125 further comprises an actuator 133. The actuator 133 is connected to the keel 102 by a connection means, for example, the connection means may be a rope, wire, cable, chain, shaft or belt. The skilled person will appreciate that many different possibilities are applicable as connection means. The actuator may be a hydraulic or pneumatic piston, winch, motor or any other rotary actuator. The actuator is configured for rotating the keel between the retracted and the extended position. Alternatively the actuator may also be directly connected to the keel 102.

[0045] In an alternative embodiment (not shown) the actuator may also be directly connected to the keel shaft

126 such that the additional wire-like connection means are avoided. Alternatively a gearbox may be provided in between the actuator and the keel shaft 126, such that the torque required by the actuator is reduced. The skilled person will appreciate that in said alternative embodiment an overrunning clutch is preferred between the gearbox and the actuator or the actuator and the keel 102 such that, when the keel 102 abruptly hits ground and is rotated towards the hull, counter torque, provided by the actuator, which would otherwise harmfully damage the device, is avoided.

[0046] In yet another alternative embodiment (not shown), the keel opening cover 129 comprises a plurality of interconnected parts, wherein a first part of the keel opening cover may be coupled to a first shaft, wherein the first shaft extends in the longitudinal direction of the keel opening 128, mounted at a lateral edge of the keel opening 128. A second part of the keel opening cover may be coupled to a second shaft, mounted at the opposite lateral edge of the keel opening 128. In this way, a swing-door like cover is formed. The first and second parts of the keel opening cover are situated in a substantially upright position when the keel is in the retracted position. When the keel 102 is in the extended position the first and second part of the keel rotate, via the first and second shaft, to a closed position wherein each of the first and second part covers at least part of the keel opening cover. Preferably each of the first and second parts covers at least 30% of the keel opening 128, more preferably at least 40%.

[0047] The keel opening cover 129 is arranged above an upper end of the keel 102, when the keel is in the retracted position. It will be clear that the keel opening cover 129 may also rest on the keel.

[0048] It will be clear to the skilled person that the keel 102 may also be positioned in any intermediate position between the retracted and extended position.

[0049] Based on the figures and the description, the skilled person will be able to understand the operation and advantages of the invention as well as different embodiments thereof. It is however noted that the description and figures are merely intended for understanding the invention, and not for limiting the invention to certain embodiments or examples used therein. Therefore it is emphasized that the scope of the invention will only be defined in the claims.

Claims

1. A keel assembly (125) configured for mounting in a hull (101) of a sailing boat for providing stability and directional guidance to said sailing boat, wherein the keel assembly (125) comprises:

- a keel (102) mounted on a keel shaft (126) such that the keel is rotatable through a keel opening (128) between a retracted position and an ex-

- tended position wherein the keel (102) protrudes substantially downward from the hull (101);
 - a keel opening cover (129) configured such that it covers, in a cover position, at least part of the keel opening (128) when the keel (102) is in the extended position.
2. Keel assembly (125) according to claim 1, wherein the keel opening cover (129) is moveably coupled to the keel (102) by a connection (134), the connection (134) being configured such that the rotation of the keel (102) to said extended position causes the keel opening cover (129) to be moved to said cover position.
 3. Keel assembly according to the previous claim, wherein the connection comprises a cover shaft (130) and wherein an upper end of the keel is coupled to a front portion of the keel opening cover (129) via the cover shaft (130).
 4. Keel assembly according to claim 2 or 3, wherein the connection is further configured such that the rotation of the keel (102) from the extended to the retracted position moves the keel opening cover (129) from the cover position to an open position.
 5. Keel assembly according to any one of the previous claims, wherein when the keel (102) is in the retracted position, the keel (102) is substantially enclosed by the hull (101).
 6. Keel assembly according to any one of the previous claims, further comprising a keel housing (127) which encloses the keel (102) at least partially in its retracted position.
 7. Keel assembly according to claim 6, wherein the keel housing (127) comprises said keel opening (128).
 8. Keel assembly according to the previous claims, wherein the keel shaft (126) is arranged at a front segment of the keel housing (127).
 9. Keel assembly according to any one of the claims 6 to 8, wherein a slot (131) is provided in the keel housing (127) and guiding pins (132) are mounted on the keel opening cover (129), wherein the slot (131) is configured for guiding the guiding pins (132) such that the keel opening cover (129) is controllably moved between said open position and cover position.
 10. Keel assembly according to any one of the previous claims, further comprising an actuator (133) being connected to the keel and wherein the actuator (133) is configured for rotating the keel between said retracted and extended position.
 11. Keel assembly according to any one of the previous claims, wherein the keel opening cover (129) is arranged above an upper end of the keel (102) when the keel (102) is in the retracted position.
 12. Keel assembly according to anyone of the previous claims, wherein a surface area of the keel opening cover (129) is substantially the same as a remaining surface area of the keel opening (128) when the keel is in the extended position.
 13. Keel assembly according to any one of the previous claims, wherein the keel has a weight greater than 1500kg, preferably greater than 2500kg, more preferably greater than 3000kg, most preferably greater than 5000kg.
 14. A sailing boat comprising a keel assembly according to anyone of the previous claims.
 15. The sailing boat according to the previous claim, wherein a ballast ratio is preferably larger than 15%, more preferably larger than 20%, most preferably larger than 25% and is preferably smaller than 55%, more preferably smaller than 48%, most preferably smaller than 40%.

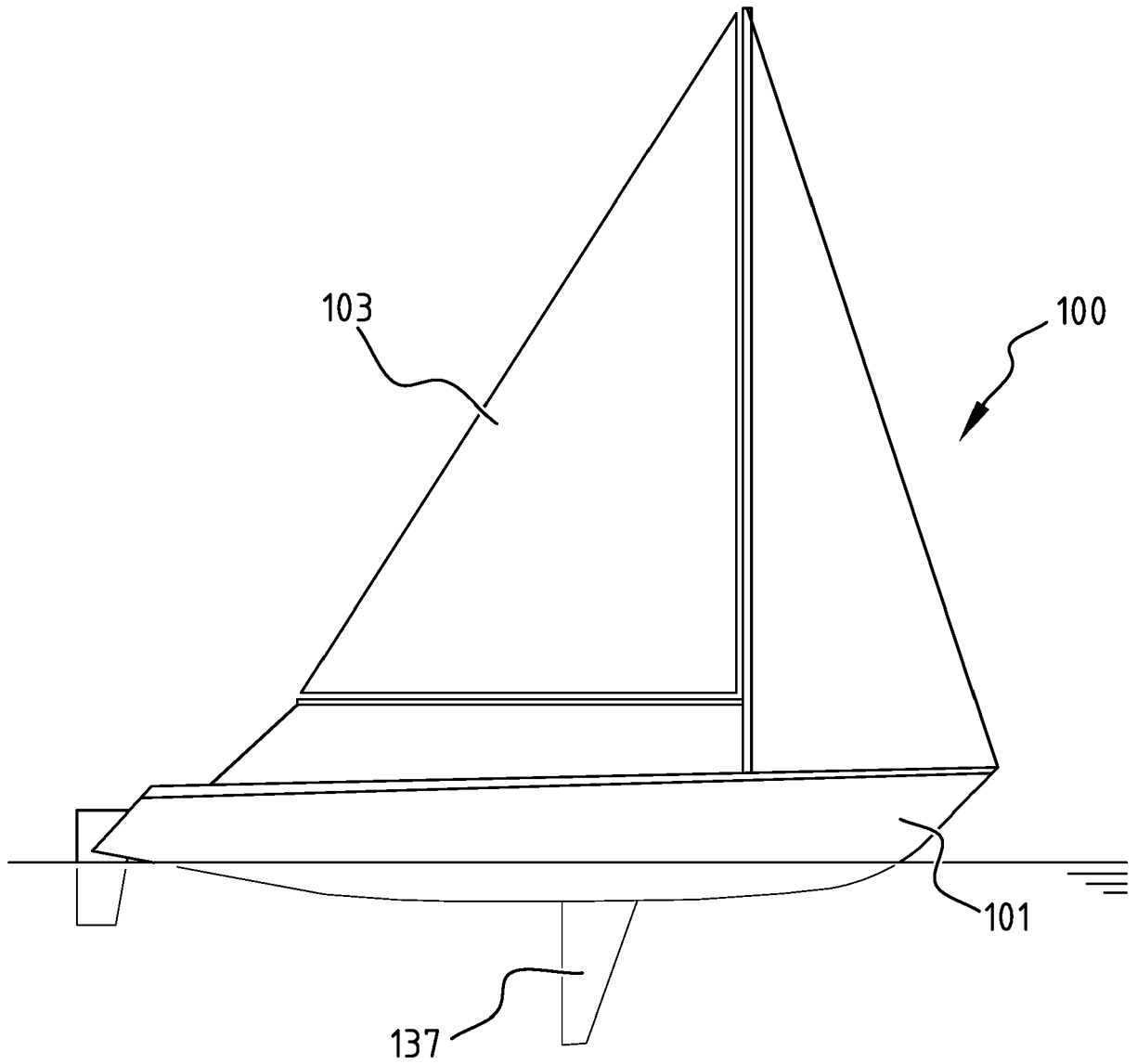
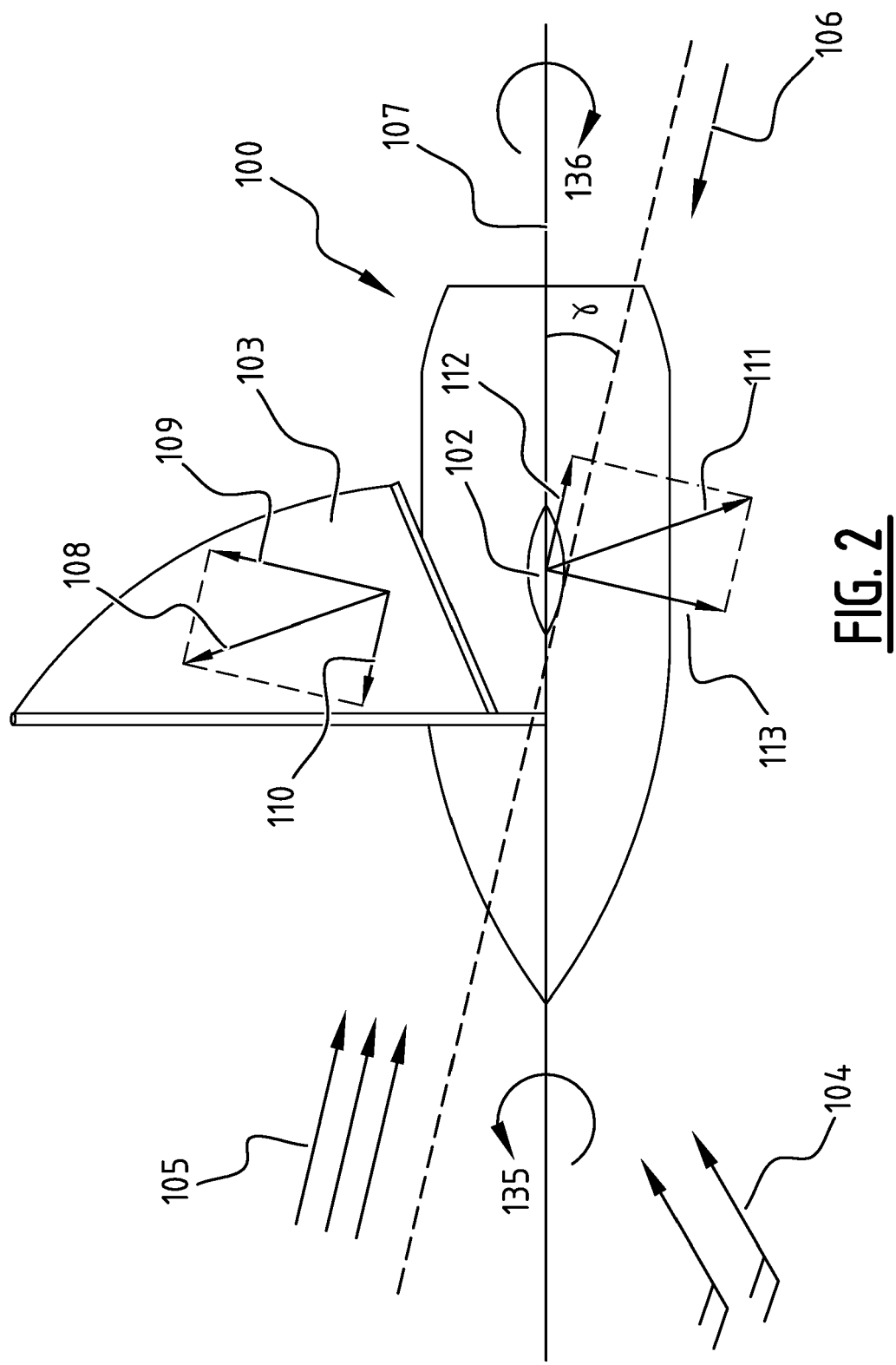


FIG. 1



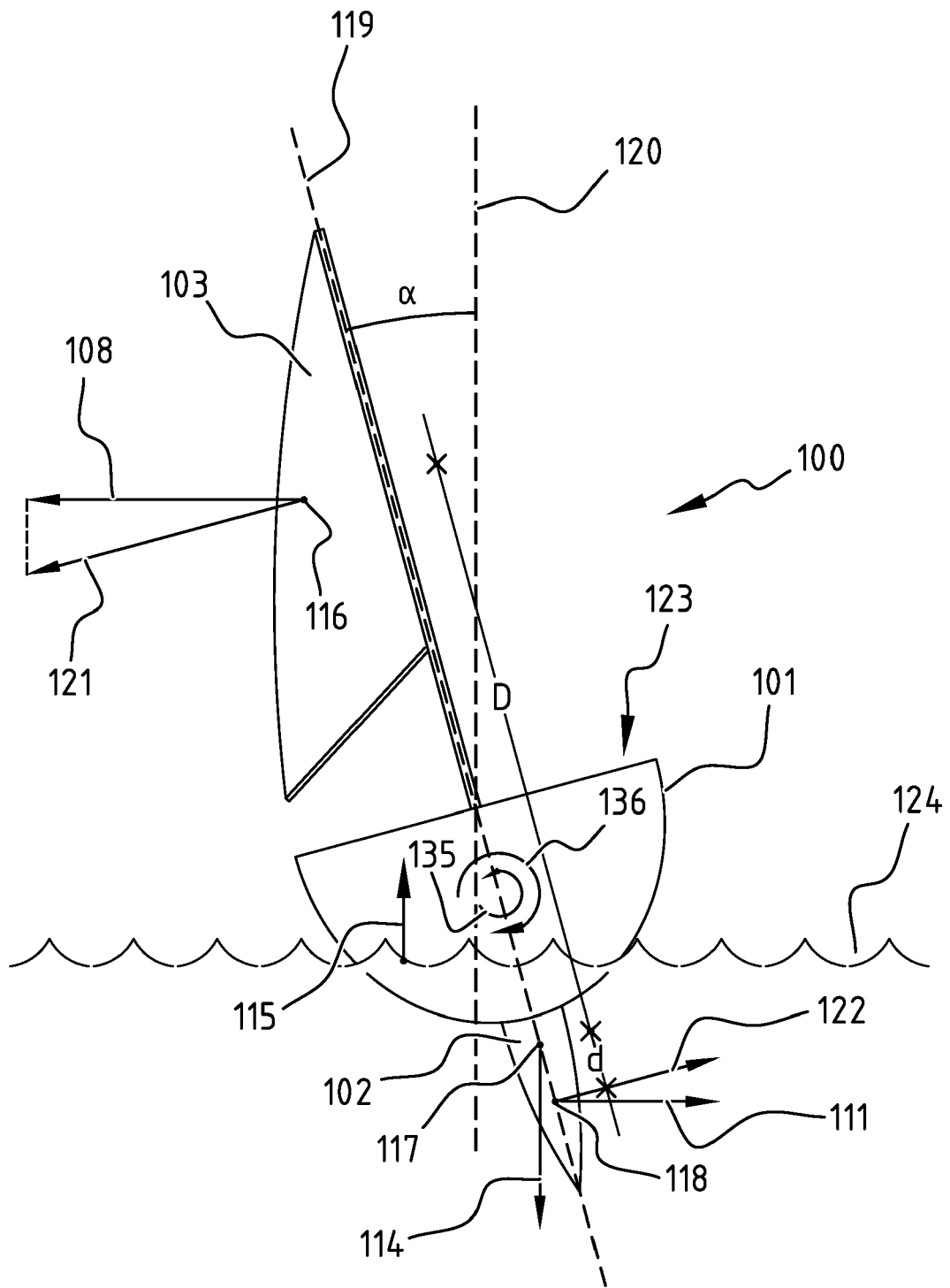


FIG. 3

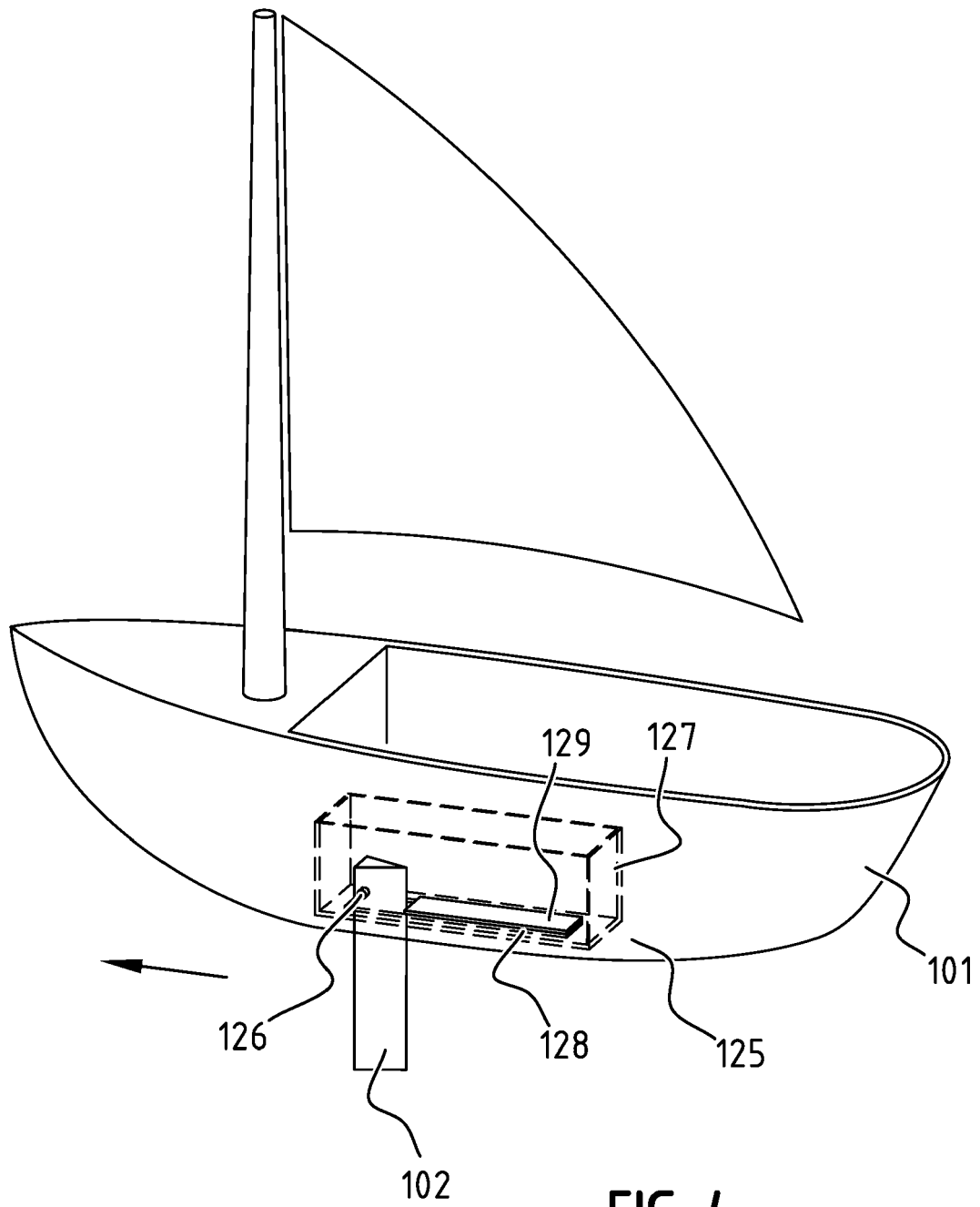


FIG. 4

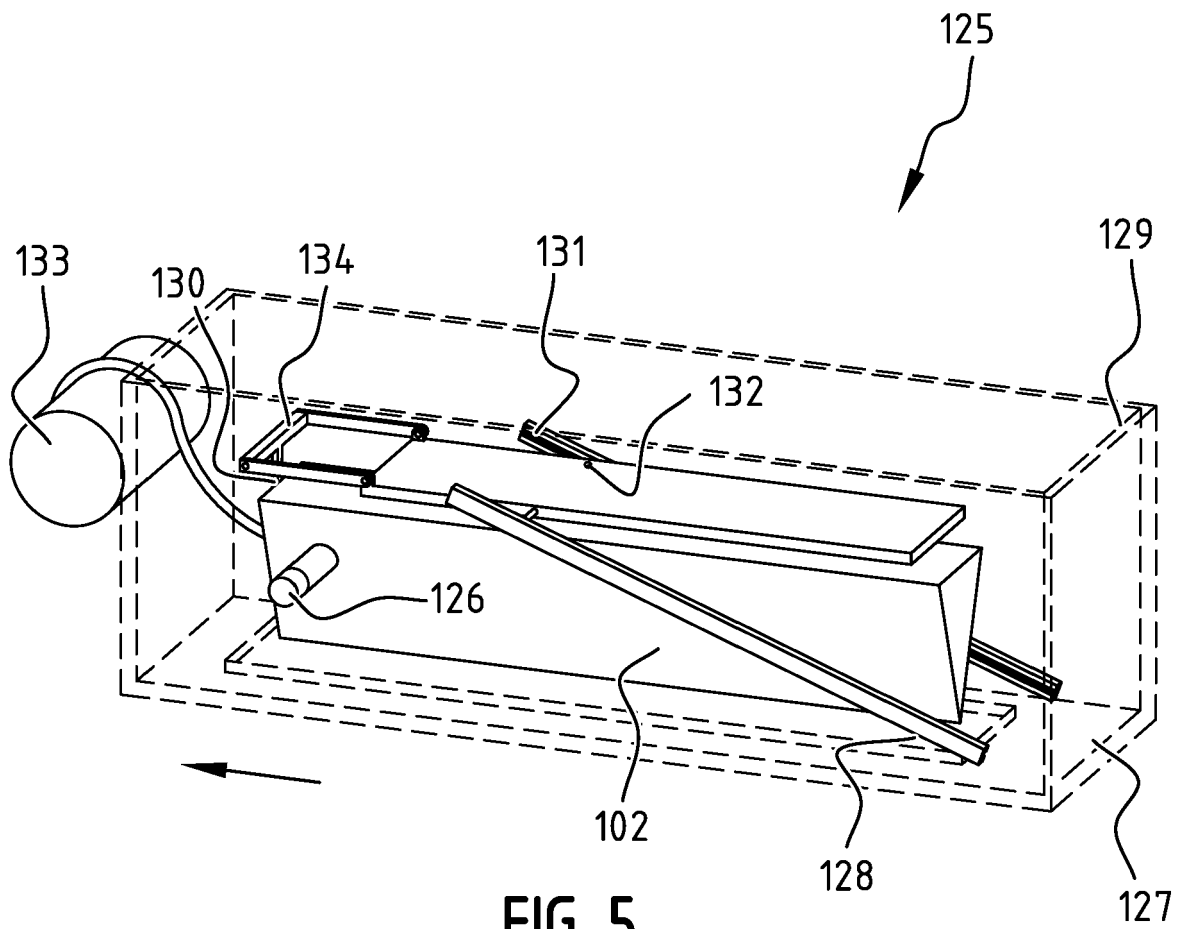


FIG. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 20 15 1468

5

10

15

20

25

30

35

40

45

50

55

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	GB 2 239 842 A (WALKER JOHN GRAHAM [GB]; WALKER JEAN MARGARET [GB]) 17 July 1991 (1991-07-17)	1,5-8, 10-15	INV. B63B41/00
A	* page 6, line 18 - page 8, line 5 * * figures 5A, 5B, 6 *	3,9	
X	US 158 708 A (HEMJE CHARLES [US]) 12 January 1875 (1875-01-12) * page 1, right-hand column, line 50 - page 2, left-hand column, line 26 * * figure 1 *	1,2,5-8, 10,11	
X	US 761 115 A (WAINRIGHT CLAUDE B [CA]) 31 May 1904 (1904-05-31) * page 1, right-hand column, lines 62 - 91 * * figures 1 - 3 *	1,2,4-6, 10,12	
A	JP H01 162895 U (MITSUBISHI HEAVY INDUSTRIES, LTD.) 13 November 1989 (1989-11-13) * abstract * * figures 1, 2 *	1,5-8, 10,12	TECHNICAL FIELDS SEARCHED (IPC)
A	DE 10 2014 221606 A1 (SKF BLOHM + VOSS IND GMBH [DE]) 28 April 2016 (2016-04-28) * abstract * * figures 1 - 3 *	1,5,6,8, 10,12	B63B B63H
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 3 June 2020	Examiner Mauriès, Laurent
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 15 1468

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-06-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2239842 A	17-07-1991	NONE	
US 158708 A	12-01-1875	NONE	
US 761115 A	31-05-1904	NONE	
JP H01162895 U	13-11-1989	NONE	
DE 102014221606 A1	28-04-2016	AU 2015334928 A1	13-04-2017
		CN 107074331 A	18-08-2017
		DE 102014221606 A1	28-04-2016
		EP 3209552 A1	30-08-2017
		JP 2017531595 A	26-10-2017
		KR 20170075726 A	03-07-2017
		US 2017247090 A1	31-08-2017
		WO 2016062803 A1	28-04-2016

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 1118360 A [0007]