(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 752 360 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.07.2014 Bulletin 2014/28

(51) Int Cl.:
B63B 1/12 *(2006.01)* ***B63H 9/08*** *(2006.01)*
B63H 9/10 *(2006.01)*

(21) Application number: **13075075.5**

(22) Date of filing: **25.11.2013**

(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

(30) Priority: **23.11.2012 NL 1039911**

(71) Applicant: **HART, Walter Willem Hubertus**
1054KX Amsterdam (NL)

(72) Inventor: **HART, Walter Willem Hubertus**
1054KX Amsterdam (NL)

(54) **Improved sailing vessel**

(57) The present invention relates to a sailing vessel, comprising:
- a forward left planing board (8) positioned substantially on a forward left position of the vessel, and
- a forward right planing board (9) positioned substantially on a forward right position of the vessel, and
- a rear left planing board (10) positioned substantially on a rear left position of the vessel, and
- a rear right planing board (11) positioned substantially on a rear right position of the vessel.

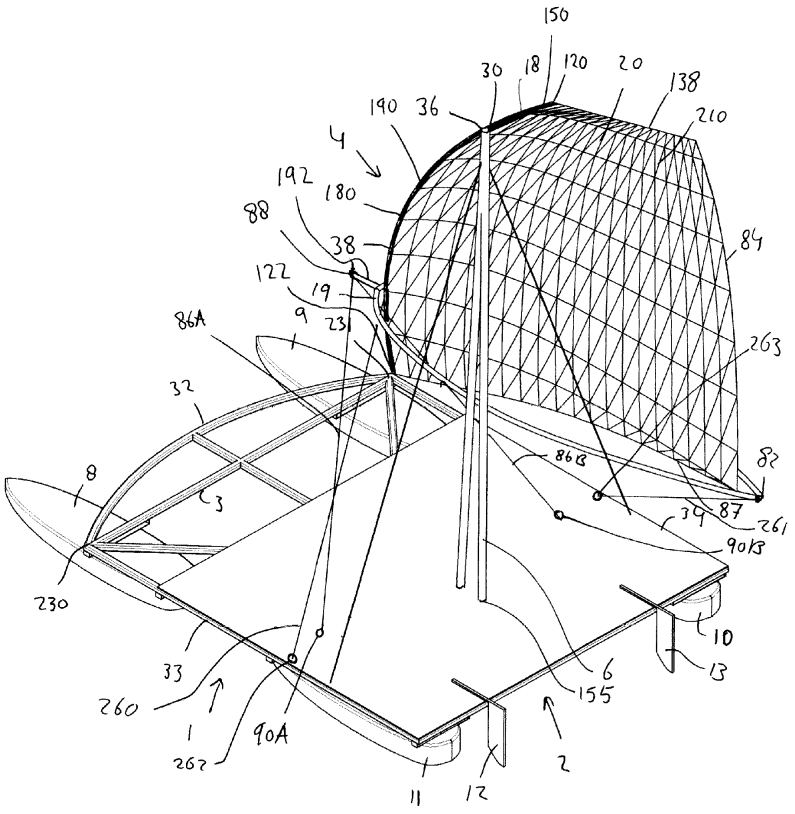


Fig. 10

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Description

[0001] The present invention relates to a sailing vessel. The present invention also relates to a method of sailing. In a further aspect, the present invention relates to a planing board, a hull assembly and a sail device for use in the sailing vessel. The present invention further relates to a mast for use in the sailing vessel.

FIELD OF THE INVENTION AND DESCRIPTION OF THE PRIOR ART

[0002] Fast sailing vessels are known. EP2184225 discloses a sailing vessel. It is an object of the present invention to provide a variant to the sailing vessel of EP2184225. It is a further object of the present invention to provide improvements to the sailing vessel of EP2184225.

SUMMARY OF THE INVENTION

[0003] The present invention relates to a sailing vessel, comprising:

- a forward left planing board positioned substantially on a forward left position of the vessel, and
- a forward right planing board positioned substantially on a forward right position of the vessel, and
- a rear left planing board positioned substantially on a rear left position of the vessel, and
- a rear right planing board positioned substantially on a rear right position of the vessel.

[0004] The planing boards allow an easy transition from Archimedes mode to planing mode, resulting in high speeds. It was found that this configuration provides more stability than the configuration with three boards shown in EP2184225.

[0005] In an embodiment, the sailing vessel comprises a curved rail which extends substantially from a left side of a hull assembly to substantially a right side of the sailing vessel and being configured for supporting a mast foot of a sail device, allowing the mast foot to move from substantially the left side to substantially the right side and vice versa. The curved rail allows an orientation of the sail device which creates both a thrust force and a lift force and leads to very little drag forces on the sailing vessel.

[0006] In an embodiment, the sailing vessel comprises:

- a mast assembly which extends upwards from a hull assembly which comprises the four planing boards, the mast assembly being located at a central longitudinal plane of the sailing vessel, and
- a sail device connected to an upper end of the mast assembly, the sail device further being connected to the curved rail at a lower connection point of the sail device, wherein the lower connection point is movable along the curved rail relative to the hull assembly from a position substantially on a left side of the hull assembly to a position substantially on a right side and vice versa, such that in use the sail device is inclined against the wind, thereby causing the wind force on the sail device to have an upward component.

[0007] In an embodiment, the sailing vessel has only a single sail device.

[0008] In an embodiment of the sailing vessel, the sail device is connected at a position along a leading edge thereof to the upper end of the mast assembly, said position being located at 60-90 percent of a total length L1 of the leading edge from a lower end of the leading edge. In effect, the mast assembly is moved forwards. Instead of supporting the sail device near its upper end, the sail device is supported further forwards. In this embodiment, the sail device extends above the highest point of the mast assembly.

[0009] This embodiment is based on the insight that the vessel of EP2184225 can only carry a sail having a limited surface area. With the features of this embodiment, a larger sail device can be carried, resulting in a faster sailboat.

[0010] In an embodiment of the sailing vessel, the mast assembly is positioned substantially at a rear portion of the vessel.

[0011] In an embodiment of the sailing vessel, the four planing boards are positioned substantially in a rectangle or square configuration, when viewed from above.

[0012] In an embodiment of the sailing vessel, each planing board has a rear tip, and the rear tips of the forward planing boards are located forward of a centre of effort of the sail device. In an embodiment of the sailing vessel, the rear tips of the forward planing boards are located aft of the curved rail.

[0013] In an embodiment, the sailing vessel comprises:

- a left fin box configured to accommodate a left fin (also called foil) and being positioned aft of the rear tip of the forward left planing board and forward of the rear tip of the rear left planing board,
- a right fin box configured to accommodate a right fin (also called foil) and being positioned aft of the rear tip of the forward right planing board and forward of the rear tip of the rear right planing board.

[0014] The left and right fin may extend substantially vertically in use. In an embodiment of the sailing vessel, the left fin box and the right fin box are connected directly to a frame interconnecting the planing boards, and not via one of the planing boards.

[0015] This embodiment has an advantage in that the planing boards can be changed like the tyres of a car without affecting the fins. The planing boards may need

to changed as a result of varying wave conditions.

[0016] It is also possible that the fin boxes are connected to the boards.

[0017] In an embodiment of the sailing vessel, in a rear view of the vessel the left fin box and right fin box are positioned closer to a longitudinal mid-plane of the sailing vessel than the rear tips of the respective left planing boards and right planing boards.

[0018] This embodiment is based on the insight that with this position, a better course stability can be obtained.

[0019] In an embodiment of the sailing vessel, in a rear view of the vessel the left fin box and right fin box are positioned between respective inner sides of the left and right planing boards and the longitudinal mid-plane of the sailing vessel.

[0020] This embodiment is based on the insight that with this position, an even better course stability can be obtained, and the planing boards can be changed without affecting the fins.

[0021] In an embodiment of the sailing vessel, the sail device comprises at least:

- a first substantially rigid member which defines the leading edge and
- a second rigid member which is rigidly connected to the first substantially rigid member and which defines at its rear end a lower rear end of the sail device, and maintains said lower rear end in a substantially fixed position relative to the leading edge.

[0022] Generally, the first rigid member will be the mast which extends inside a luff of the sail. The second rigid member will generally be the boom which is rigidly connected to the first substantially rigid member.

[0023] In an embodiment of the sailing vessel, the sail device is substantially rigid wing having a double skin. Rigid wings are used more and more and the present invention is in particular suitable to be used in combination with a rigid wing.

[0024] In an embodiment of the sailing vessel, the planing boards have a maximum width which is at least 15 percent of a maximum width of the hull assembly.

[0025] In an embodiment of the sailing vessel, at least the forward planing boards have a wedge-type form, when viewed in side view, an underside of the planing boards being substantially flat and even and oriented at a small pitch angle, an upper side also being substantially flat and even, the underside and upper side converging near a forward tip of the planing boards.

[0026] In an embodiment, the sailing vessel comprises a left rudder and a right rudder, wherein in a rear view of the vessel the left and right rudder are positioned inward with respect to the planing boards, i.e. wherein the left rudder and right rudder are positioned between the rear tips of the respective left and right planing boards and the longitudinal mid-plane of the sailing vessel.

[0027] In an embodiment, the sailing vessel comprises a control device constructed to rotate the sail device about a rotation axis over an angle γ greater than 270 degrees relative to the boat during jibing of the sailing vessel, wherein during the rotation a lower rear end of the sail device swings over the bow of the vessel.

[0028] This embodiment provides a substantially improvement in that a gap underneath the sail can be reduced significantly. This embodiment is based on the insight that the EP2184225 has a "leak" underneath the sail. In EP2184225, the fact that the sail moves from left to right over the central portion of the frame implies that in the left position and the right position, there will always be a gap between the lower ridge of the sail and the water. This gap can be substantially reduced with this embodiment. Because the sail no longer moves over the central portion of the frame, the lower ridge of the sail can stay closer to the water. This assists in achieving the so-called end plating effect, and results in a speed increase.

[0029] In an embodiment of the sailing vessel, the control device comprises at least one line which is connected to a rear end of the sail device, and extends along the leeside of the sail device towards the leading edge, and curves around the leading edge, and extends from the leading edge to a connection point on the sailing vessel.

[0030] In an embodiment of the sailing vessel, for changing tack the sail device is configured to - when viewed from above - rotate clockwise over at least 270 degrees when a lower connection point of the sail device is moved from a substantially left side of the sailing vessel to a substantially right side of the sailing vessel along the curved rail and is configured to rotate counter-clockwise over at least 270 degrees when the lower connection point of the sail device is moved from a right side of the sailing vessel to a left side of the sailing vessel along the curved rail.

[0031] In an embodiment of the sailing vessel, the sail device is configured to position the rear edge of the sail device forward of the leading edge of the sail device during jibing.

[0032] In an embodiment, the sailing vessel comprises at least one tacking line extending between a tacking line connection point on the hull assembly or the mast assembly and a forward point on the sail device, the tacking line being configured for pulling the leading edge of the sail device in a rear direction and substantially toward the mast assembly, thereby rotating the rear edge of the sail device forward of the leading edge.

[0033] This embodiment advantageously enables fast and controlled jibing. Since the boat generally jibes when it changes tack, the tacking lines may also be referred to as jibing lines.

[0034] In an embodiment of the sailing vessel, the tacking line connection point is located substantially to the rear of the leading edge of the sail device.

[0035] In an embodiment of the sailing vessel, the tacking line connection point is located on the longitudinal midplane of the sailing vessel.

[0036] In an embodiment of the sailing vessel, the sail device comprises a protruding element which projects in a forward direction from the leading edge of the sail device or from a forward tip of the boom over a distance of at least 15 percent of a length of the foot of the sail device, wherein the forward point is connected to said protruding element. This reduces the force required for jibing.

[0037] In an embodiment, the sailing vessel comprises a first tacking line and a second tacking line which are both connected to respective forward points on the sailing device, wherein the first and second tacking lines extend between the respective forward points on the sail device and respective left and right tacking line connection points on the hull assembly.

[0038] In an embodiment of the sailing vessel, in side view an upper rear portion of the sail device extends to the rear of the mast assembly when the sail device has a small, in particular a minimal sheet angle.

[0039] This embodiment has an advantage in that a larger sail device can be used. However, it brings along a disadvantage of a more complex jibing procedure than is used by the vessel of EP2184225, because otherwise the mast assembly is in the way.

[0040] In an embodiment, the sail device is taller than the mast assembly and extends above the upper end of the mast assembly.

[0041] In an embodiment of the sailing vessel, the sail device comprises a sail, a wishbone boom and a mast which extends through a luff in the sail, wherein the mast defines the leading edge of the sail, and wherein the mast is substantially straight when not under a load and is forced into a curved shape by a compression force exerted on the mast by the sail, the sail being connected to an upper end of the mast and a lower end of the mast.

[0042] In an embodiment, the sailing vessel comprises a left rudder assembly and a right rudder assembly, each rudder assembly comprising a first, pivotable blade and a second, non-pivotable blade. The non pivotable blade improves the course stability. The sailing vessel of the invention does not contact the water with long sleek hulls like a traditional catamaran. For this reason it is less course stable. This embodiment mitigates this disadvantage.

[0043] In an embodiment of the sailing vessel, in side view the leading edge of the sail device is curved. It was found that this improves the aerodynamics. In use, the direction of the apparent wind changes over the height, and the angle of the leading edge should change analogously over the height. This results in a more optimal ratio of thrust (Fx) and lift (Fz) of the wind force.

[0044] In an embodiment, the curvature is strongest near a middle portion or directly below the middle portion of the leading edge, the curvature being least strong at the upper end and lower end of the leading edge.

[0045] In an embodiment of the sailing vessel, in side view the leading edge does not have a strong curvature at the lower end or upper end of the leading edge.

[0046] In an embodiment of the sailing vessel, in side view an angle (β) enclosed by the leading edge and the foot of the sail decreases when travelling upward along the leading edge. In an embodiment of the sailing vessel, said angle (β) gradually decreases.

[0047] The present invention further relates to a sail for use in a sailing vessel according to any of claims 1 - 9.

[0048] In an embodiment, the sail comprises a luff extending along the leading edge for accommodating a mast, the sail further having a rake angle (β) between 50 and 66 degrees, wherein a length of the gaff is at least 1/6 of a length of the leading edge of the sail, and wherein a length of the foot of the sail is at least 30 percent of the length of the leading edge, and wherein the surface area is at least 18 m^2, wherein in side view the leading edge of the sail device is curved, the curvature being strongest near a middle portion or directly below the middle portion of the leading edge, the curvature being least strong at the upper end and lower end of the leading edge.

[0049] In an embodiment of the sail, in side view an angle (β) enclosed by the leading edge and the foot of the sail decreases when travelling upward along the leading edge. In an embodiment of the sail, said angle (β) gradually decreases.

[0050] "Gaff' is used to indicate the upper edge of the sail.

[0051] In an embodiment, the sail comprises:

- a first cut-out along the leading edge for allowing the boom to be connected to the mast inside the luff, and
- a second cut-out along the leading edge allowing the mast inside the luff to be connected to the mast assembly, the second cut-out being located at 60-90 percent of a total length L1 of the leading edge from a lower end of the leading edge.

[0052] In en embodiment, at least one or more of the battens in the sail are oriented downwards, i.e. are higher near the leading edge than near the trailing edge of the sail, when seen in side view.

[0053] The present invention further relates to a frame for use in a sailing vessel according to any of claims 1 - 9, the frame comprising:

- mounting positions for mounting a first planing board, a second planing board, a third planing board and a fourth planing board,
- a left fin box and a right fin box,
- a mounting position for a mast assembly,
- a curved rail which extends substantially from a left side of the hull assembly to a right side of the hull assembly, the curved rail being configured for supporting a mast foot of the sail device.

[0054] The present invention further relates to a planing board for use in a sailing vessel according to any of claims 1 - 9, the planing board comprising a substantially flat and straight underside which at the rear end of the planing boards ends in a sharp edge, the planing board

comprising substantially vertical side walls, which are substantially vertical over at least 70 percent of a height of the side walls.

[0055] In an embodiment, the planing board has a wedge-type form, when viewed in side view, an underside of the planing boards being substantially flat and even, an upper side also being substantially flat and even, the underside and upper side converging near a forward tip of the planing boards.

[0056] The present invention further relates to a method of sailing comprising:

- providing a sailing vessel according to any of claims 1-9,
- positioning the sail device such that the lower connection point is located substantially on the leeside of the vessel, the sail device being oriented such that an upper part of the sail is located more to the weather side of the vessel than a lower part of the sail.

[0057] Generally, the planing boards will be board or board-like objects. The boards are elongate.

[0058] The planing boards may be provided with a dead rise, i.e. have a V-shape. The V-shape makes the planing action somewhat less efficient, but improves the dynamic behaviour in waves.

[0059] In an embodiment, the distance between the two forward planing boards is smaller than the distance between the two rear planing boards, such that the four planing boards form a trapezoidal configuration, when viewed from above. This results in a boat with a forward side which is narrower than the rear. The distance may also be greater, which results in a boat with a wider forward part than the rear part.

[0060] In an embodiment, the forward planing boards have a greater width than the rear planing boards. In use, the forward planing boards generally carry a greater load than the rear planing boards. This greater load can be transferred to the water with the greater width.

[0061] In an embodiment, the forward planing boards have a greater volume than the rear planing boards. The sailing vessel should also be able to sail in Archimedes mode, and to this, end the forward planing boards have a greater volume than the rear planing boards.

[0062] The invention also relates to a hull assembly. The hull assembly may be integral hull with four planing boards, but may also be a frame with four planing boards connected to it. The four planing boards may be connected to the frame via detachable couplings. This allows replacement of a board by another board in case of damage or changing conditions in the weather, the water, the crew or the payload of the sailing vessel.

[0063] The invention is further explained in the accompanying, non-limiting drawing, wherein like reference numerals denote like parts, and wherein double arrows indicate directions of movement.

LIST OF THE FIGURES

[0064]

Figure 1 shows a side view of the sailing vessel according to the invention.
Figure 2 shows a front view of the sailing vessel according to the invention.
Figure 3 shows a bottom view of the sailing vessel according to the invention.
Figure 4 shows a bird's eye view of the sailing vessel according to the invention.
Figure 5 shows a bird's eye view of the sailing vessel according to the invention from a different angle.
Figure 6 shows a bird's eye view of the sailing vessel according to the invention during gibing.
Figure 7 shows a rear view of the sailing vessel according to the invention during gibing.
Figure 8 shows a bird's eye view of the sailing vessel according to the invention during gibing.
Figure 9 shows a bird's eye view of the sailing vessel according to the invention during gibing.
Figure 10 shows a bird's eye view of another embodiment of the sailing vessel.
Figure 11 shows a side view of the embodiment of figure 10.
Figure 12 shows a rear view of the embodiment of figure 11.
Figure 13 shows a detailed cross section of the curved rail and the mast foot.
Figure 14 shows a detailed side view of the connection between the sail device and the mast assembly.

DETAILED DESCRIPTION OF THE FIGURES

First embodiment

[0065] Turning to figures 1, 2, 3, 4 and 5, the sailing vessel 1 according to the invention is shown. The vessel 1 comprises a hull assembly 2 which comprises a frame 3 and four planing boards 8, 9, 10 and 11. The planing boards may also be indicated as planing hulls. The vessel 1 comprises a sail device 4 and a mast 6. The vessel 1 further comprises a left rudder assembly 12 and a right rudder assembly 13, which are mounted to the frame 3.

[0066] The vessel 1 further comprises a left fin 14 and a right fin 15, each provided in a respective fin box 50, 51. The fin boxes have openings at the top so that the fins can be inserted into the fin box from the top and can be hoisted upward out of the water. The fin boxes are connected directly to the frame, not via the planing boards.

[0067] The mast 6 is positioned substantially at the rear of the vessel. The mast is inclined to the rear over a small angle, but may also be vertical. The mast is fixed to the hull assembly via lines 24, 25.which extend from points at the left rear part 26 and right rear part 27 of the hull assembly 2 to the upper end 30 of the mast 6.

[0068] The mast comprises two poles which meet near the upper end 30 of the mast and are spaced apart near a lower end of the mast at the frame 3. The mast 6 can be also be a single beam, an A-frame (in side view) or have a different construction.

[0069] A trampoline 220 or hard deck 220 is provided at least at a rear portion of the frame so that the sailors have a place to sit on. Seats may be provided on the trampoline 220 or deck 220.

[0070] In side view, the leading edge 38 makes an angle β with the horizontal of about 70-90 degrees near the lower end 152 of the leading edge and an angle of about 30-50 degrees near an upper end 150 of the leading edge 38. When seen in side view, the angle between the leading edge 38 and the horizontal decreases gradually when travelling along the leading edge 38 in an upward direction.

[0071] The trailing edge of the front planing boards 8, 9 is located forward of the centre of effort of the sail. The trailing edge of the rear planing boards is located aft of the centre of effort of the sail. The pressure point 62 (or centre of effort) of the sail device is located near the leeside of the hull assembly.

[0072] In side view, the boom 19 extends downwards, i.e. is inclined to the back. In side view the boom is inclined over at least 10 degrees. The boom substantially follows the flow lines of the air flow, which are directed downwards. A gap 92 between the lower edge 87 of the sail and the water line 300 is minimal to create more pressure on the sail. This is called the "end plating" effect.

[0073] The gap 92, when measured half way the lower edge 87 of the sail, is smaller than ten percent of the total height 95 of the sail device above the water line 300. This remains true when the weather side of the vessel is raised from the water in use due to the force of the wind. Contrary to catamarans, the gap 92 underneath the sail does not increase when the sailing vessel rolls over a roll angle and sails on its leeside only. Instead, the gap 92 decreases in size or stays substantially the same.

[0074] In side view, a rear portion 104 of the sail extends to the rear of the mast assembly 6. This is best seen in figure 1. The rear portion 104 may be the upper rear portion of the sail device. This happens when the sail device has a small sheet angle. In particular the rear portion of the gaff extends to the rear of the mast assembly, in side view and with a small sheet angle.

Frame

[0075] The frame 3 comprises multiple lateral bars 246 and longitudinal bars 248 rigidly connected to one another. A curved rail 32 extends substantially from the left side 33 of the vessel to the right side 34 of the vessel. The center of the rail is located further forward than the left end and right end of the rail. The rail 32 may be positioned in a substantially horizontal plane. The cross-bars and longitudinal bars may be I-bars H-bars or tubular bars, i.e. with a round, square or rectangular cross-section. The frame is manufactured from carbon, but aluminium may also be used.

[0076] Diagonal bars may be included in the frame for further stiffness. Furthermore, beams or wires which protrude from a plane defined by the cross-bars 246 and longitudinal bars 248 may be provided to create more torsion stiffness.

[0077] The frame 2 has a length and a width. The frame 2 has four corners. The frame has left and right sides. The frame is composed of bars or beams.

[0078] A left and right longitudinal bar may extend along the inner sides of the planing boards. Protruding parts of the lateral bars 246 may extend outwardly beyond the left and right longitudinal bars that extend along the inner sides of the planing boards.

[0079] The width of the frame 3 may be larger at the front part of the frame than at the rear part.

Boards

[0080] The four boards 8, 9, 10, 11 are each located substantially at respective corners of the frame 3. The boards have a width which may vary along the length of the boards. The rear lower edges 45 of the planing boards are curved as is known in general from windsurf boards. The side walls 68 of the boards extend substantially vertically over at least 70 percent of the height of the side walls.

[0081] The planing boards are constructed to let the sailing vessel plane, i.e. make the transition between Archimedes mode and planing mode.

[0082] The maximum width of the forward boards may be greater than the maximum width of the rear boards. The volume of the forward boards 8, 9 may be the same or greater than the volume of the rear boards 10, 11. The volume of the forward boards may be at least 10 percent greater, preferably 30 percent greater. The forward boards may have a greater height than the rear boards.

[0083] The upper side of the boards may be substantially parallel to the plane defined by the cross beams and longitudinal beams of the frame 3

[0084] The planing boards 8, 9, 10, 11 each have a rear edge 45. The rear edge 45 of the forward boards 9, 11 is located in front of the centre of effort 42 of the sail device 4.

[0085] The rear boards 10, 11 are at an equal distance from one another as the front boards 8, 9. However, the rear boards may also be closer to one another than the front boards.

[0086] The boards are connected to the frame via brackets. The brackets may be integral with the frame or integral with the boards or constructed as separate parts. Each board is connected to the frame via a front bracket and a rear bracket.

[0087] In this way, the boards can be changed in case of damage, transport of the sailing vessel or changing sailing conditions. For instance, for flat water one type of board may be suitable, and for water with waves another

type of board may be more suitable. The choice of boards may further depend on the wind speed and the payload carried on the boat,

[0088] The couplings also allow the boards to be reoriented relative to the frame. The couplings allow the pitch angle δ of the boards to be adjusted. In particular, the pitch angle of the rear portion of the underside 250 of the boards is relevant, because it is only the rear portion of the underside 250 which contacts the water at full speed. Typical pitch angles δ of the rear portion vary between 1 and 6 degrees. The couplings also allow a roll angle of the boards relative to the frame 3 to be adjusted. The boards may be pivoted over a roll angle about a longitudinal axis relative to the frame to ensure that when the boards on the weather are lifted slightly above the water, the underside of the leeside boards is still horizontal so that planing is optimal. The roll angle may typically be 1-3 degrees relative to the frame.

[0089] In side view, the underside of the boards may have a slightly curved shape so that the underside 250 curves upwards towards the bow. In an embodiment, in side view the planing boards curve from a pitch angle of between 1 and 6 degrees to the horizontal near a rear tip 44 thereof to an angle of between 5 and 10 degrees three quarters of the forward planing boards from the rear end of the boards. However, in side view the planing boards may also have substantially straight planing surface.

[0090] The planing boards 8, 9, 10, 11 may be substantially hollow or filled with foam. A combination is also possible, i.e. the boards may be partly hollow, partly filled with foam.

[0091] The forward planing boards may have a greater width than the rear planing boards, but may also have the same width. The width 70 of the underside 250 of the boards is at least 15 percent of the width 72 of the hull assembly.

[0092] The boards 8, 9, 10, 11 and the frame 2 may also form an integral construction. This allows a stronger construction, but makes it more difficult to repair damage or adapt the boat to varying conditions. Also, transport of the vessel on a lorry or trailer is more difficult in this embodiment. This embodiment is considered very suitable for ocean going variants, because it can be stronger.

[0093] The distance between the two forward planing boards may also be smaller than the distance between the two rear planing boards, such that the four planing boards form a trapezoidal configuration, when viewed from above.

Sail device

[0094] The sail device 4 is essentially an extremely large windsurf sail and comprises a sail mast 18, a boom 19 and a sail 20. The sail 20 comprises a luff 190, i.e. a tubular section along the leading edge which accommodates the mast 18. The sail mast is positioned inside the luff of the sail. The boom is connected to said sail mast at one end and to the sail at a second end. The sail, sail mast and boom together form the sail device.

[0095] The sail mast 18 and the boom 19 are connected to one another at a connection point 22. The sail device 4 is connected to the mast 6 at an upper end 35 of the sail device 4.

[0096] The sail 20 comprises pockets for battens 348 and accommodates the battens inside the pockets. This is known from windsurf sails.

[0097] Turning to figure 13, the lower end 122 of the mast 18 is connected to the rail 32 via a cardanian coupling 170 and a sliding member 123 which together form the mast foot 170. The cardanian coupling may also be a diabolo coupling. The sliding member 123 allows the mast foot 170 of the sail device to move from the left side 33 to the right side 34 of the rail and back. This allows the vessel to sail on both tacks. The sail device can pivot relative to the rest of the sailing vessel about an axis 80 defined by the lower connection point 28 and the upper connection point. During gibing, the sail device 4 moves from left to right or vice versa forward of the mast 6. In use, the rotation axis is inclined to the rear and inclined to the weather side.

[0098] The boom 19 is inclined to the rear, when seen in side view, i.e. the front end of the boom is higher than the rear end. At least a number of the battens are also inclined to the rear, when seen in side view, i.e. the front ends of the battens are positioned higher than the rear ends. The boom and battens follow the dominant direction of the airflow which is directed downwards by the sail device 4.The boom is substantially rigidly connected to the mast 18.

[0099] The sail device may comprise camber inducers like windsurf sails have. In this case, the luff 190 is extra wide, providing a double skin along a portion of the sail near the leading edge 38.

[0100] It is noted that the sail device 4 may also be a wing, i.e. a rigid double skin sail device 4.

[0101] A control device 350 is provided for controlling the rotation of the sail during sailing and during jibing. The control device comprises at least one tacking line 86, a left line 260 and right line 261 for varying the sheet angle of the sail device and for tacking the sail device. A protruding element 192 protrudes forward from the boom 19. The tacking line 86 is connected to the forward tip of the boom or to a forward point on the protruding element. The function of the control device 350 is explained further below.

Fins and fin boxes

[0102] The fins 14, 15 (or foils) are mounted in fin boxes 50, 51. The fin boxes 50, 51 are mounted directly to the frame 2 so that the lateral forces, drag forces and bending moments from the fins are directly transferred to the frame 3 and not via the planing boards. Because the fin boxes are not connected to the boards, in use the boards 8, 9, 10, 11 are kept substantially free of the lateral forces

and bending moments resulting from the water pressure on the fins.

[0103] The fin boxes comprise through holes which extend substantially vertically and which have a size and shape that matches the size and shape of the fins. The fin boxes have a stop preventing the fins from falling through the fin boxes.

[0104] The fin boxes 50, 51 may be integrated in a longitudinal bar 248 of the frame 3 or mounted to the side of said bar 248. Although in rear view the fins 14, 15 are shown in an inclined orientation, the fins 14, 15 may also be positioned vertically or substantially vertically. In rear view the fins are substantially straight. The fins may have an asymmetric profile, resulting in a left fin and a right fin. The left fin box 50 and right fin box 51 are positioned forward of the forward ends of the rear planing boards.

Mast assembly

[0105] The mast assembly 6 may be positioned substantially at the rear of the frame. The mast assembly comprises a base which has a certain length and is connected to the frame. Preferably, the mast assembly is removably connected to the frame 3.

[0106] At the upper end of the mast, a sail connection point is defined. The sail is connected to said connection point.

Rudder assembly

[0107] The rudder assemblies 12, 13 may be connected directly to the frame and not to the rear planing boards. In rear view, the rudder assemblies are positioned closer to the mid plane 66 of the vessel than the inner sides of the planing boards.

[0108] Each rudder assembly 12, 13 comprises a fixed blade 131 and a pivoting blade 130, resembling a rear wing of a plane. The fixed blade 131 assists in directional stability of the sailing vessel, At high speed, the planing boards make very little contact with the water and thus do not contribute much to the directional stability of the boat. The fixed blade assists in this.

[0109] The pivotable blade 130 is used for steering and is connected to the fixed blade via hinges. Both the fixed blade and the pivotable blade can be raised from the water so that the rudder assembly on the weather side can be raised from the water to reduce drag.

Second embodiment

[0110] Turning to figures 10, 11, 12 and 14, a second embodiment is shown wherein the mast assembly 6 is positioned further forward than in the first embodiment. The mast assembly 6 may still be in the rear half of the vessel or may be located substantially centrally on the vessel. The sail device 4 is taller than the mast assembly 6 and extends above the upper end 30 of the mast assembly. The sail device 4 is connected at a position 36 along a leading edge 38 thereof to the upper end 30 of the mast assembly 6, said position 36 being located at 60-90 percent of a total length L1 of the leading edge from a lower end 152 of the leading edge 38.

[0111] The sail has a first cut-out 240 along the leading edge 38 for allowing the boom to be connected to the mast 18 inside the luff, and a second cut-out 241 along the leading edge allowing the mast 18 inside the luff to be connected to the mast assembly 6 at the second cut-out, the second cut-out being located at 60-90 percent of a total length L1 of the leading edge from a lower end 152 of the leading edge 38.

[0112] The mast 18 inside the luff 180 is longer than the mast assembly 6 and is connected to the mast assembly 6 via a connection point 255. The connection allows the sail device to be rotated over an angle greater than 270 degrees relative to the mast assembly. An upper portion of the mast 18 extends above the connection point with the mast assembly.

[0113] The second embodiment has an advantage in that bending moments in the mast 18 inside the luff 180 are reduced, thereby allowing greater sails to be used and increasing the possible size of the sailing vessel. Alternatively, a same size of sail is possible with a smaller diameter mast 18 inside the luff. The upper part 210 of the sail device 4 is positioned on the weather side of the vessel, whereas the lower part 212 of the sail device 4 is positioned on the leeside of the vessel.

[0114] On the mast, two fixed rings 245, 246 are mounted. Between the fixed rings 245, 246, a rotary ring 247 is provided which can rotate about the mast 18. The rotary ring 247 is connected to the connection point 255 on the upper end 30 of the mast assembly. The connection point 255 is located at a front side of the mast assembly. Other constructions of the connection point 255 are possible.

[0115] The second embodiment has a left tacking line 86A extending between the forward point 88 and a left connection point 90A and a right tacking line 86B extending between the forward point 88 and a right connection point 90B of the tacking line.

[0116] Many other features of the second embodiment are similar to the first embodiment as is clear from the drawings.

Use

[0117] In use, a roll axis of the vessel is defined by the two boards on the leeside of the vessel. Generally, the rudder assembly and the fin on the weather side will be raised during sailing. This reduces drag.

[0118] In use, the centre of effort 62 of the sail device is positioned in a first area located on the left side of a central longitudinal plane 66 which extends substantially through the mast assembly 6, and alternatively positioned in a second area located on the right side of the central longitudinal plane 66.

[0119] In use, the sail device 4 is positioned in an inclined orientation relative to the hull assembly, an upper

part of the sail device being located closer to a weather side of the sailing vessel than a lower part of the sail device. The rotation axis 80 of the sail device can be inclined to the left over an angle (α) relative to the hull assembly and alternatively the rotation axis 80 can be inclined to the right over an angle (α') relative to the hull assembly.

[0120] Turning to figures 6, the sailing vessel comprises a left line 260 connecting the rear tip 82 of the boom 19 to a connection point 262 on the hull assembly 2. The left line 260 is part of the control device 350 and is used to control the sheet angle during sailing. When the sailing vessel makes a gibe, the left line 260 is loosened. The force of the wind causes the sail device 4 to rotate about the rotation axis 80, wherein the rear tip 82 of the boom 19 rotates in the direction of the bow of the vessel. The leading edge 38 rotates in a rear direction, i.e. toward the mast assembly 6.

[0121] In order to further facilitate the rotation, a tacking line 86 may be provided which extends between a forward point 88 on the sail device 4 and a connection point 90 on the hull assembly, directly forward of the mast assembly 6. The connection point may also be provided on the mast assembly 6. The tacking line 86 is pulled, thereby rotating the sail device 4 about the rotation axis 80 and pulling the forward ridge 38 to the rear.

[0122] If the protruding element 192 is provided which extends forward of the boom, the force that needs to be exerted on the tacking line 86 is smaller because the protruding element 192 creates a larger arm about the rotation axis 80. At the same or during a separate, consecutive step, the lower connection point 28, i.e. the mast foot 170, is moved along the curved rail 32 to toward the mid plane of the vessel. This is done with a winch 360 which is connected to the line 362 that is connected to the mast foot 170. The line 362 is a closed loop. The winch 360 and the closed loop line 362 are shown in figure 8. The winch 360 is provided on the hull assembly near the mast assembly 6.

[0123] Turning to figure 7, when the lower connection point approaches the center of the vessel, the rear tip 82 of the boom 19 is positioned relatively high in the air. The left line 260 is further loosened, since the rear end 82 of the boom continues to move forward. A part 78 of the leading edge 38 of the sail device between the upper end 30 of the mast assembly and the lower connection point 28 of the sail device moves through a gap 79 defined by an axis 80 of rotation of the sail device and the mast assembly (6)

[0124] Turning to figure 8, when the mast foot 170 has passed the longitudinal midplane 66 of the vessel, and the rear end 82 of the boom has also passed the midplane, a right line 261 which extends between a connection point 263 on the right side of the hull assembly and the rear tip 82 of the boom is pulled, i.e. is shortened. This can be done manually or via a winch.

[0125] Turning to figure 9, the rear tip 82 is then pulled to the rear and inward, thereby further rotating the sail device 4 about the axis 80. The left line 260 is further loosened and comes to rest against the leeside of the sail device 4, extending from the rear tip 82 of the boom to the forward edge 38 of the sail device and from the forward edge 38 to the left connection point 262.

[0126] The connection points 262 and 263 of the left line 260 and right line 261 may also be positioned on the mast assembly 6 or on the midplane 66 of the hull assembly 2..

[0127] If the sailing vessel has two tacking lines 86A, 86B , the procedure is quite similar, except that the tacking lines are alternately used. When the sailing vessel changes tack from left to right, first the right tacking line 86B is pulled and subsequently the left tacking line 86A is pulled. When tacking from right to left, first the left tacking line 86A is pulled and then the right tacking line 86B.

[0128] The sailing vessel may reach a high speed. Changing tack generally takes place by jibing. When the vessel needs to change tack, this can be done at high speed, similar to a windsurfer. It will be clear that the same tacking procedure may also be performed with a sail device 4 in the form of a fixed wing. In this respect the words sail device are to be construed broadly. It will be clear to a person skilled in the art that the sailing vessel described herein above combines known techniques from both windsurfing and catamarans.

[0129] It will be obvious to a person skilled in the art that numerous changes in the details and the arrangement of the parts may be varied over considerable range without departing from the scope of the claims.

Claims

1. Sailing vessel (1), comprising:

   - a forward left planing board (8) positioned substantially on a forward left position of the vessel, and
   - a forward right planing board (9) positioned substantially on a forward right position of the vessel, and
   - a rear left planing board (10) positioned substantially on a rear left position of the vessel, and
   - a rear right planing board (11) positioned substantially on a rear right position of the vessel.

2. Sailing vessel of claim 1, comprising a curved rail (32) which extends substantially from a left side (33) of a hull assembly (2) to substantially a right side (34) of the sailing vessel and being configured for supporting a mast foot (170) of a sail device, allowing the mast foot (170) to move from substantially the left side to substantially the right side and vice versa, the sailing vessel further comprising:

   - a mast assembly (6) which extends upwards from a hull assembly (2) which comprises the

four planing boards, the mast assembly being located at a central longitudinal plane (66) of the sailing vessel, and

- a sail device (4) connected to an upper end (30) of the mast assembly, the sail device further being connected to the curved rail at a lower connection point (28) of the sail device, wherein the lower connection point is movable along the curved rail (32) relative to the hull assembly from a position (230) substantially on a left side (33) of the hull assembly to a position (231) substantially on a right side (34) and vice versa, such that in use the sail device is inclined against the wind, thereby causing the wind force on the sail device to have an upward component,

wherein the sail device (4) is connected at a position (36) along a leading edge (38) thereof to the upper end (30) of the mast assembly (6), said position (36) being located at 60-90 percent of a total length (L1) of the leading edge from a lower end (152) of the leading edge (38),
the sailing vessel further comprising a control device (350) constructed to rotate the sail device about a rotation axis (80) over an angle greater than 270 degrees relative to the boat during tacking of the sailing vessel, wherein during the rotation a lower rear end (82) of the sail device swings over the bow (83) of the vessel,
and wherein in side view an upper rear portion (104) of the sail device (4) extends to the rear of the mast assembly (6) when the sail device has a small, in particular a minimal sheet angle.

3. Sailing vessel of claim 2, wherein for changing tack the sail device (4) is configured to - when viewed from above - rotate clockwise over at least 270 degrees when a lower connection point (28) of the sail device is moved from a substantially left side of the sailing vessel to a substantially right side of the sailing vessel along the curved rail (32) and is configured to rotate counterclockwise over at least 270 degrees when the lower connection point (28) of the sail device is moved from a right side of the sailing vessel to a left side of the sailing vessel along the curved rail,

4. Sailing vessel of any of the preceding claims, comprising:

- a left fin box (50) configured to accommodate a left fin (14) and being positioned aft of the rear tip (44) of the forward left planing board and forward of the rear tip (44) of the rear left planing board (11),
- a right fin box (51) configured to accommodate a right fin (15) and being positioned aft of the rear tip (44) of the forward right planing board and forward of the rear tip (44) of the rear right planing board (10), and

wherein the left fin box (50) and the right fin box (51) are connected directly to a frame (3) interconnecting the planing boards, and not via one of the planing boards (8, 9, 10, 11).

5. Sailing vessel of claim 4, wherein in a rear view of the vessel the left fin box (50) and right fin box (51) are positioned between respective inner sides (68) of the left and right planing boards (8, 9, 10, 11) and the longitudinal mid-plane (66) of the sailing vessel.

6. Sailing vessel of any of the preceding claims, wherein the planing boards have a maximum width (70) which is at least 15 percent of a maximum width (72) of the hull assembly (2).

7. Sailing vessel of claim 2, wherein the control device (350) comprises at least one line (260,261) which is connected to a rear end (82) of the sail device, and extends along the leeside of the sail device towards the leading edge, and curves around the leading edge, and extends from the leading edge to a connection point (262, 263) on the sailing vessel, and wherein the control device comprises at least one tacking line (86) extending between a tacking line connection point (90) on the hull assembly (2) or the mast assembly (6) and a forward point (88) on the sail device (4), the tacking line being configured for pulling the leading edge (38) of the sail device in a rear direction and substantially toward the mast assembly (6), thereby rotating the rear edge (84) of the sail device forward of the leading edge (38), and wherein the tacking line connection point (90) is located substantially to the rear of the leading edge (38) of the sail device.

8. Sailing vessel of any of the preceding claims, wherein the sail device comprises a protruding element (192) which projects in a forward direction from the leading edge (38) of the sail device or from a forward tip (94) of the boom (19) over a distance of at least 15 percent of a length of the foot (87) of the sail device (4), wherein the forward point (88) is connected to said protruding element (192).

9. Sailing vessel of any of the preceding claims, wherein the sail device (4) comprises a sail (20), a wishbone boom (19) and a mast (18) which extends through a luff in the sail, wherein the mast (18) defines the leading edge (38) of the sail, and wherein the mast (18) is substantially straight when not under a load and is forced into a curved shape by a compression force exerted on the mast by the sail, the sail being connected to an upper end (120) of the mast (18) and a lower end (122) of the mast.

10. Sail for use in a sailing vessel according to any of claims 1 - 9, wherein the sail comprises a luff (190) extending along the leading edge (38) for accommodating a mast (18), the sail further having a rake angle (β) between 50 and 66 degrees, wherein a length of the gaff (138) is at least 1/6 of a length of the leading edge of the sail, and wherein a length of the foot (87) of the sail is at least 30 percent of the length of the leading edge, and wherein the surface area is at least 18 m^2, wherein in side view the leading edge (38) of the sail device (4) is curved, the curvature being strongest near a middle portion (180) or directly below the middle portion of the leading edge (18), the curvature being least strong at the upper end (150) and lower end (152) of the leading edge (18).

11. Sail according to claim 10, comprising

- a first cut-out (240) along the leading edge (38) for allowing the boom to be connected to the mast (18) inside the luff, and
- a second cut-out (241) along the leading edge allowing the mast (18) inside the luff to be connected to the mast assembly (6) at the second cut-out, the second cut-out being located at 60-90 percent of a total length (L1) of the leading edge from a lower end (152) of the leading edge (38).

12. A frame (3) for use in a sailing vessel according to any of claims 1 - 9, the frame comprising:

- mounting positions (160) for mounting a first planing board, (8) a second planing board (9), a third planing board (10) and a fourth planing board (11),
- a left fin box (50) and a right fin box (51),
- a mounting position (155) for a mast assembly (6),
- a curved rail (32) which extends substantially from a left side of the hull assembly to a right side of the hull assembly, the curved rail being configured for supporting a mast foot (170) of the sail device (4).

13. Planing board (8, 9, 10, 11) for use in a sailing vessel according to any of claims 1 - 9, the planing board comprising a substantially flat and straight underside (250) which at the rear end (44) of the planing boards ends in a sharp edge, the planing board comprising substantially vertical side walls (68), which are substantially vertical over at least 70 percent of a height of the side walls.

14. Planing board according to claim 13, having a wedge-type form, when viewed in side view, an underside of the planing boards being substantially flat and even, an upper side also being substantially flat and even, the underside and upper side converging near a forward tip of the planing boards.

15. Method of sailing comprising:

- providing a sailing vessel according to any of claims 1 - 9,
- positioning the sail device such that the lower connection point is located substantially on the leeside of the vessel, the sail device being oriented such that an upper part of the sail (210) is located more to the weather side of the vessel than a lower part (212) of the sail.

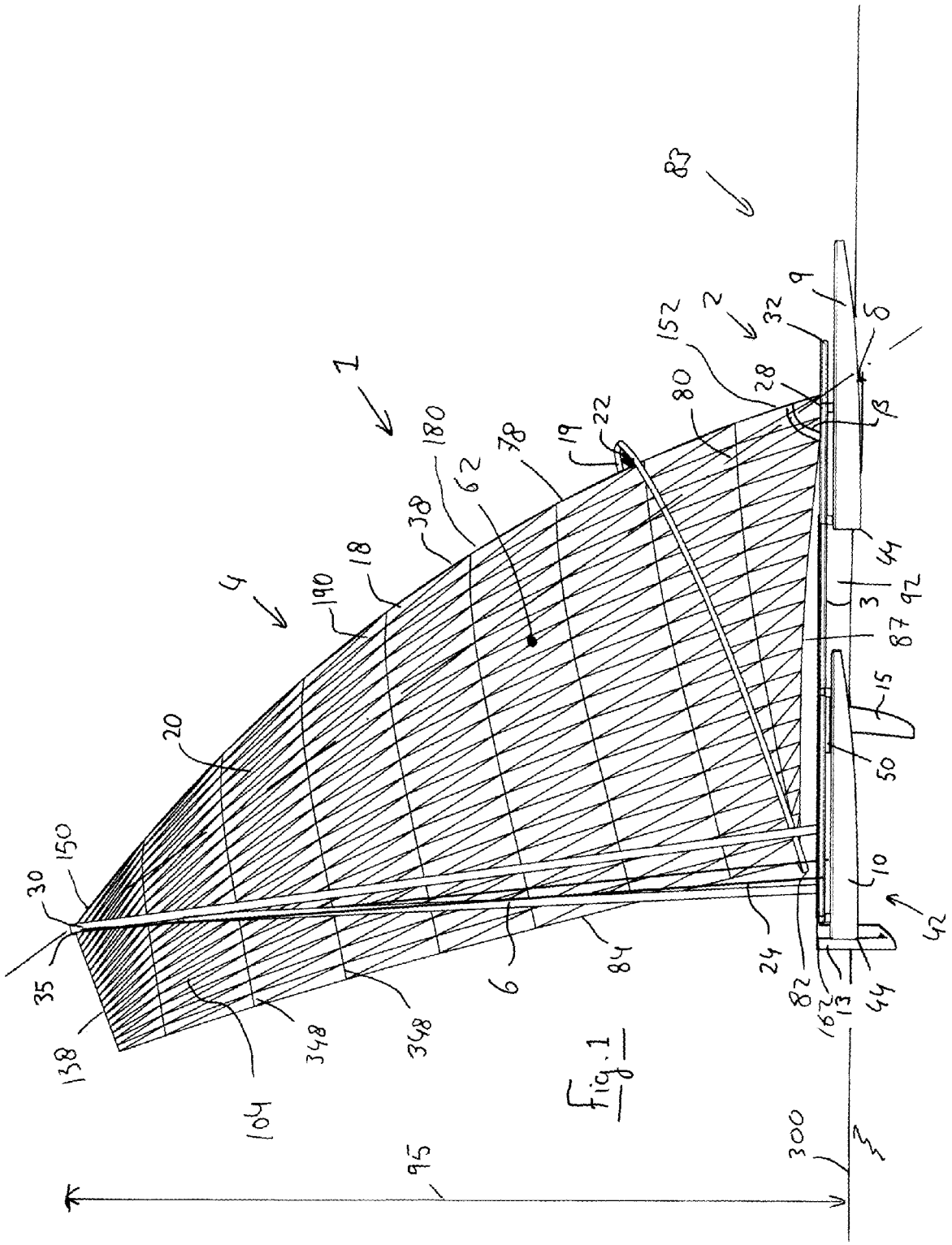

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Fig. 1

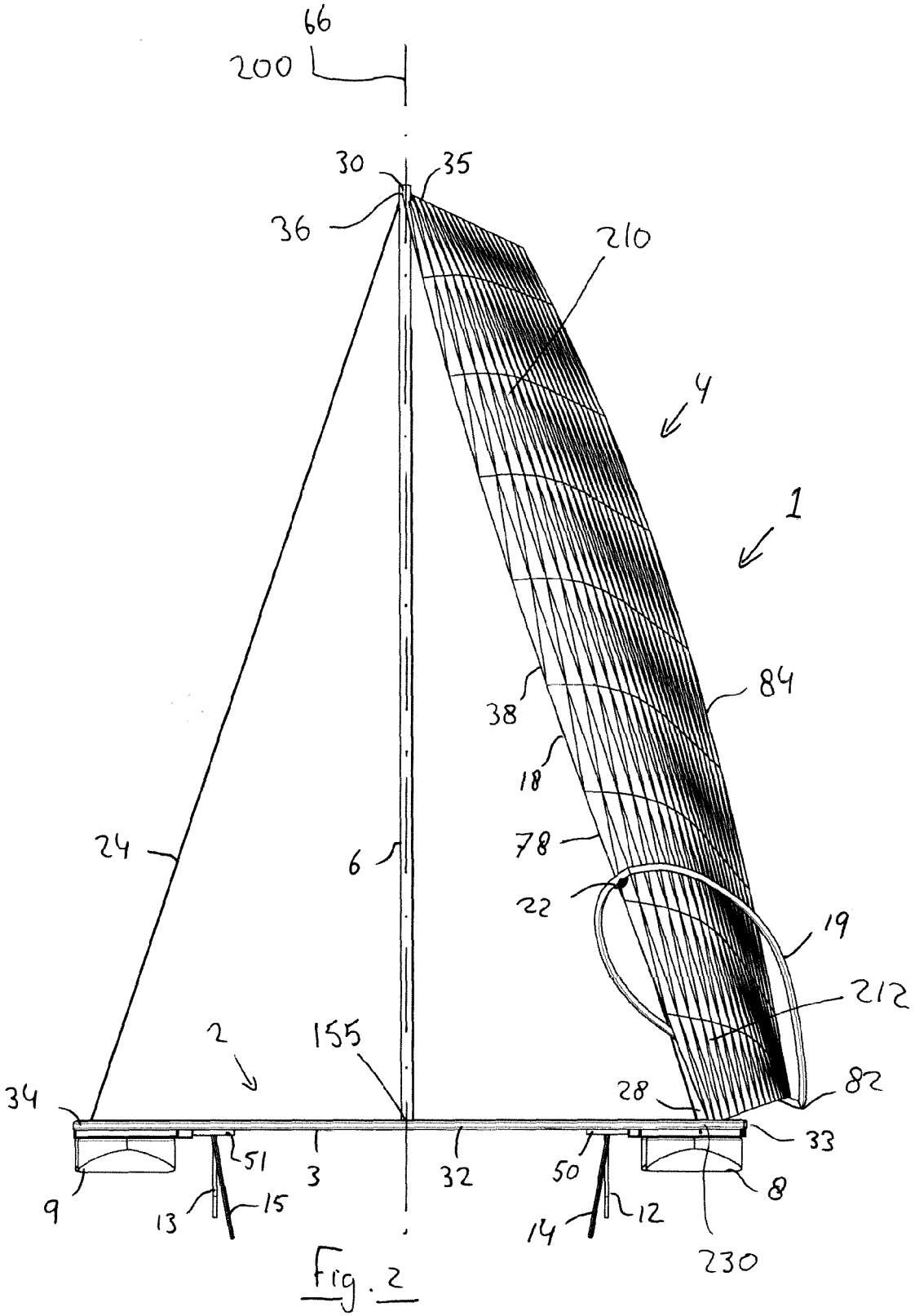

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Fig. 2

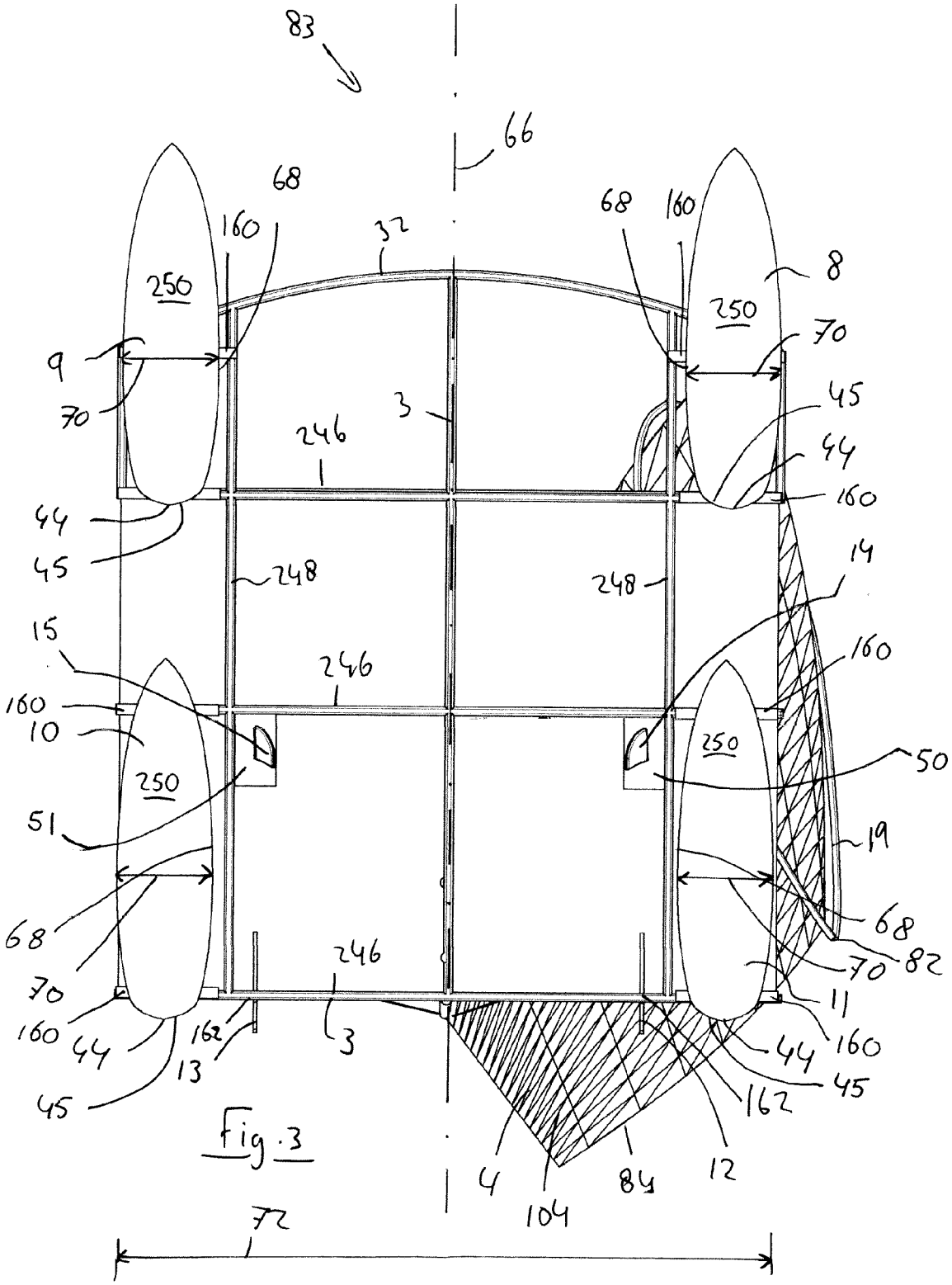

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Fig. 3

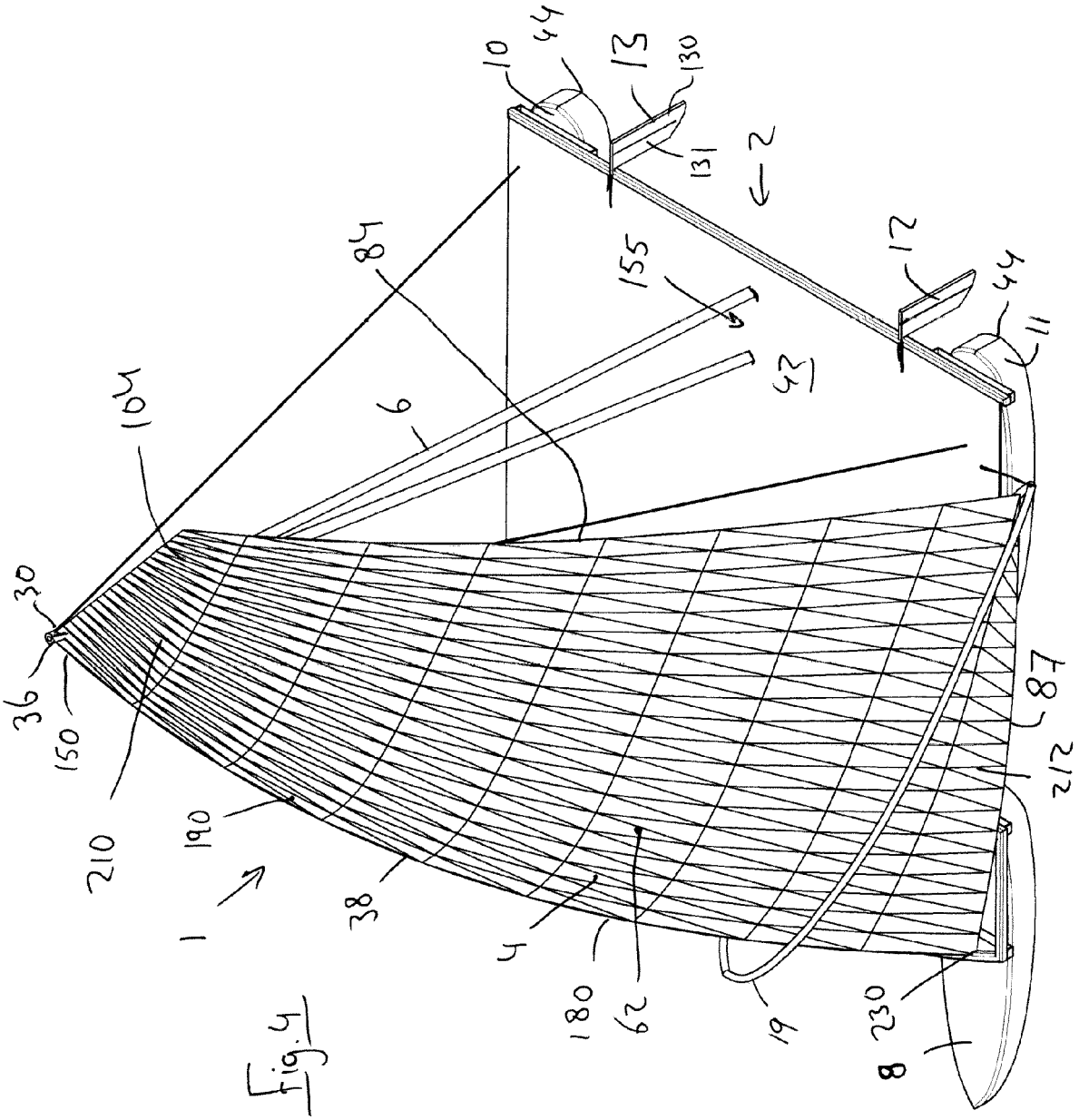
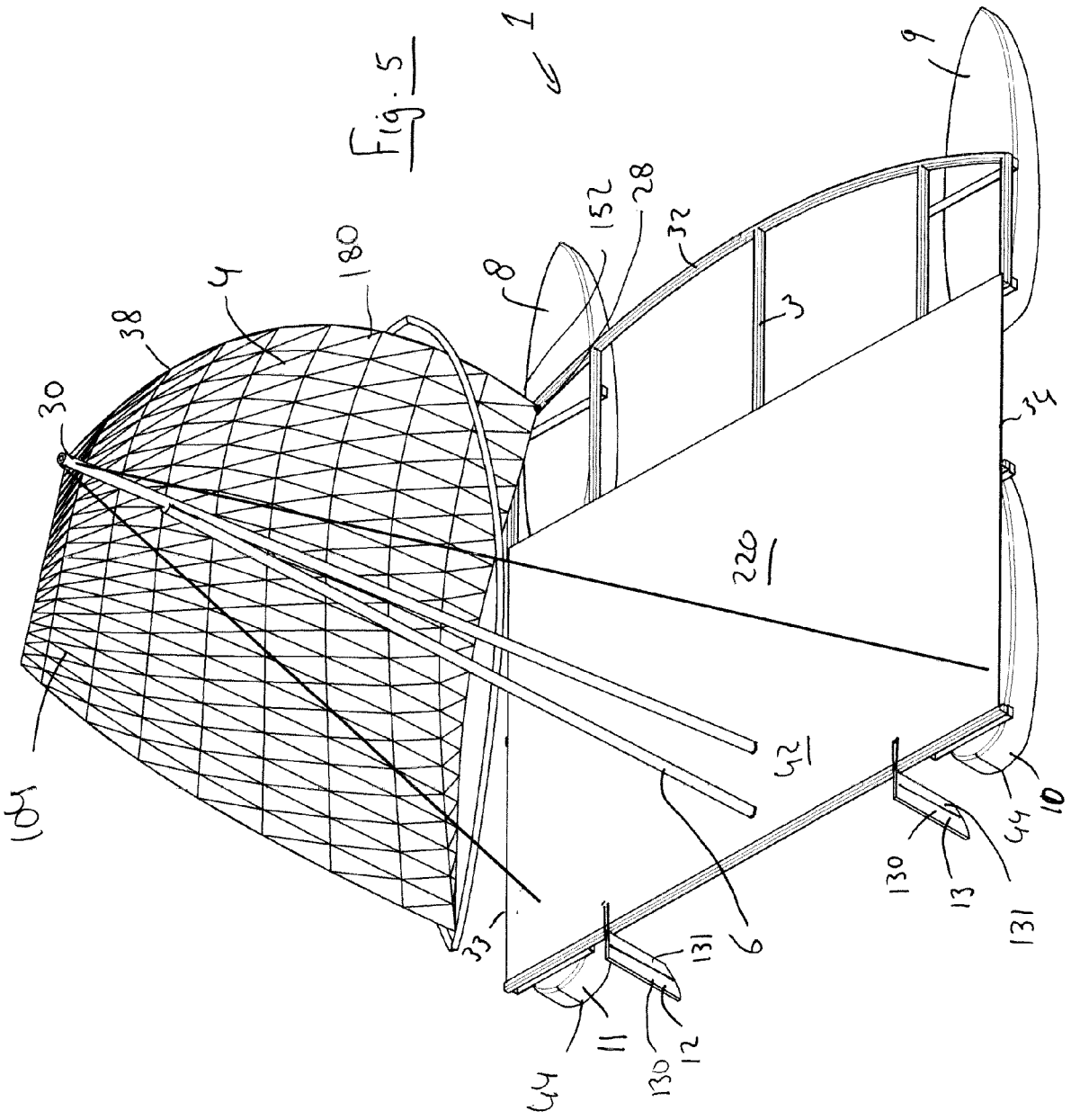
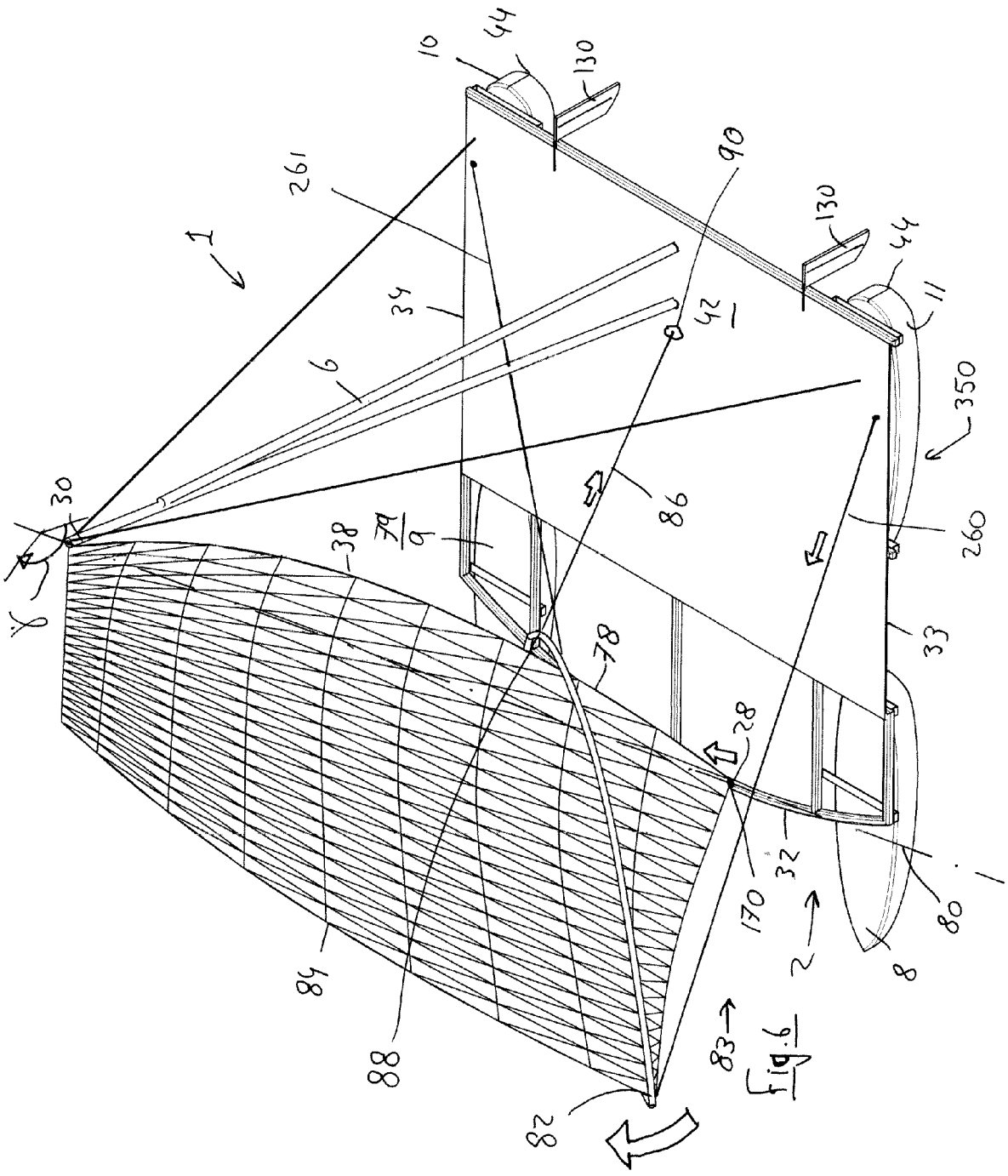

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Fig. 4

Fig. 5




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Fig.6

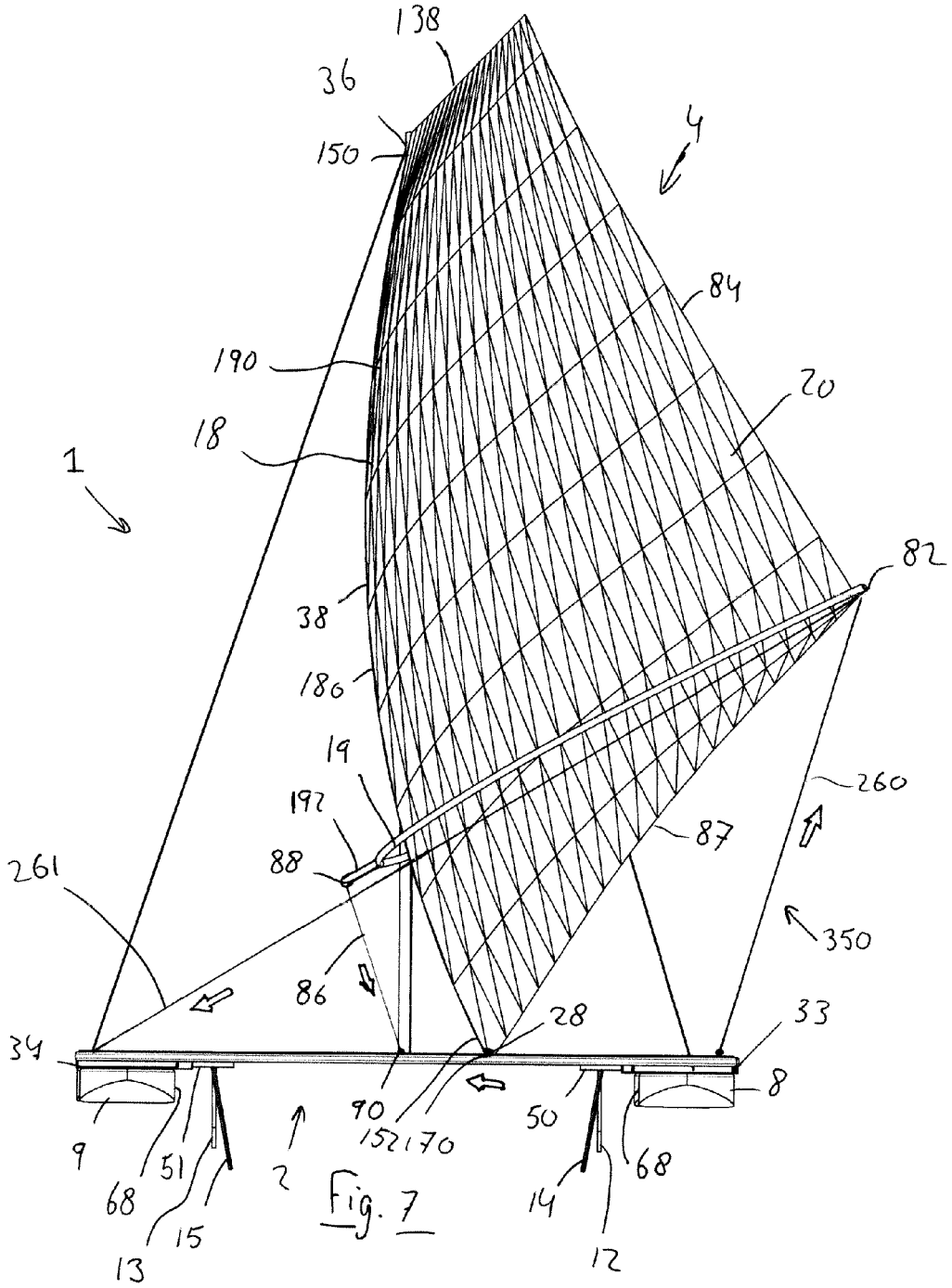

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Fig. 7

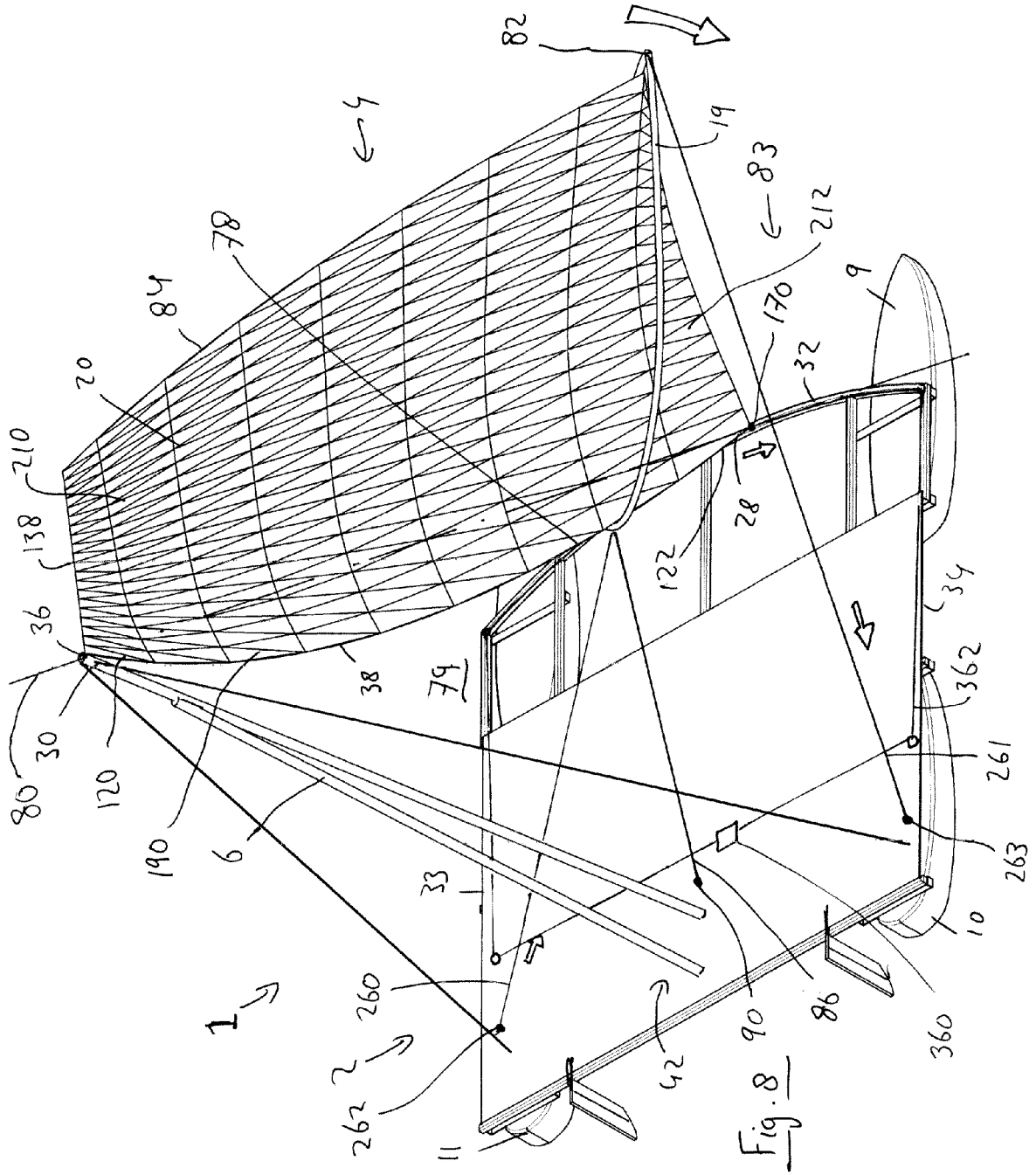

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Fig. 8

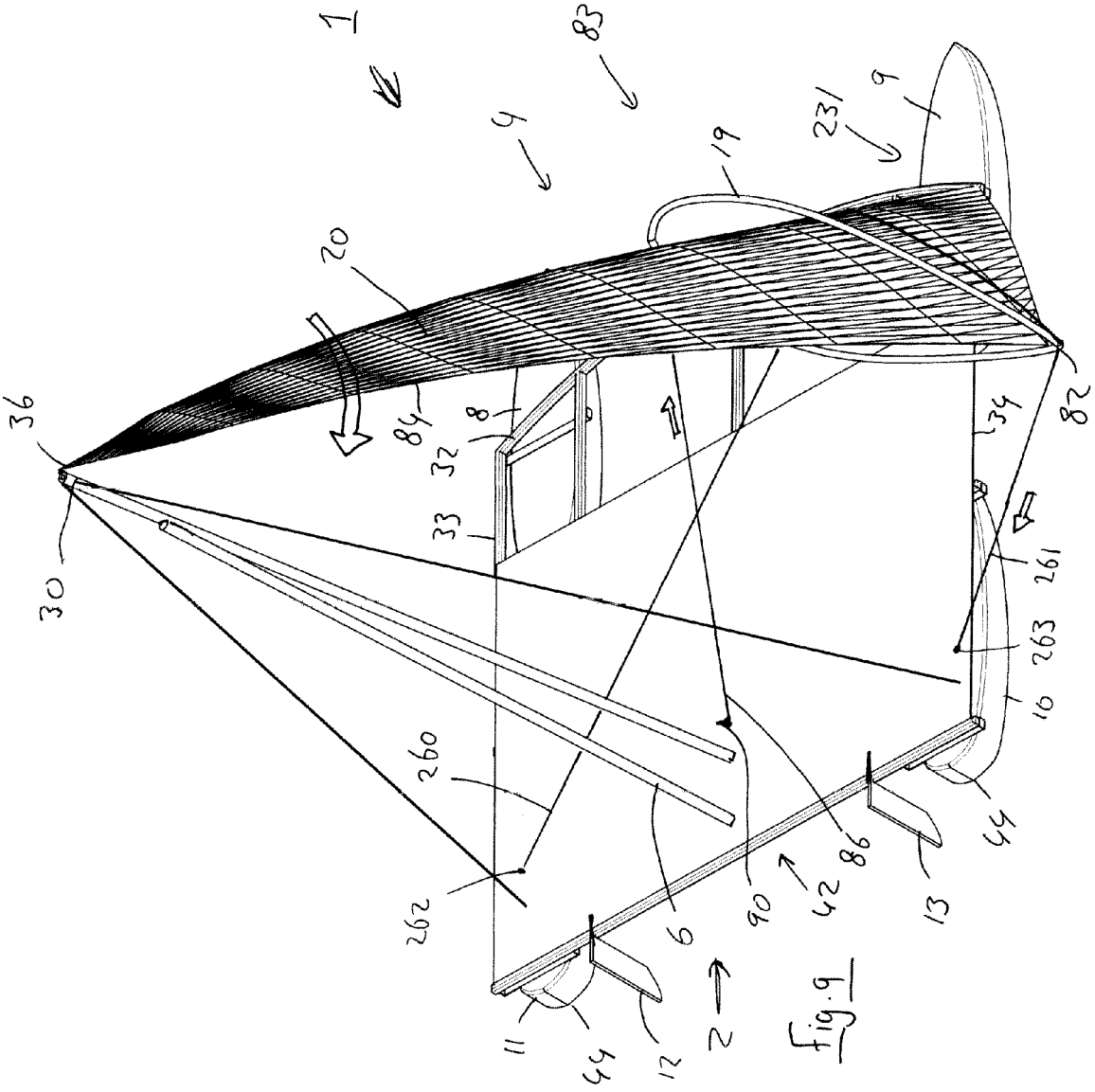

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Fig.9

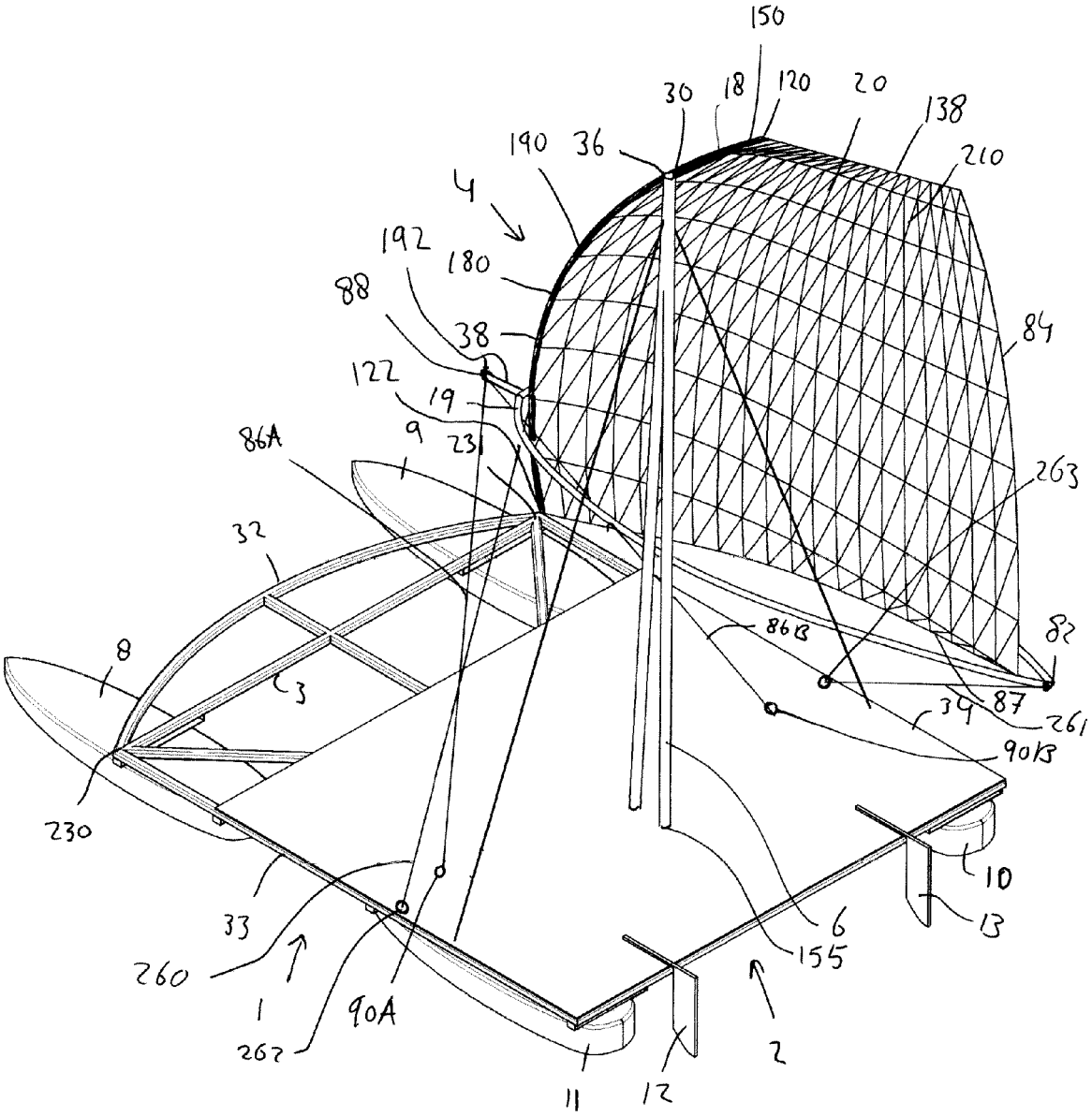

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Fig. 10

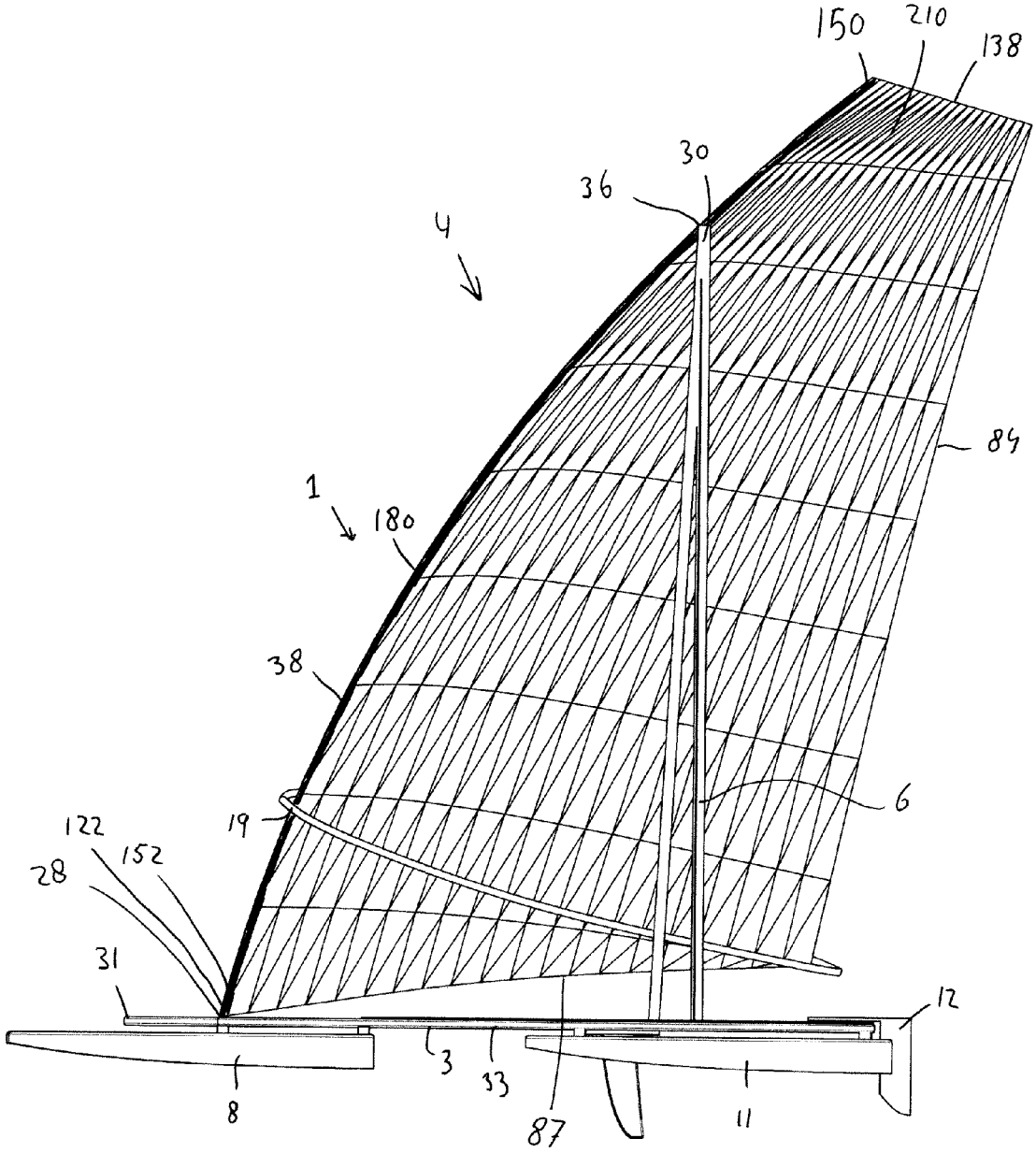


Fig. 11

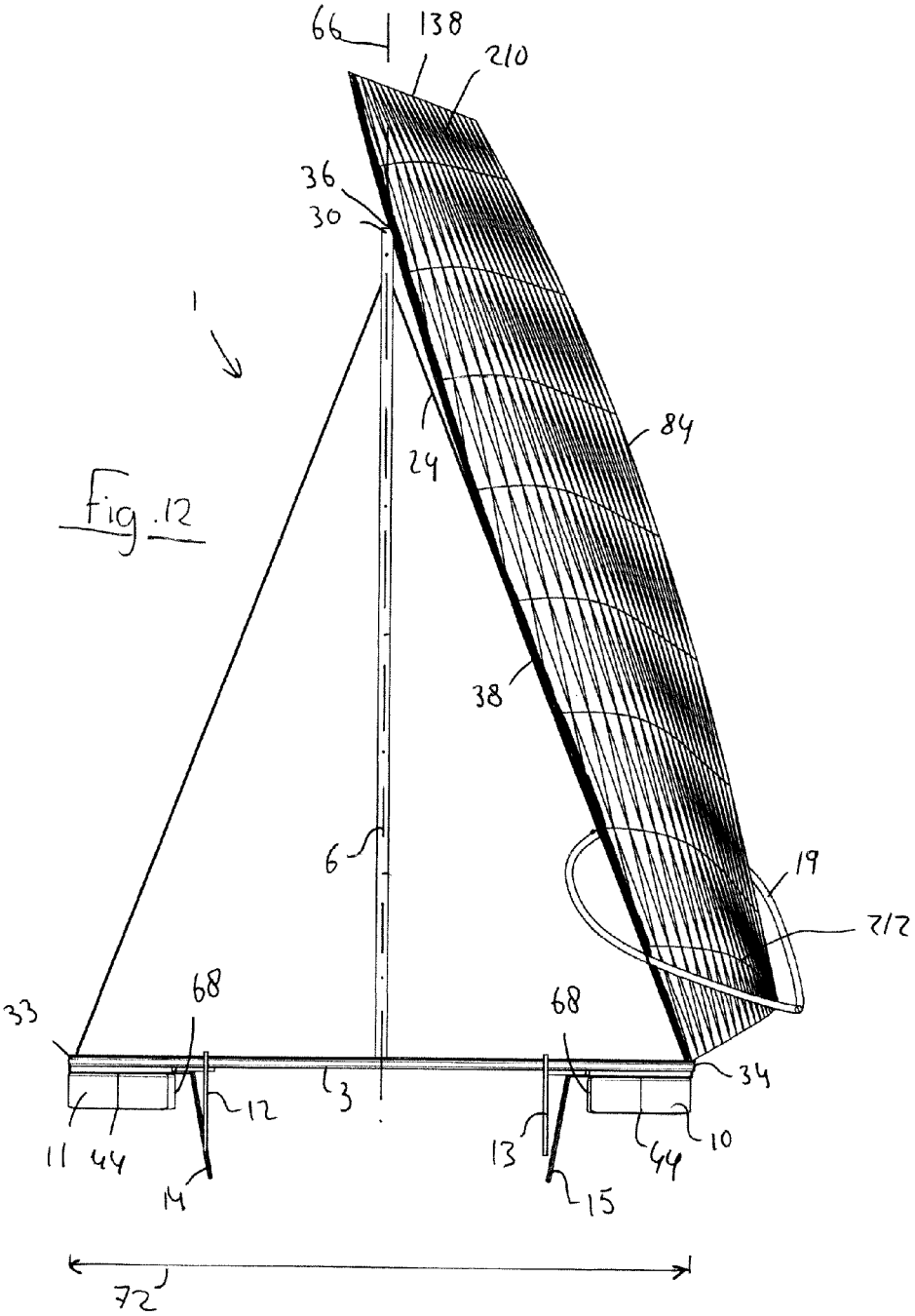

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Fig. 12

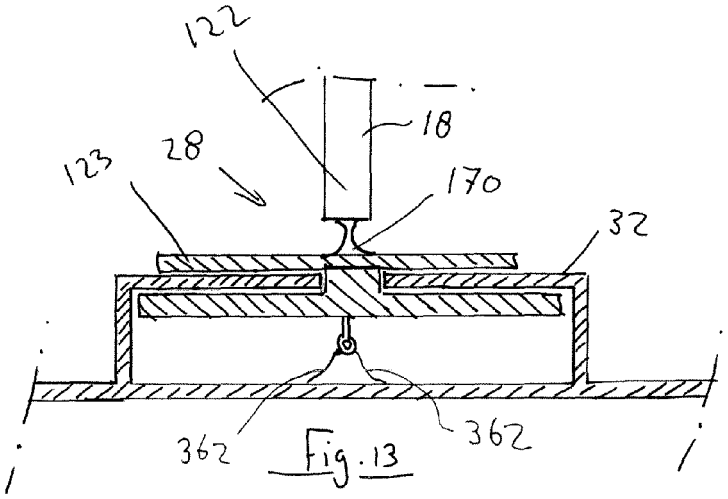

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Fig. 13

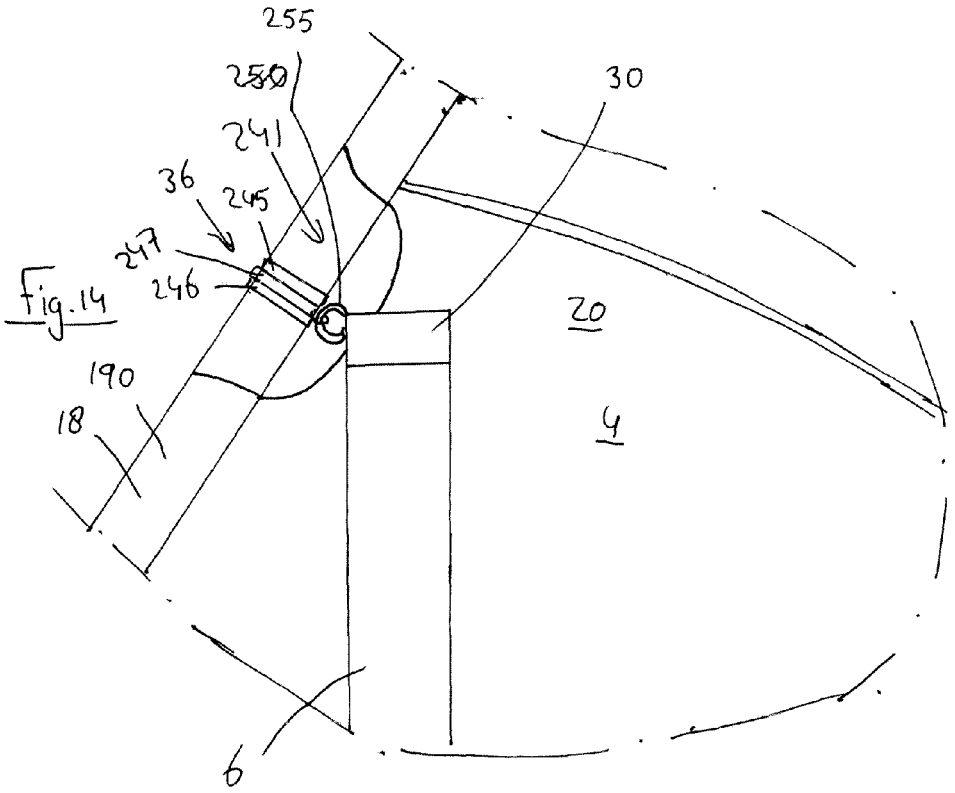

255
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Fig. 14

REFERENCES CITED IN THE DESCRIPTION

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