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(54) Benævnelse: **VANDFARTØJ MED TRAPPEFORMET SKROG OG UDENBORDS FINNER**

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DESCRIPTION

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Provisional Application No. 61/187644, filed June 16, 2009.

BACKGROUND

[0002] As well-described in U.S. Patent No. 6,666,160, to Orneblad, "since man first ventured onto water in boats, he has tried to design hulls that increase speed without unduly sacrificing stability." One avenue for reducing the hydrodynamic drag on a hull, and therefore improve hull efficiency in high-performance watercraft, is to provide a stepped hull wherein the lower surface of the hull is not a smooth surface, but rather includes transverse steps. Stepped hulls can be used to improve the performance of a hull by improving the on-plane performance characteristics, thereby reducing the wetted surface of the hull. Stepped hulls have been known for years, including, for example, U.S. Patent No. 1,121,006, to Fauber, U.S. Patent No. 1,858,030, to Batty, and U.S. Patent No. 6,250,246, to Hubley, each of which is hereby incorporated by reference.

[0003] Fauber discloses a hull having a plurality of stepped portions, or "hydroplane members," and an internal air duct system for delivering air under pressure to the stepped portions of the hull, for example, using the drive IC engine as a pump to force air into the internal air duct system. Hubley discloses an internal air duct system having entry openings near the bow of the hull and exit openings in the face of a step on the hull. These forced air systems assist in avoiding producing a vacuum in the stepped hull portions, and in lifting the hull out of the water, reducing the wetted area.

[0004] However the internal duct systems are relatively complicated to incorporate into a hull. Also, a common problem with stepped hulls are that during turns the boat may tend to spin generally about the step on the hull, particularly when a forced air system is tending to lift the aftward portion of the hull away from the water.

[0005] We are aware of JP-A-06 122390 which discloses a high performance watercraft with a planing hull having a forward hull portion and a step defined at an aft end of the forward hull portion demarcating a stepped hull portion, and ram air fins fixed to the port and starboard hull side walls.

[0006] We are also aware of US-A- 6 666 160 that discloses an alternative high performance watercraft in which a midship step is provided that is offset from a forward planing surface of the hull.

SUMMARY

[0007] The invention is defined by the features of independent claim 1. A high-performance planing watercraft with a stepped hull is disclosed. A pair of outboard fins are fixed to the hull side walls. The fins extend outwardly and downwardly towards the water. Preferably the fins extend downwardly at least to the level of the stepped hull portion. The outboard fins each define a channel and are configured such that during planing operation the channel is angled with respect to the incoming air, such that the air is compressed in the channel and is thereby forced at least partially toward the stepped hull portion, thereby reducing the wetted surface area. In level operation the outboard fins are relatively level, and flow through the channels tends to create a vacuum which helps to maintain the stepped hull portion in good contact with the water.

[0008] In an embodiment of the watercraft the fins are generally L-shaped, having a first leg extending outwardly from the hull and a second leg extending downwardly from the first leg.

[0009] In an embodiment of the watercraft a pair of oppositely disposed outboard strakes are attached to the stepped hull portion. The strakes may be tapered near the front end, to provide a port or flow path to facilitate air flow to and from the stepped hull portion.

[0010] In an embodiment of the watercraft the fin's leading edge is forward of the stepped hull portion and extends to the transom, for example, extending along 30% to 50% of the length of the hull.

[0011] In an embodiment of the watercraft a second stepped hull portion is provided, which is upwardly offset from the first stepped hull portion, and may further comprise a second set of strakes along the outboard edges thereof.

DESCRIPTION OF THE DRAWINGS

[0012] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a perspective view of a watercraft having a stepped hull with performance fins in accordance with the present invention;

FIGURE 2 is a perspective front, left, lower view of the hull of the watercraft shown in FIGURE 1;

FIGURE 3 is a perspective rear, left lower view of the hull shown in FIGURE 2;

FIGURE 4 is a front view of the hull shown in FIGURE 2;

FIGURE 5 is a left side view of the hull shown in FIGURE 2; and

FIGURE 6 is a rear view of the hull shown in FIGURE 2.

DETAILED DESCRIPTION

[0013] A high-performance watercraft 99 in accordance with the present invention is shown operating at planing speeds in FIGURE 1. The watercraft 99 includes a stepped planing hull 100 having oppositely disposed port and starboard performance fins, referred to herein as ram air fins 120, located on an aft portion of the hull 100. The ram air fins 120 extend longitudinally along the stepped portion of the hull 100. This exemplary embodiment generally corresponds with the Apostle™ Series high-performance watercraft manufactured by SAFE Boats International L.L.C. (www.safeboats.com), although the present invention may be applied to various watercraft by persons of skill in the art.

[0014] The hull 100 in a current embodiment is formed primarily from aluminum, and may be, for example, from 29 feet (8,84 meter) to 42 feet (12,80 meter) in length. Other hull sizes are also contemplated. An optional foam sponson 98 is shown disposed about the upper perimeter of the hull 100. A control console 96 with the operator controls is disposed approximately mid-ship, and a plurality of outboard motors 95 (four shown) provide propulsion. It will be readily apparent to persons of skill in the art that other lengths, construction materials, number and type of motors, and the like, may be used without departing from the present invention.

[0015] The stepped hull 100 of the watercraft 99 is shown in FIGURES 2-6. FIGURE 2 shows a perspective view of the hull 100 from a generally front-left-lower perspective, and FIGURE 3 shows a perspective view from a rear-left-lower perspective. The hull 100 is a planing V-hull having a center keel 101, a first step 102 and a second step 104. The hull may be, for example, a semi-V, a modified-V, a full deep-V, or the like. Although this hull 100 comprises two steps, it will be appreciated to persons of skill in the art that a single step, or more than two steps, may alternatively be provided without departing from the present invention.

[0016] The hull includes a forward hull portion 103 located forward of the first step 102. The first step 102 demarcates a first stepped hull portion 106, and the second step 104 demarcates a second stepped hull portion 108. Although not required for the present invention, the hull 100 includes upper flange 90 and lower flange 92 for mounting the foam sponson 98 (see FIGURE 1) such as the Foam Stabilized Watercraft disclosed in U.S. Patent No 5,282,436, to the present inventor, which is hereby incorporated by reference in its entirety. Although the current embodiment of the invention is applied to a foam stabilized watercraft 99, the invention is suitable for hulls without such sponson.

[0017] The first stepped hull portion 106 includes oppositely disposed first outboard strakes 110, one on the port side and the other on the starboard side of the first stepped hull portion 106. Similarly, the second stepped hull portion 108 includes oppositely disposed second outboard strakes 112 (one visible), one on the port side and the other on the starboard side of the second stepped hull portion 108. The outboard strakes 110, 112 in this embodiment are located at (or define a portion of) the hull chine 109, e.g., the location where the side walls 114 meet the stepped hull portion 106 or 108.

[0018] In a currently preferred embodiment, the front or leading end 111 of the first outboard strakes 110 and the front or leading end 113 of the second outboard strakes 112 are tapered. The tapered leading ends 111, 113 may optionally be spaced away from the associated first and second steps 102, 104. The tapered leading ends 111, 113 define ports providing a flow path or port for air to enter under the hull 100 near the steps 102, 104.

[0019] Refer now also to FIGURE 4, showing a front view of the hull 100, to FIGURE 5, showing a left side view of the hull 100, and to FIGURE 6 showing a rear view of the hull 100. Oppositely disposed and outwardly extending ram air fins 120 are attached to the port and starboard side walls 114 of the hull 100, generally along the stepped hull portions 106, 108. The ram air fins 120 are generally L-shaped or arcuate elongate structures that extend outwardly from the side walls 114 and downwardly. For convenience, the ram air fins 120 may be affixed to, or formed integrally with, the lower flanges 92. For example, the ram air fins 120 may be welded to the watercraft 99. As seen most clearly in FIGURE 4, the ram air fins 120, cooperatively with the hull side walls 114, define a downwardly open channel 130. The ram air fins 120 are preferably sized such that the distal edge 122 of the ram air fins 120 extend downwardly at least to a horizontal level defined by the lower edges of the outboard strakes 110, 112. In the current hull 100 the ram air fins 120 extend downwardly slightly beyond the level of the strakes 110, 112.

[0020] The leading edge 124 of each of the ram air fins 120 (FIGURE 5) is preferably located forward of the first step 102, and optionally extends approximately to the transom or aft end 116 of the hull 100. For example, the ram air fins 120 may extend along the aft-most 30% to 50% of the length of the hull 100.

[0021] Now the function of the watercraft 99, and in particular the ram air fins 120 will be described. When the hull 100 is moving forward through the water, air enters the channels 130 defined by the ram air fins 120. The entering air is at least partially directed underneath the hull 100, and in particular beneath the first and second stepped hull portions 106, 108.

[0022] The planing hull 100 is configures to lift the bow of the watercraft out of the water when the watercraft 99 is operated at higher speeds, for example, in generally straight-line travel. The hydrodynamic forces lift the bow of the planing hull 100 away from the water such that the hull angle with respect to the water increases, i.e., the angle of attack increases as the hull 100 pivots about a horizontal transverse axis. As will be appreciated from FIGURE 1, the ram air

fins 120, which are fixed to the hull 100, also increase in angle relative to the direction of travel. The increased angle of attack causes air entering the channels 130 is be turned downwardly by the inclined surface of the ram air fins 120, such that the air pressure in the channels 130 increases.

[0023] The higher air pressure in the channel 130 increases air flow through the ports defined at the first and second steps 102, 104 by the outboard strakes 110, 112, such that air is forced under the first and second stepped hull portions 106, 108. Increased air flow under the stepped hull portions 106, 108 aids in reducing the effective wetted surface area and thereby decreasing the hydrodynamic drag on the hull 100, improving performance. In addition, it is believed that the aerodynamic forces of the inclined ram air fins 120 will produce an upward force on the ram air fin 120, which will further help to raise the hull 100 out of the water and reduce the wetted area when the hull 100 is in a planing mode.

[0024] The reason for the tapered and spaced leading ends 111, 113 of the first and second strakes 110, 112 will now be appreciated. In a current embodiment, the ports defined by the tapered first and second strakes 110, 112 provide a means for preferentially directing air, compressed by the ram air fins 120 as described above, under the hull 100 near the first and second steps 102, 104.

[0025] In addition to improving performance of the hull 100 during planing operation, the ram air fins 120 also improve control of the watercraft 99 during turns. As noted above, a common problem with prior art stepped hull watercraft is that when the operator turns the watercraft the hull in some circumstances the hull will undesirably tend to pivot generally about the hull step. This is believed to be caused by the stepped portions of the hull being only in partial contact with the water such that the hull reacts hydrodynamically as if the step were the aft end, or transom, of the hull. This undesirable effect occurs even when the watercraft is trimmed for approximately horizontal operation.

[0026] In the hull 100 disclosed herein, however, as the hull 100 is trimmed to level to initiate a turn, the hull inclination or angle of attack decreases. As the inclination angle of the hull 100 decreases, the ram air fin 120 moves towards a horizontal orientation, and therefore no longer presents an inclined surface to the local air flow. The air flowing through the channels 130 is no longer compressed, and therefore the tendency of air to flow into the stepped hull portions 106, 108 is reduced or eliminated. Moreover, the channels 130, which are now disposed near the waterline, will allow water to flow therethrough in level operation. Due to the Bernoulli principle, water flowing through the channels 130 will produce a vacuum at the ports defined by the outboard strakes 110, 112. The vacuum assist provided by the Bernoulli principle advantageously ensures that the stepped hull portions 106, 108 are in good contact with the water, reducing or eliminating any tendency of the watercraft to pivot or turn about one of the steps 102, 104. Therefore, the ram air fins 120 disclosed herein have the very desirable effect of forcing air into the stepped portions of the hull 106, 108 during planing operation, and of drawing air out from under the stepped portions of the hull 106, 108 when the watercraft 99 is in relatively level operation.

[0027] Additionally, during turning of the watercraft 99 the tendency of the hull to heel into the turn is counteracted by the ram air fins 120. In particular, the ram air fin 120 located on the inside of the turn radius tends to hydrodynamically resist being submerged into the water. The ram air fin 120 located outwardly from the turn radius may produce a downward force as the outward fin 120 is moving out of the water. The result is that the hull 100 will remain relatively level with the water surface. The first and second stepped hull portions 106, 108 will therefore tend to remain in contact with the water, and the hull will turn in a very stable and predictable manner, even at relatively high speeds.

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

- WO61187644A **[0001]**
- US6666160B **[0002]**
- US1121006A **[0002]**
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- JP6122390A **[0005]**
- US6666160A **[0006]**
- US5282436A **[0016]**

Patentkrav

1. Vandfartøj (99) omfattende:

et skrog (100) med en bagbordssidevæg og en styrbordssidevæg, hvor skroget yderligere omfatter en forreste skrogdel (103) og en første trappeformet skrogdel (106) opadgående forskudt fra den forreste skrogdel;

en krum bagbordsfinne (120) der strækker sig udad fra bagbordssidevæggen og nedad mindst til den første trappeformede skrogdel (106); og

en krum styrbordsfinne (120) der strækker sig udad fra styrbordssidevæggen og nedad mindst til den første trappeformede skrogdel (106);

hvor den krumme bagbordsfinne (120) definerer en nedadgående åben langstrakt kanal der strækker sig langs en del af bagbordssidevæggen tilstødende den første trappeformede skrogdel (106), og den krumme styrbordsfinne definerer en nedadgående åben langstrakt kanal der strækker sig langs en del af styrbordssidevæggen tilstødende den første trappeformede skrogdel (106);

en første rang (110) fastgjort til en udenbords bagbordskant af den første trappeformede skrogdel (106) og en anden rang (112) fastgjort til en udenbords styrbordskant af den første trappeformede skrogdel (106), hvor hver af den første og anden rang (110, 112) tilspidser ved en forreste ende og er positioneret til at definere en strømningsåbning til komprimeret luft til den første trappeformede skrogdel (106), og hvor de krumme bagbords- og styrbordsfinner (120) er konfigureret til at komprimere luft under planeringsdrift af vandfartøjet således at luft som kommer ind i de langstrakte kanaler drives under den første trappeformede skrogdel (106).

2. Vandfartøjet (99) ifølge krav 1, hvor de krumme bagbords- og styrbordsfinner (120) er generelt L-formede, omfattende et første ben der strækker sig udad fra skroget (100) og et andet ben der strækker sig nedad fra det første ben.

3. Vandfartøjet (99) ifølge krav 1, hvor de krumme bagbords- og styrbordsfinner (120) er vinklede således at de krumme finner (120) er cirka horisontale, når vandfartøjet er i en trimmet niveaukonfiguration.

4. Vandfartøjet (99) ifølge krav 1, hvor de krumme bagbords- og styrbordsfinner (120) er fastgjort langs en agterdel af vandfartøjet.

5. Vandfartøjet (99) ifølge krav 1, hvor de krumme bagbords- og styrbordsfinner (120) strækker sig til en tværsprosse af vandfartøjet.

6. Vandfartøjet (99) ifølge krav 1, hvor skroget (100) yderligere omfatter en anden trappeformet skrogdel (108) opadgående forskudt fra den første trappeformede skrogdel (106).

7. Vandfartøjet (99) ifølge krav 6, yderligere omfattende en tredje rang fastgjort til en udenbords bagbordskant af den anden trappeformede skrogdel (108) og en fjerde rang fastgjort til en udenbords styrbordskant af den anden trappeformede skrogdel (108).

8. Vandfartøjet (99) ifølge et hvilket som helst af kravene 1 til 7 i hvilket skroget (100) er et aluminiumsskrog.

DRAWINGS

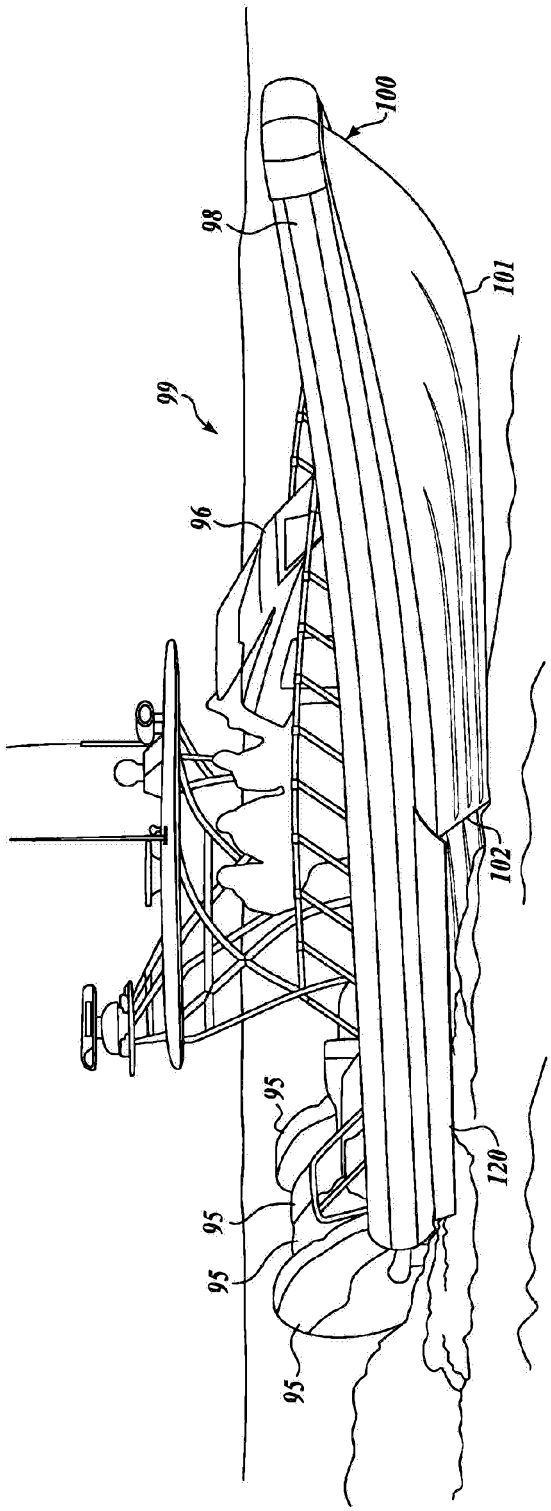


Fig.1.

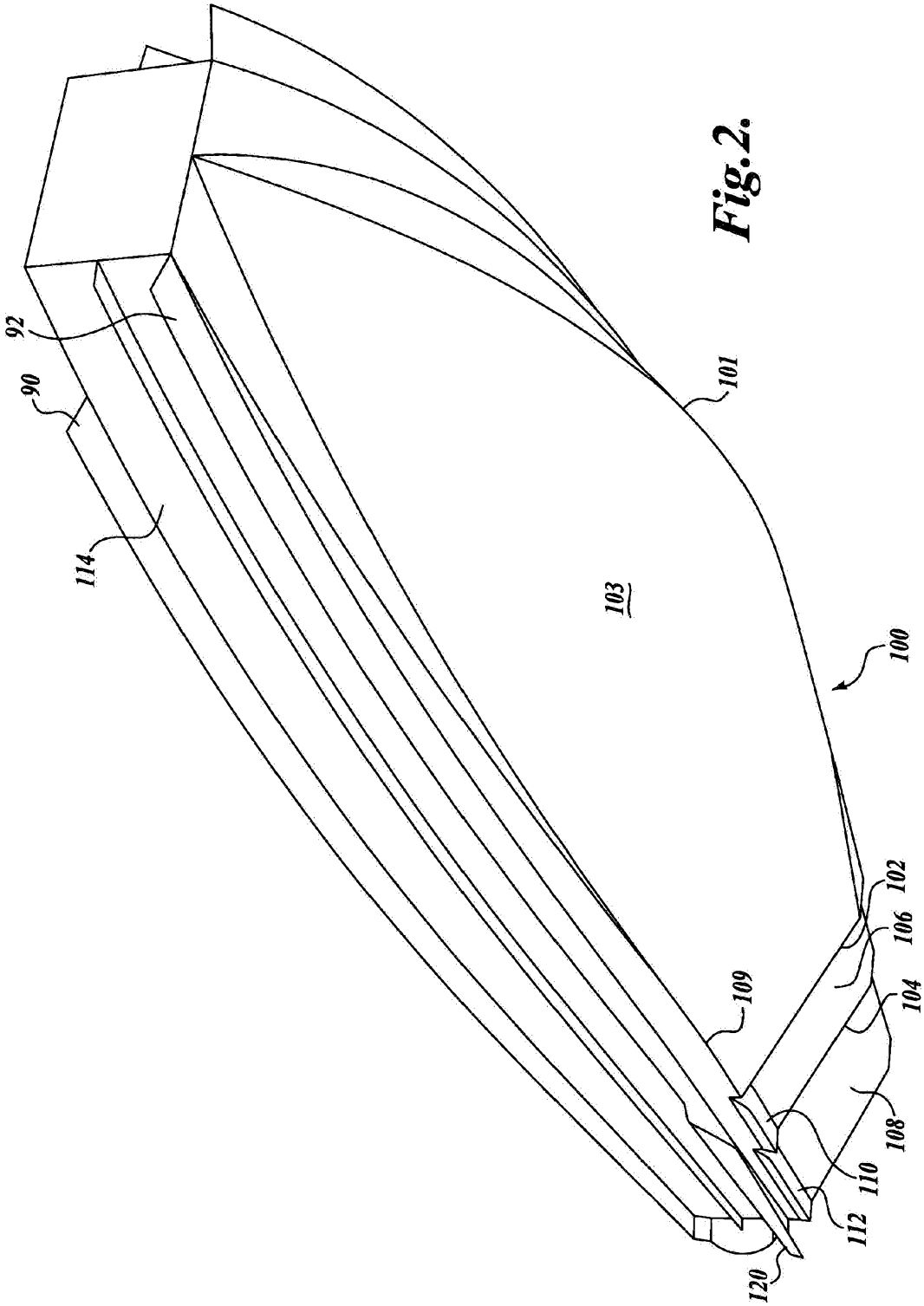
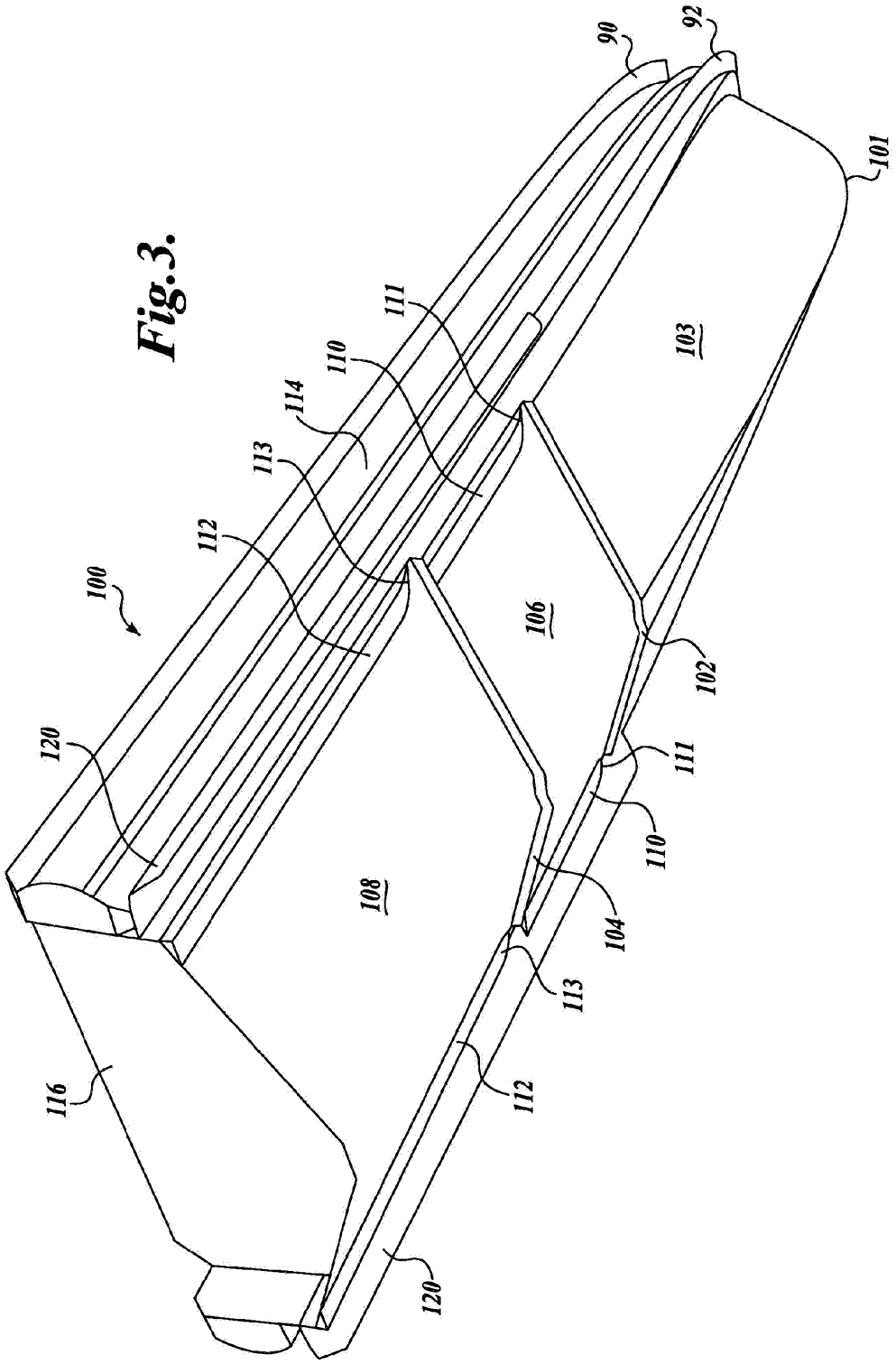


Fig.2.


90
92
101
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103
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116
112
120

Fig.3.

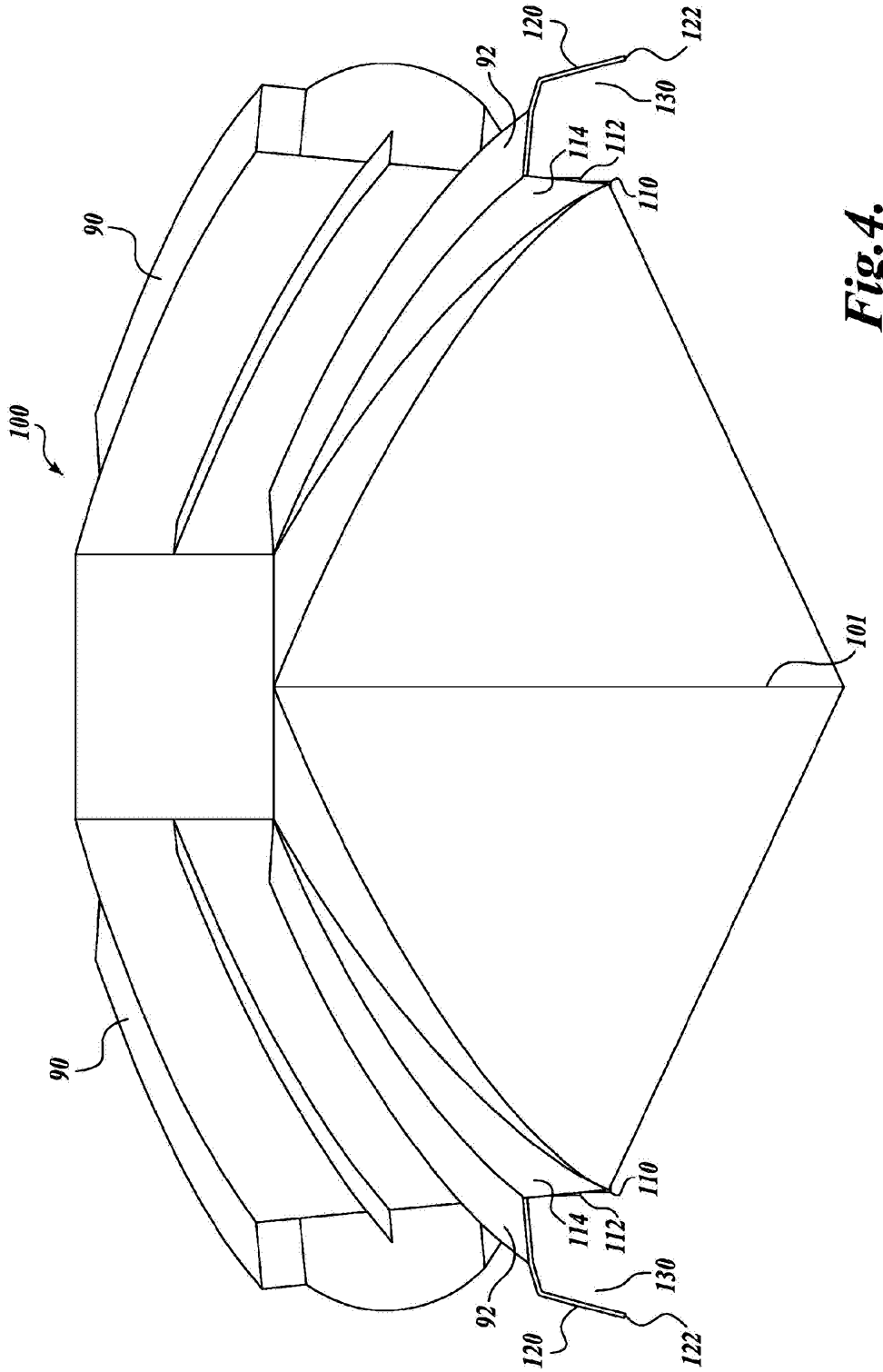
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Fig.4.

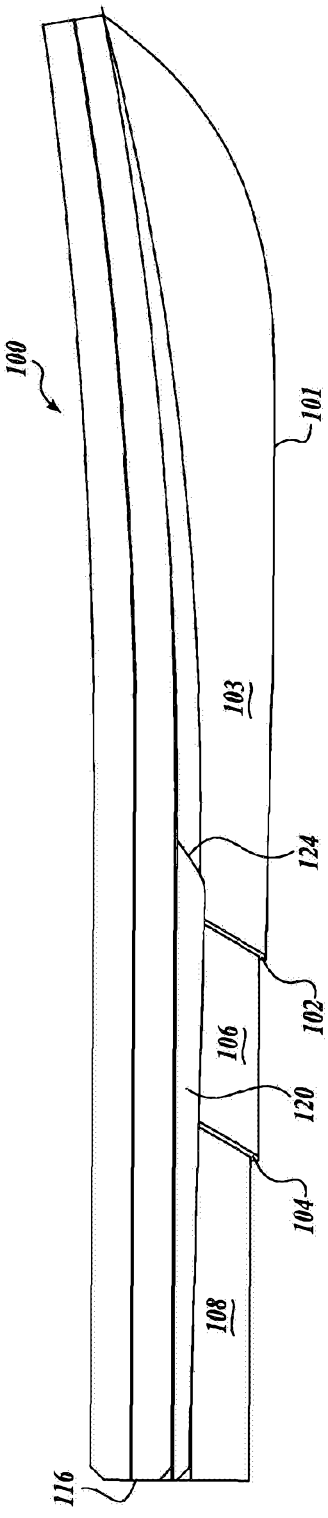

Fig.5.

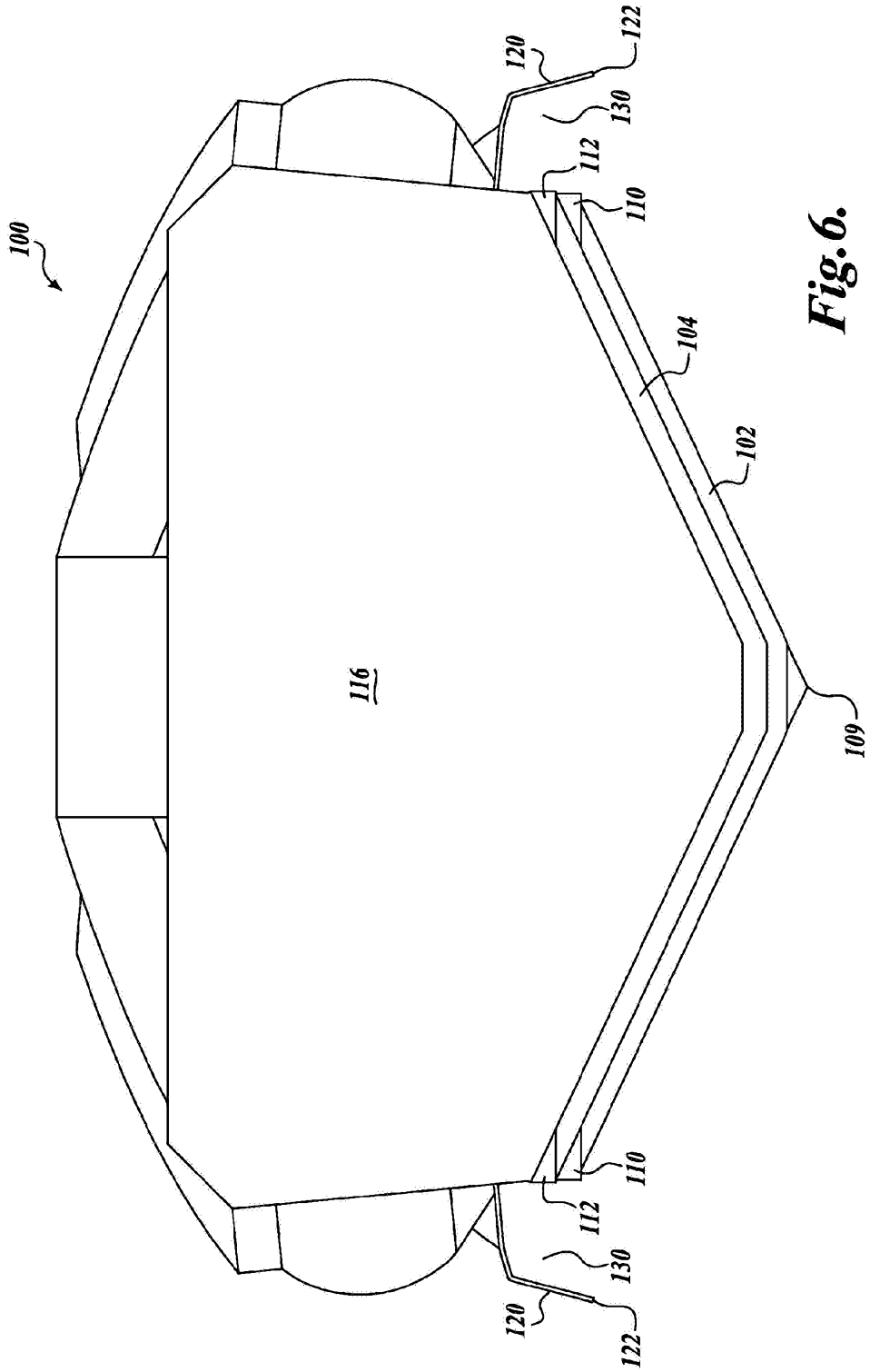

Fig.6.