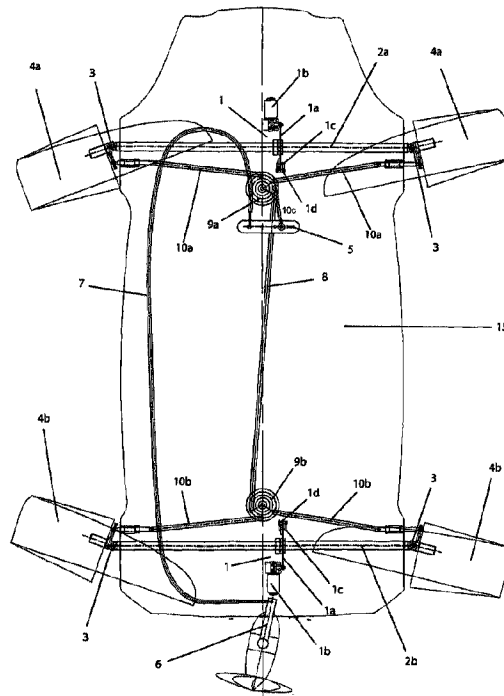




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(54) Titre : SYSTEME DE COMMANDE DE NAVIRE A AILES SOUS-MARINES MOBILES
(54) Title: VESSEL CONTROL SYSTEM WITH MOVABLE UNDERWATER WINGS



(57) **Abrégé/Abstract:**

A control system and method for steering a vessel with moving front and rear pairs of underwater wings is described where steering the front pair of wings in one direction, results in the rear pair of wings (4b) turning in the opposite direction. This reduces the turning radius and the vessel's roll compared to conventional steering systems, thereby increasing maneuverability and allowing for an even and maximum distance between the surface and the entire hull of the vessel. This prevents waves from crashing into the vessel's hull in wavy waters, which lowers energy consumption and makes for a peaceful and quiet ride. Steering can be done with only the motor (6), with the two pairs of wings (4a and 4b) at the same time or separately, or in a combined manner with the motor (6) and the two pairs of wings (4a and 4b) at the same time or separately.

Abstract

A control system and method for steering a vessel with moving front and rear pairs of underwater wings is described where steering the front pair of wings in one direction, results in the rear pair of wings (4b) turning in the opposite direction. This reduces the turning radius and the vessel's roll compared to conventional steering systems, thereby increasing maneuverability and allowing for an even and maximum distance between the surface and the entire hull of the vessel. This prevents waves from crashing into the vessel's hull in wavy waters, which lowers energy consumption and makes for a peaceful and quiet ride. Steering can be done with only the motor (6), with the two pairs of wings (4a and 4b) at the same time or separately, or in a combined manner with the motor (6) and the two pairs of wings (4a and 4b) at the same time or separately.

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VESSEL CONTROL SYSTEM WITH MOVABLE UNDERWATER WINGS

The subject of the invention is a control system with movable underwater wings and an underwater wings lifting system with a safety brake. Specifically, it is a control system that supports the vessel's function with underwater wings and simultaneously controls the underwater wings lifting system and has a safety function in the form of the emergency brake.

The technical problem that the invention tackles, is steering a vessel with moving underwater wings and a motor (or wind propulsion) or only with moving wings. This reduces power consumption with minimal negative effects on the environment. The problem that the invention solves is how control a vessel with a flexible underwater wings - be it with the motor or the wings themselves - in order to minimize water resistance and, hence, energy consumption. While the system is using using an electric motor or wind propulsion it is one hundred percent environmentally friendly, while the use of an internal combustion engine has a significantly reduced the negative impact on the environment due to the fact that, only the ends of the wings are underwater, which makes the water resistance is minimal, energy consumption is significantly lower. This invention also reduces the noise emitted by a vessel, which is an additional positive impact on the environment. A further problem, which the invention addresses, is performing quick turns with a minimum radius and minimum vessel heeling. Therefore, the vessel turns in a nimble and agile manner and the voyage is safe, peaceful and smooth at both low as well as high speed, regardless of the waters' choplines.

The use of vessels with underwater wings is already known. The first vessel with such underwater wings was developed and designed by Italian inventor Enrico Forlanini in 1906. Similar solutions are used in many patents, such as for example in the patent US

6,095,076, where the invention automatically adjusts the wings' camber when sailing, thus maintaining the vessel above the waterline, but it cannot use the wings to change direction. The invention patent US 3,949,695 describes mechanical wing tilt control (manual) and only changes the angle in order to increase lift and cannot change the direction of travel. Invention patent US 4,582,011 describes trimaran with foldable underwater wings, which can be folded back to allow for easy vessel transport. During the voyage, the wings do not move and remain fixed in set position. It is impossible to change direction using the wings. The invention in US Patent 3,199,484 automatically regulates the vessel's height depending on the speed. The system in patent SI 23103 A has retractable wings, which remain below sea level. The wings' lift is adjustable up to the water surface - the wing angle is adjustable between 0 and 60 degrees of the vertical position and is to be set before prior to sailing. The system uses the propulsion or the rudder to steer, which it cannot do with the wings. The invention is classified as a flying vessel seaplane or airplane. It is used in the so-called separate wings, which must be extended wide between themselves, so that may allow stable sailing. The invention patented SI 22250 is a regulated system for lifting vessels out of the water using a front mounted float.

A problem, which remains unresolved, is the mobility of wings during the voyage in order to provide steering. Related known solutions otherwise regulate wing angle, but this is to control the vessel's lift. This invention addresses with a special steering system, connected to obile underwater wings, which control both the lift and the steering of the vessel. A special lifting system with a safety brake allows stable, but adjustable adjustment of the wings in a pre-set position during the voyage. This same system also has a safety feature that returns the wings to their pre-set position in the event of a crash or hitting an obstacle.

The invention will be described the example and pictures showing:

- Figure 1: Floor plan of the steering system vessels with moving underwater wings and lifting system with safety brake
- Figure 2: vessel with lowered moving underwater wings
- Figure 3: a vessel with the raised moving underwater wings

Control system of the vessel:

The steering of the vessel is primarily conducted with with at least one wheel (steering wheel) 16, it is also possible to steer the vessel with a joystick, pedals (feet), with a control yoke and pedal (as in airplanes), an electronic control platform (touch screen or voice and the like) and other control solutions.

Previous similar technical solutions for control of similar vessels mainly only used the motor 6, which is also possible on this vessel through the aforementioned solutions. However, this method causes large vessel roll in the turning direction and increased energy consumption.

The invention therefore makes steering possible (via the above-mentioned modes) with at least two pairs of wings 4a and 4b. When turning, the front pair of wings 4a turns into the direction of turn, and the rear pair of wings 4b, in the opposite direction, thereby reducing turning radius. The pairs of wings 4a and 4b settle in the direction of the turn radius. The front water resistance for the underwater wings is significantly reduced, because underwater wings travel exactly in the direction of travel and not create drag with their flanks. Thus the turning is quick, the vessel roll is minimal. The steering system with moving underwater wings works with at least two pairs of underwater wings 4a and 4b, or with at least two underwater wings, one located at the front of vessel, and the other at the back. In case of larger vessels it is possible to add additional wings, depending on the length and size of the vessel. In case of a large number of wings the wing movement and turning system remains the same. The minimal roll of the vessel while turning gives a uniform maximum distance between the waterline and the entire vessel hull, which is an advantage in wavy water, since waves do not crash into the hull, which enables a lower energy consumption, and a peaceful and quiet ride. The wings 4a and 4b are used to steer through the control system which is comprised of:

- The linking axles 8
- Two lever disks: the front disk 9a and rear disk 9b
- The front 10a and rear levers 10b
- The lever plate 5

The wing steering system leaves can be operated in the above-mentioned ways by turning

the wheel 16 (or other control elements above vessel), which is connected to the lever plate 5, in the desired direction of travel. The lever plate 5 with the angle in turn direction and rotates lever discs 9a and 9b, which are linked to the linking axle 8, which, during the turn and rotation of lever discs 9a and 9b is moved along the vessel (forwards or backwards, depending on the turning direction; if we turn to the left, the linking axle 8 moves toward the stern 12, however, if we turn to the right, the linking axle 8 moves toward the bow of the vessel 11. In this, the front lever disc 9a turns in the direction of the turn and the rear lever disc 9b turns in the opposite direction. The lever discs 9a and 9b are mounted on each side levers 10a and 10b which, when turning the lever discs 9a and 9b are moved in the appropriate direction, namely, both the front levers 10a as well as rear levers 10b move the direction of the turn, wings 4a and 4b, which are connected to the levers 10a and 10b, however, due to the way the levers connect to wings 4a and 4b turn opposite directions. Thus, the front wings 4a turn in the direction of the turn and the rear wings 4b, turn in the opposite direction. When turning, the underwater wings 4a and 4b, produce less drag, because they follow the direction of the turn and because the sides of the wings do not push on water (like classic rudders) but follow the direction of travel. It is also possible to steer with only the front wings 4a or only rear wings 4b or with both the front and rear wings at 4a and 4b, as described above. Moreover, it is possible to steer with only the wings on the right or on the left side of the vessel.

The main advantage of the invention is the combined steering (via the above-mentioned steering modes) with wings 4a and 4b and the motor 6 at the same time. With this kind of combined steering, the vessel does not roll at a certain proportion between the angle of the underwater wings and angle of the motor. The wings 4a and 4b are therefore under equal loads and the hull is at its highest position above the water. This achieves the minimum possible wettability of the underwater wings and the maximum speed of the vessel. This is especially important with wavy waters, where it is desired to keep the hull above the waterline or at the highest possible position above the water. In the combined steering mode (using the wings 4a and 4b, as well as the motor 6) energy consumption is reduced, the vessel does not produce waves, making the voyage steadier and safer. All of the above can be done even at low speeds in the combined steering mode (wings 4a and 4b and the motor 6). In combined steering mode, the Bowden cable 7, which is mounted on lever plate 5 and connects it with motor 6 steering, moves the motor 6 in the same

direction as the rear wings 4b, or, in the opposite direction as the front wings 4a.

A lower fuel consumption can be achieved with raising the hull early and sailing on the wings. This can be achieved at a low speeds if we change the angle of the motor 6 with the Bowden cable 7 that steers the motor, with which we can move the motor 6 away from the vessel's stern 12. The adjustable angle between the motor 6 and the stern of the vessel 12 can thus be reduced during sailing and can, therefore, increase the vessel's top speed.

The steering system of the vessel is primarily rigid with a direct transfer made with levers. It is, however, possible to make a hydraulic steering system or a system with ropes or other mechanisms and elements that enable movement.

The drive or vessel motor 6:

The motor 6 is preferably an electric outboard motor with a submersible propeller, but may also be an internal combustion engine, hybrid or jet. However, they can also be used with an outboard motor with a partially submerged propeller, which may be electric, internal combustion or hybrid and an aircraft engine with the propeller above the waterline. Wind propulsion is also possible. The pushdrives (electric motors or internal combustion engines) are usually located at the stern of the vessel (the rear of the vessel) 12, it is also possible for the motors to be located at the ends of the underwater part of the wings, and can be electric, internal combustion, hybrid or jet. It is also possible to place the drive on the front end of the vessel 11, such as various pull motors and wind propulsion.

The lift system 1 with the safety brake 1c:

The lift system 1 with the safety brake 1c is primarily mechanical, but can also be hydraulic, electric, with levers or other mechanisms or elements that enable movement. It is installed on the front 2a and the rear axle 2b. The number of lifting systems 1 with a safety brake 1c depends on the number of axles, which have wings attached to them. It is composed of:

- the disc or sprocket 1a that allows rotation of the axles 2a and 2b and the joints 3, the wings 4a and 4b are attached to

- the electric motor 1b that drives the disc 1a
- the brake 1c that keeps the wings in their set position.
- the sensor 1d that detects the change of angle of the wings 4a and 4b and returns them to the preset position/angle.

The lifting system 1 with the safety brake 1c allows the lowering of wings 4a and 4b under the hull of the vessel to the desired position and attitude, as shown in Figure 2, which results in a buoyancy and thus the vessel already rising from the water, at very low speed. With the help of the electric motor the disc or sprocket 1a rotates the front 2a and rear axle 2b, the joints 3 and wings 4a and 4b, which are attached thereto into the position set through the control unit prior to sailing. The brake 1c holds the entire lifting system 1 in the set position with the wings 4a and 4b.

The lifting system 1 with the safety brake 1c also enables the wings to rise above the vessel as shown in Figure 3. During this, the disc 1a rotates the axles 2 and joints 3 into a position that enables the wings 4a and 4b to be lifted above the vessel. This is useful when the vessel is in shallow water, during transportation (the wings 4a and 4b can also be removed with a simple procedure), and also in berth, when the vessel is in the water for a long time. This way the accumulation of algae, sludge and similar is prevented. Moreover this prevents (salt) water erosion and extends the wings' 4a and 4b lifetime. In case of high waves, when sailing with wings 4a and 4b is difficult the wings 4a and 4b are raised above the vessel as shown in Figure 3, to enable the vessel to continue sailing. Sailing can continue as a vessel without wings (eg. boat) to ensure additional safety for passengers and vessels.

The lifting system with the safety brake 1c also has a safety function, which in the case of hitting an obstacle, makes the system reduce the force of impact on the wings 4a and 4b, in that the brake 1c, which normally holds the wings in a set position, works as a classic brake. Upon hitting the obstacle the wings 4a and 4b rotate in order to brake, which decreases the chance of damage of the vessel and its passengers. The system has a built-in sensor that returns the wings 4a and 4b in the desired position or angle upon stabilization after the crash.

The preference mode for the wing 4a and 4b position settings is pre-set, and can be set as such before starting sailing. One can, however, adjust (optimize) the wings 4a and 4b during sailing through the system the system, which measures the water resistance at the specified speed, taking into account the data on the weight of the passengers and cargo, which has previously been recorded in the control platform in the cabin.

PATENT CLAIMS

1. A steering control system for steering a vessel having a hull (13), seats (14) and a helm (16), wherein the control system comprises:
 - at least two pairs of front and rear underwater wings (4a and 4b);
 - a lever plate (5) located in a lower part (15) of an interior of the vessel,
 - a Bowden cable (7) connecting said lever plate (5) with a motor (6) that is mounted to the vessel,
 - a front lever disc (9a) and a rear lever disc (9b) that are mounted to the lower part (15) of the vessel,
 - a linking axle (8) linking said front lever disc (9a) and said rear lever disc (9b) and being adapted to allow said front and rear lever discs (9a, 9b) to turn in opposite directions,
 - front levers (10a) and rear levers (10b) mounted on one side of said front lever disc (9a) and said rear lever disc (9b), respectively, and being adapted to connect said front and rear lever discs (9a, 9b) to the at least two pairs of front and rear underwater wings (4a, 4b); and
 - a safety brake (1c) mounted on a lifting system (1) that is connected to each of the at least two pairs of front and rear underwater wings (4a, 4b).
2. The steering control system of the vessel according to Claim 1, wherein when steering without the motor (6), the lever plate (5) is connected with the front lever disc (9a) via an additional front lever (10c), and the at least two pairs of front and rear underwater wings (4a and 4b) are attached to their respective lifting systems (1) via a front axle (2a) and a rear axle (2b), respectively.
3. The steering control system of the vessel according to Claim 1, wherein the front levers (10a) of the control system are connected to the pair of front underwater wings (4a) via joints (3) and the joints (3) are adapted to attach the pair of front underwater wings (4a) to a front axle (2a), and the rear levers (10b) of the control system are connected to the pair of rear underwater wings (4b) in front of the joints (3) and the joints (3) are adapted to attach the pair of rear underwater wings (4b) to a rear axle (2b).

4. The steering control system of the vessel according to any one of Claims 1 to 3, wherein the lever plate (5) is connected to the motor (6) via the Bowden cable (7) and the lever plate (5) is connected to the front lever disc (9a) via the additional front lever (10c).
5. The steering control system of claim 4, further comprising additional underwater wings or at least one additional motor.
6. The steering control system of the vessel according to any one of Claims 1 to 4, wherein in a combined steering mode which uses the motor (6) and the at least two pairs of wings (4a) and (4b), the Bowden cable (7) is mounted on the lever plate (5) and connected to the motor (6).
7. The steering control system of the vessel according to Claim 1, wherein the steering control system further comprises:
 - a disc or a sprocket (1a) installed on the front and rear axles (2a) and (2b); and
 - an additional motor (1b) or another propulsion means attached to the disc or the sprocket (1a)
 wherein the safety brake (1c) has a sensor (1d) that is attached to the disc or the sprocket (1a).
8. A process of controlling a steering control system of a vessel having a hull, a pair of front underwater wings (4a), and a pair of rear underwater wings (4b) to perform steering without a motor (6), wherein the method comprises:
 - turning a helm (16), which is connected to a lever plate (5), in a direction of a turn;
 - rotating the lever plate (5) in the direction of the turn, the lever plate (5) being connected to front and rear lever discs (9a, 9b);
 - turning front and rear lever discs (9a, 9b) due to rotation of the lever plate (5), which includes turning the front lever disc (9a) in the direction of the turn while turning the rear lever disc (9b) in an opposite direction of the direction of the turn which moves front and rear levers (10a, 10b) in the direction of the turn, wherein the front and rear lever discs (9a, 9b) are cross-linked with a linking axle (8), to which the pairs of front and rear underwater wings (4a, 4b), a lifting system (1) and a safety brake (1c) are connected, and

turning the pairs of front and rear underwater wings (4a, 4b), which are connected to the front and rear levers (10a, 10b), in opposite directions due to the movement of the front and rear levers (10a, 10b) so the pair front underwater wings (4a) turn in the direction of the turn while the pair rear underwater wings (4b) turn in the opposite direction of the turn.

9. The process of controlling the steering control system of the vessel according to Claim 8, wherein the process comprises performing combined steering with the motor (6) and the front and rear underwater wings (4a and 4b), by using a Bowden cable (7), which is attached to the lever plate (5) and connects the lever plate (5) to the motor (6), to move the motor (6) in the same direction as the rear underwater wings (4b) based on the turn of the helm (16).

10. The process of controlling the steering control system of the vessel according to Claim 8, wherein the process further comprises rotating a front axle (2a), a rear axle (2b) and joints (3), where the joints (3) connect the front and rear axles (2a, 2b) to the front underwater wings (4a) and the rear underwater wings (4b) respectively, to a position that allows the front and rear underwater wings (4a and 4b) to lower under the hull of the vessel (13) into the water by using the lifting system (1) with the safety brake (1c) and an additional motor (1b) that are coupled to the front and rear axles (2a, 2b).

11. The process of controlling the steering control system of the vessel according to Claim 8, wherein the process further comprises rotating a front axle (2a), a rear axle (2b) and joints (3), where the joints (3) connect the front and rear axles (2a, 2b) to the front underwater wings (4a) and the rear underwater wings (4b), respectively, into a pre-set position that is pre-set on a control unit prior to sailing the vessel, and holding the front and rear underwater wings (4a and 4b) in the pre-set position by using an additional motor (1b), and the lifting system (1) with the safety brake (1c) that are coupled to the front and rear axles (2a, 2b).

12. The process of controlling the steering control system of the vessel according to any one of Claims 10 to 11, wherein the process further comprises: rotating the front axle (2a), the rear axle (2b) and the joints (3), where the joints (3) connect the front and rear axles (2a, 2b) to the front underwater wings (4a) and the rear underwater wings (4b) respectively, into another position

that allows the front and rear underwater wings (4a and 4b) to rise above the hull of the vessel (13) and out of the water by using an electric motor (1b), and the lifting system (1) with the safety brake (1c) that are coupled to the front and rear axles (2a, 2b).

13. The process of controlling the steering control system of the vessel according to any one of Claims 9 or 10, wherein the process further comprises:

holding the front and rear underwater wings (4a, 4b) in a pre-set position using the lifting system (1) with the safety brake; and

releasing the safety brake (1c) so that the front and rear underwater wings (4a, 4b) rotate backward and rise above the hull of the vessel (13) or out of the water to reduce an impact force on the front and rear underwater wings (4a, 4b) when hitting an obstacle, in order to reduce or eliminate damage to the underwater wings (4a, 4b).

14. The process of controlling the steering control system of the vessel according to Claim 11, wherein the process further comprises:

holding the front and rear underwater wings (4a, 4b) in the pre-set position using the lifting system (1) with the safety brake; and

releasing the safety brake (1c) so that the front and rear underwater wings (4a, 4b) rotate backward and rise above the hull of the vessel (13) or out of the water to reduce an impact force on the front and rear underwater wings (4a, 4b) when hitting an obstacle, in order to reduce or eliminate damage to the underwater wings (4a, 4b).

15. The process of controlling the steering control system of the vessel according to any one of Claims 11 or 14, wherein upon hitting an obstacle, the process further comprises rotating the front and rear underwater wings (4a and 4b) in order to brake and using a sensor to return the front and rear underwater wings (4a and 4b) to the pre-set position or angle upon stabilization after hitting the obstacle.

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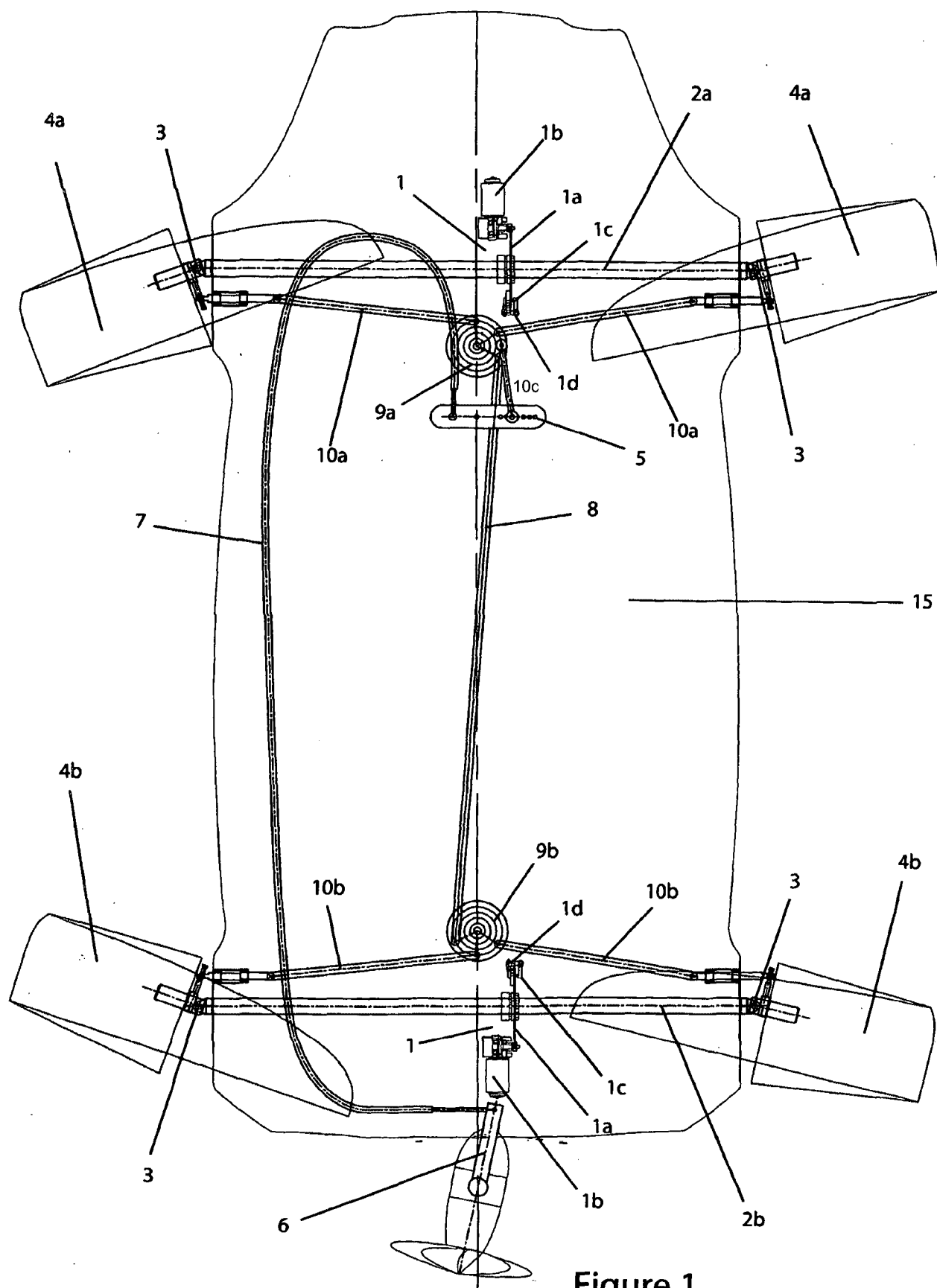


Figure 1

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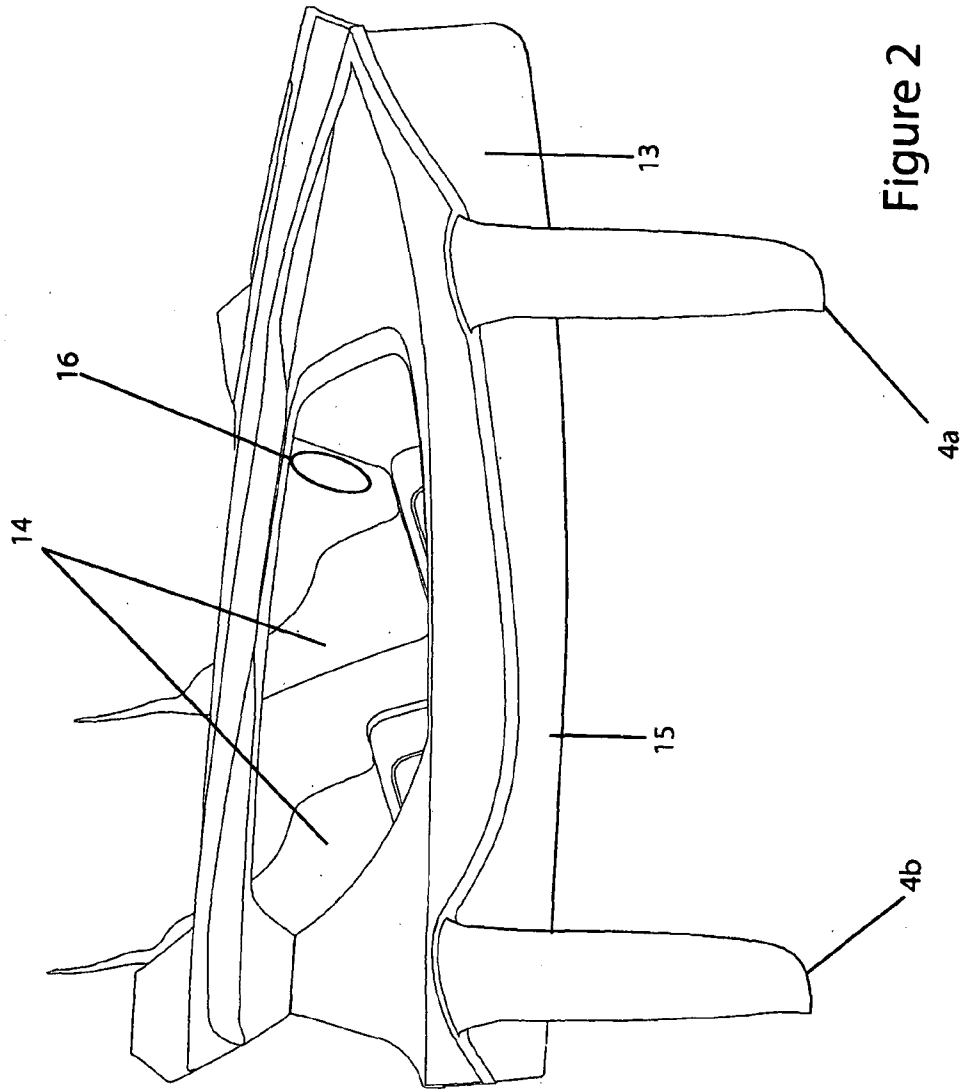


Figure 2

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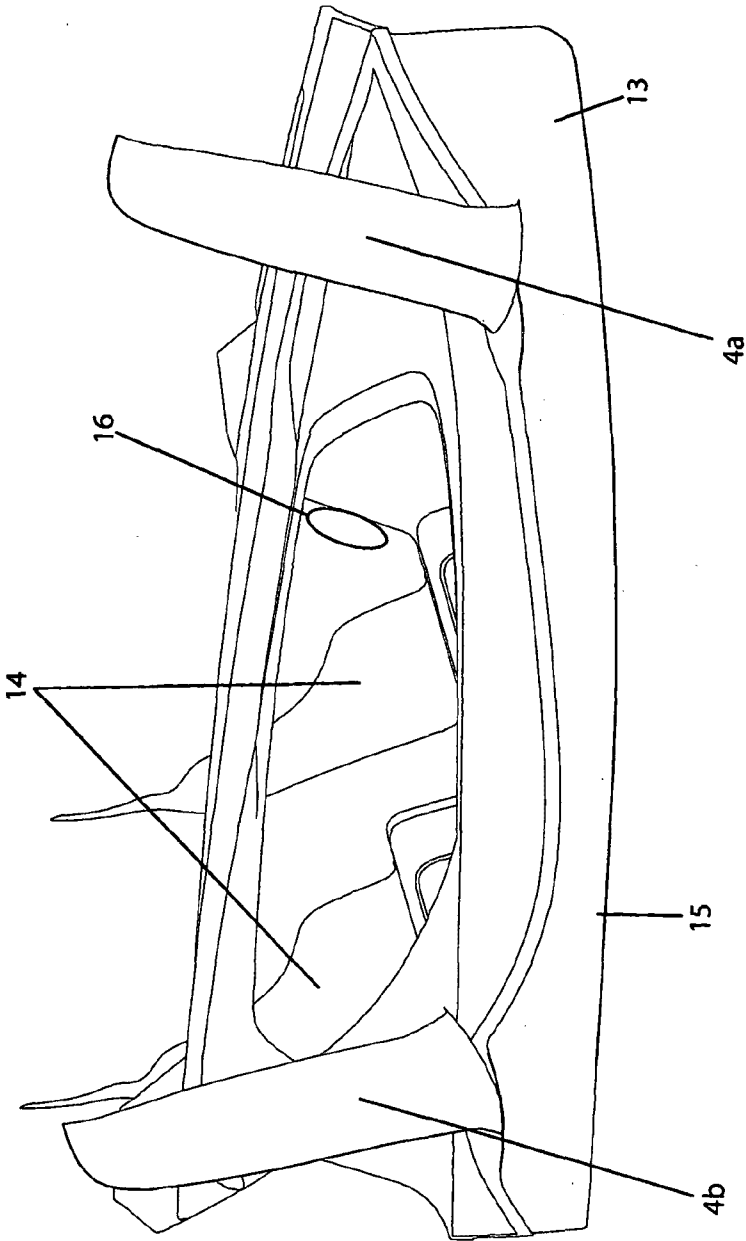


Figure 3

