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(54) A PROPULSION ASSEMBLY FOR A MARINE VESSEL

(57) The invention provides a propulsion assembly (5) for a marine vessel, comprising
- a first part (51) which is adapted to be mounted to the vessel externally thereof, and
- a second part (52) which comprises one or more propellers,
- wherein the first part comprises a mechanical power provider (511, 512) comprising a first part output shaft (412, 422),
- wherein the second part comprises a second part input shaft (2152) adapted to be driven by the first part output shaft, and to drive the one or more propellers (230),
- wherein the second part input shaft extends in an angle to respective rotational axes of the one or more propellers which is larger than 70 degrees and smaller than 110 degrees, for example 90 degrees,
- wherein the first part output shaft (412, 422) extends in an angle to the second part input shaft (2152) which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees.

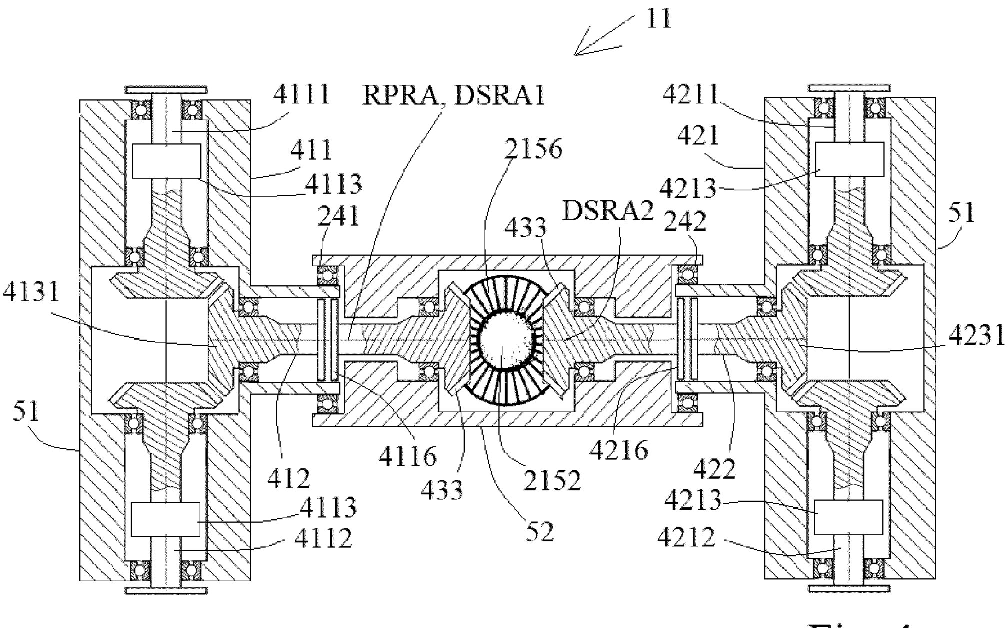

Fig. 4

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Description

TECHNICAL FIELD

[0001] The invention relates to a propulsion assembly for a marine vessel, and to a marine vessel.

BACKGROUND

[0002] Outboard engines are an increasingly popular choice for the propulsion of marine surface vessels, e.g. boats, such as power boats. The boats may be designed e,g, as pleasure boats, utility boats, or racing boats.

[0003] Relatively recently, outboard engines with increasing sizes have appeared on the market. Outboard engines with V8 engines, or even V12 engines, are now available.

[0004] A problem with outboard engines, in particular large ones, is that the attachments of the outboard engines to the hulls of the boats, will experience high loads. Therefore, if excessive wear and early failure is to be avoided, the attachments need to be designed for these high loads. This will affect the weight and the cost of the engine and boat combination. The relatively high weight will negatively affect the performance of the boat, in terms of its speed performance, handling characteristics, and/or fuel consumption.

SUMMARY

[0005] An object of the invention is to improve the performance of boats adapted to be driven by outboard engines.

[0006] The object is reached with a propulsion assembly according to claim 1. Thus, the invention provides a propulsion assembly for a marine vessel, comprising

- a first part which is adapted to be mounted to the vessel externally thereof, and
- a second part which comprises one or more propellers,
- wherein the first part comprises a mechanical power provider comprising a first part output shaft,
- wherein the second part comprises a second part input shaft adapted to be driven by the first part output shaft, and to drive the one or more propellers,
- wherein the second part input shaft extends in an angle to respective rotational axes of the one or more propellers which is larger than 70 degrees and smaller than 110 degrees, for example 90 degrees,
- wherein the first part output shaft extends in an angle to the second part input shaft which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees.

[0007] Thus, the first part is adapted to be mounted to the vessel externally thereof. Thereby, the first part may be mounted externally of a hull of the vessel. For example, the first part may be mounted to a transom of the vessel. Thereby, the installation of the propulsion assembly may be regarded as similar to that of a traditional boat outboard engine.

[0008] As exemplified below, the mechanical power provider may comprise an internal combustion engine or an electrical motor.

[0009] In embodiments of the invention, the second part input shaft is oriented in relation to the first part output shaft in an angle which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees.

[0010] When the propulsion assembly is mounted to the vessel, the second part input shaft may extend for example substantially vertically. Since the first part output shaft extends in an angle to the second part input shaft which is larger than 70 degrees and smaller than 110 degrees, the elevation of the mechanical power provider may be reduced compared to that of traditional outboard engines. For example, the first part output shaft may be substantially horizontal. This means the distance from a mounting bracket, for mounting the propulsion assembly to the vessel, to the center of gravity of the mechanical power provider may be reduced. Thereby, inertia bending moments at the attachment of the propulsion assembly may be reduced. Such bending moments may be caused e.g. by the vessel quickly changing pitch position while traveling.

[0011] In other words, a traditional outboard engine may have a lot of mass relatively high above the attachment to the vessel hull. This creates a long moment arm, and therefore high moments of inertia in the attachment when the boat quickly changes pitch position while traveling. By the first part output shaft extending in the 70-110 degree angle to the second part input shaft, said mass may be moved closer to the attachment, and said moment arm may be reduced.

[0012] Thereby, the attachment may be designed for relatively low loads. This will reduce the weight and the cost of the engine and boat combination. This will improve the speed performance, handling characteristics, and/or fuel consumption of the boat.

[0013] In addition, the invention allowing, compared to traditional outboard engines, a reduced elevation of the center of gravity of the propulsion assembly, the behavior of the vessel, when it turns at high speed, may be improved.

[0014] Thereby, the performance of boats adapted to be driven by outboard engines will be improved.

[0015] Further, the reduced height of the propulsion assembly, made possible in embodiments of the invention, may allow room for a stern platform on the vessel, e.g. for swimming. A traditional outboard engine usually takes space away from such a platform.

[0016] It is understood that the one or more propellers may be driven by the second part input shaft via one or more respective propeller shafts.

[0017] It is also understood that rotational axes of the one or more propellers may be substantially horizontal when the vessel is driven by the propulsion assembly. Therefore, since the second part input shaft extends in 70-110 degree angle to respective rotational axes of the one or more propellers, e.g. perpendicularly, the propulsion assembly may be adapted to be mounted to the vessel so that when the second part is in a position in which the one or more propellers can generate a thrust by acting on water supporting the vessel, the second part input shaft extends in an angle to a horizontal plane, which is 70-110 degrees. More generally, the propulsion assembly may be adapted to be mounted to the vessel so that when the second part is in the position in which the one or more propellers can generate a thrust by acting on water supporting the vessel, the second part input shaft extends in an angle to the horizontal plane, which is 60-120 degrees, preferably 70-110 degrees, for example 90 degrees. Said position of the second part in which the propellers can generate a thrust by acting on water supporting the vessel may be a position for a trim of the second part for a relatively high speed of the vessel. Said horizontal plane can be defined as a plane formed by flat water surrounding the boat when the boat is at rest. For example, the horizontal plane can be defined as a plane comprising a contour where a hull of the vessel meets the water surface when the vessel is floating at rest in flat water. It is also understood that the one or more propellers can generate a thrust by acting on water supporting the vessel, if the one or more propellers are partly or fully submerged in the water.

[0018] Preferably, the propulsion assembly is adapted to be mounted to the vessel so that the first part output shaft extends in an angle to a direction of straight travel of the vessel which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees. Thereby, the first part output shaft may be e.g. perpendicular to direction of straight travel of the vessel. Thereby, the first part output shaft may extend along a stern of the vessel. Thereby, the moment arm between the mechanical power provider and the attachment of the propulsion assembly to the vessel hull may be further reduced. This will further reduce loads on the attachment.

[0019] Preferably, the propulsion assembly comprises a shaft connection connecting the first part output shaft to the second part input shaft. The shaft connection is preferably a bevel gear. It is understood that the shaft connection connects the first part output shaft to the second part input shaft. Thereby, the first part output shaft is adapted to drive the second part input shaft. The bevel gear may comprise an output gear wheel which is fixed to the first part output shaft. The bevel gear may further comprise an input gear wheel which is fixed to the second part input shaft. The output gear wheel and the input gear wheel may be in engagement with each other. Particular advantages with such a bevel gear are provided in embodiments of the invention described below.

[0020] Preferably, the first part is adapted to be fixed in relation to the vessel, and the second part is rotatable in relation to the first part around a second part rotation axis. Thereby, a rotational axis of the first part output shaft preferably coincides with the second part rotation axis.

[0021] Thereby, the second part is rotatable in relation the mechanical power provider. The rotational axis of the first part output shaft may be a center axis of the first part output shaft. The second part rotation axis may extend in an angle to a direction of straight travel of the vessel which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees. The second part rotation axis may be substantially horizontal.

[0022] If the rotational axis of the first part output shaft coincides with the second part rotation axis, the angle between the first part output shaft and the second part input shaft does not need to change when the second part is rotated around the second part rotation axis. Therefore it is possible to allow the second part to be tilted to large tilt angles, while the one or more propellers are driven by the mechanical power provider.

[0023] Where the rotational axis of the first part output shaft coincides with the second part rotation axis, and, as exemplified above, the propulsion assembly comprises a shaft connection connecting the first part output shaft to the second part input shaft, wherein the shaft connection is a bevel gear, the input gear wheel can rotate, during tilting of the second part, along the output gear wheel, without the engagement between the gear wheels to be affected in any way. Thereby, any tilt angle of the second part is allowed, regardless whether or not the propulsion assembly is in operation.

[0024] The bevel gear may be of any suitable type. For example, the wheels of the bevel gear may be straight or curved. Thus, the bevel gear may be any of a straight bevel gear, a spiral bevel gear, a hypoid bevel gear, or a Zerol® bevel gear.

[0025] It should be noted however, that in some embodiments, the shaft connection between the first part output shaft and the second part input shaft may comprise a universal joint. For example, the shaft connection may comprise a chain of universal joints. With such a chain of universal joints, a large angle, e.g. 90 degrees, between the first part output shaft and the second part input shaft may be provided. Again, where the rotational axis of the first part output shaft coincides with the second part rotation axis, the angle between the first part output shaft and the second part input shaft does not need to change when the second part is tilted around the second part rotation axis. Further alternatives are possible. For example, the shaft connection may comprise a flexible shaft.

[0026] Preferably, the second part is rotatable in relation to the first part for tilting the second part out of water supporting the vessel. Thereby, when the vessel is at rest, the extended angular tilting range provided by the rotational axis of the first part output shaft coinciding with the second part rotation axis, can secure that the second part is well away from the water. Thereby, the risk of fouling of the second part is reduced.

[0027] The second part may be rotatable in relation to the first part for a trim function of the propulsion assembly. Thereby, use is made of the advantage of embodiments of the invention that the second part may be rotated around the second part rotation axis, to any angular position, while the one or more propellers are driven by the mechanical power provider.

[0028] It should be noted however that in some embodiments of the invention, the mechanical power provider is also rotatable. Thereby, the first part output shaft rotational axis does necessarily coincide with the rotational axis of the mechanical power provider and the second part. It is important to note that the advantages above with the first part output shaft extending in a 70-110 degree angle to the second part input shaft, e.g. that inertia bending moments at the attachment of the propulsion assembly may be reduced, are achieved regardless of whether or not the mechanical power provider is tilted with the second part.

[0029] Preferably, the first part comprises a mounting bracket for mounting the propulsion assembly to the vessel, which mounting bracket comprises a mounting arm for supporting the mechanical power provider and the second part. The mounting bracket may provide an attachment of the propulsion assembly to a hull of the vessel. The mounting bracket may for example be adapted to be mounted to a transom of the vessel. The mounting bracket may comprise a fixing part, for fixing the mounting bracket to the vessel. The mounting arm may extend from the fixing part. The fixing part may for example be provided with holes for bolts to be extended through holes in a hull of the vessel, e.g. in the transom thereof, for fixing the propulsion assembly to the vessel.

[0030] In some embodiments, where the propulsion assembly comprises a shaft connection connecting the first part output shaft to the second part input shaft the mechanical power provider is located between the mounting arm and the shaft connection. Thereby, the mechanical power provider may be located close to, or adjacent to the second part. Thereby, the mechanical power provider and the second part may form a compact arrangement.

[0031] It should be noted that the mounting bracket may comprise a further mounting arm for mounting the propulsion assembly to the vessel. The further mounting arm could be located on a side of the shaft connection which is opposite to the side on which the mechanical power provider is located. Thus, the mechanical power provider and the second part may be held by two mounting arms located on opposite sides of the second part.

[0032] In some embodiments, the mounting arm is located between the mechanical power provider and the shaft connection. This may be advantageous for relatively large propulsion assemblies. The reason is that maximum distances of the mechanical power provider and the second part, from the mounting arm, may be relatively short. Thereby, bending moments caused by gravity may be kept relatively low. In such embodiments, a further mounting arm of the mounting bracket may be provided. The two mounting arms may be located on opposite sides of the second part. Thereby, the mechanical power provider may be located externally of the pair of mounting arms.

[0033] The mechanical power provider may comprise one or more power supply units. Such a power supply unit may be an internal combustion engine. In some embodiments, the mechanical power provider comprises a power supply unit in the form of an electric motor. In further embodiments, the mechanical power provider comprises a hybrid drivetrain, e.g. with a combination of an engine and a motor.

[0034] The mechanical power provider may comprise a gear for changing the rotational speed, between one or more of the one or more power supply units and the fixable part output shaft.

[0035] Where the mechanical power provider comprises an electric motor, a more environmentally friendly propulsion assembly may be provided compared to one that comprises an internal combustion engine instead of a motor.

[0036] As suggested, the mechanical power provider may comprise an internal combustion engine. Since in embodiments of the invention, the angle between the first part output shaft and the second part input shaft is 70-110 degrees, substantially 90 degrees. Thereby, a horizontal engine installation is allowed. This is advantageous compared to many modern outboard engines, with standing engine installations. Standing engine installations require relatively complicated arrangements e.g. for the engine lubrication and cooling. The horizontal engine installation allowed in embodiments of the invention permits simpler engine arrangements. For example, automobile engines may be used.

[0037] In some embodiments, the mechanical power provider is referred to as a first mechanical power provider, and the first part output shaft is referred to as a primary first part output shaft. Thereby, the first part may comprise a second mechanical power provider comprising a secondary first part output shaft.

[0038] The propulsion assembly may comprise a shaft connection connecting the primary first part output shaft and the secondary first part output shaft to the second part input shaft.

[0039] The first and second mechanical power providers may be located on opposite sides of the shaft connection.

[0040] The secondary first part output shaft preferably extends in an angle to the second part input shaft which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees. The secondary first part output shaft may be parallel with the primary first part output shaft. Preferably, the secondary first part output shaft is coaxial with the primary first part output shaft.

[0041] By the secondary first part output shaft extending in the 70-110 degree angle to the second part input shaft, the mass of the second mechanical power provider may be kept relatively close to the attachment of the propulsion assembly to the vessel hull. Thereby the moment arm from the attachment to the second mechanical power provider may be relatively short. Thereby loads of the attachment may be kept relatively low.

[0042] Preferably, where the first part is adapted to be fixed in relation to the vessel, and the second part is rotatable in relation to the first part around a second part rotation axis, a rotational axis of the secondary first part output shaft coincides with the second part rotation axis.

[0043] Thus, the rotational axes of the first and secondary first part output shafts may both coincide with the second part rotation axis. Thereby, the angle between the first part output shafts and the second part input shaft does not need to change when the second part is rotated around the second part rotation axis. Thereby, any tilt angle of the second part is allowed, regardless whether or not the propulsion assembly is in operation.

[0044] Where the shaft connection is a bevel gear, the bevel gear may comprise a first output gear wheel which is fixed to the primary first part output shaft, and a second output gear wheel which is fixed to the secondary first part output shaft. The bevel gear may further comprise an input gear wheel which is fixed to the second part input shaft. The output gear wheels may both be engaged with the input gear wheel. The output gear wheels may be located on opposite sides of the input gear wheel.

[0045] As understood, the propulsion assembly may comprise a plurality of mechanical power providers, each comprising one or more power supply units. The power supply units may be internal combustion engines or electric motors. An advantage thereby is that for a given total power requirement of the propulsion assembly, the size of each power supply unit may, compared to a case with a single power supply unit, be reduced. This allows the use of readily available power supply units for relatively large power requirements. This allows scaling up power capacities of propulsion assemblies, while using readily available power supply units.

[0046] In some embodiments, the first and secondary first part output shafts are output shafts of respective power supply units of the first and second mechanical power providers, respectively. For example, the power supply units may be electrical motors, the output shafts of which are directly connected to the second part input shaft via the shaft connection. Thereby, a propulsion assembly may be provided with particularly simple and robust features.

[0047] In some embodiments, where the propulsion assembly comprises a shaft connection connecting the first part output shaft to the second part input shaft, the mechanical power provider comprises a first power supply unit, and a first input shaft. Thereby, the first input shaft may be adapted to be driven by the first power supply unit. Alternatively, the first input shaft may form a power supply output shaft of the first power supply unit. The first input shaft may extend in an angle to the first part output shaft which is larger than zero degrees and smaller than 180 degrees, for example 90 degrees. In such embodiments, the shaft connection is a first shaft connection, and the propulsion assembly comprises a second shaft connection connecting the first input shaft to the first part output shaft.

[0048] In such embodiments, with a first power supply unit, the mechanical power provider may comprise a second power supply unit, and a second input shaft, Thereby, the second input shaft may be adapted to be driven by the second power supply unit. Alternatively, the second input shaft may form a power supply output shaft of the second power supply unit. The second input shaft may extend in an angle to the first part output shaft which is larger than zero degrees and smaller than 180 degrees, e.g. 90 degrees. Thereby, the second shaft connection may connect the second input shaft to the first part output shaft.

[0049] Thus, the mechanical power provider may comprise two power supply units, both connected via respective input shafts and the second shaft connection, to the first part output shaft. Thereby, the power supply units may be located on opposite sides of the second shaft connection.

[0050] Where the second shaft connection may be a bevel gear, the bevel gear may comprise gear wheels which are fixed to a respective of the input shafts. The bevel gear may further comprise a gear wheel which is fixed to the first part output shaft.

[0051] Where the propulsion assembly comprises a plurality of mechanical power providers, each mechanical power provider may comprise two power supply units. Thereby, said advantage, that for a given total power requirement of the propulsion assembly the size of each power supply unit may be reduced, may be further exploited.

[0052] Where the mechanical power provider comprises a power supply unit, and the power supply unit comprises a power supply output shaft, the power supply output shaft may form the first part output shaft. Alternatively, the first power supply output shaft may be adapted to drive the first part output shaft, wherein a rotational axis of the first power supply output shaft coincides with, or is parallel with, the rotational axis of the first part output shaft. Thereby, propulsion assemblies with particularly simple and robust features may be provided.

[0053] In some embodiments, the propulsion assembly comprises a single mechanical power provider, comprising a single power supply unit, e.g. in the form of an electric motor. The power supply output shaft of the single power supply unit may form the first part output shaft. Such an embodiment may be suitable for small propulsion assemblies, for example for auxiliary use of a vessel, e.g. for trolling.

[0054] Preferably, the second part comprises a steering arrangement arranged to rotate the one or more thrust generating devices around a rotational axis of the second part input shaft, for steering a vessel to which the propulsion assembly is mounted. Thus, a steering axis of the propulsion unit may coincide with the rotational axis of the second part input shaft. For the steering function, the second part may comprise a not-steerable part, and a steerable part. The steerable part may be located under the non-steerable part, and comprise the one of more thrust generating devices. Thereby, the steering capacity maybe provided in a manner that is simple to implement.

[0055] The object is also reached with a marine vessel comprising a propulsion assembly according to any one of claims 1-18.

[0056] Further advantages and advantageous features of the invention are disclosed in the following description and in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0057] With reference to the appended drawings, below follows a more detailed description of embodiments of the invention cited as examples. In the drawings:

- Fig. 1 is a perspective view from below of a marine vessel comprising a propulsion assembly according to an embodiment of the invention.
- Fig. 2 is a schematic sectioned side view of the propulsion assembly of the marine vessel in fig. 1.
- Fig. 3 is a schematic top view of the propulsion assembly in fig. 2.
- Fig. 4 is a cross-sectional view of the propulsion assembly in fig. 2 and fig. 3, with the cross-section oriented as indicated by the arrows IV-IV in fig. 2.
- Fig. 5 is a cross-sectional view of the propulsion assembly in fig. 2 and fig. 3, with the cross-section oriented as indicated by the arrows V-V in fig. 3.
- Fig. 6 is a side view as in fig. 2, with a second part of the propulsion assembly tilted.
- Fig. 7 is a schematic top view of a propulsion assembly according to an alternative embodiment of the invention.
- Fig. 8 is a partially sectioned top view of a propulsion assembly according to a further embodiment of the invention.
- Fig. 9 is a partially sectioned top view of a propulsion assembly according to another embodiment of the invention.
- Fig. 10 shows parts of an embodiment of a propulsion assembly according to yet another embodiment of the invention.
- Fig. 11 shows a top view of a propulsion assembly according to a further embodiment of the invention.
- Fig. 12 - fig. 14 show respective schematic sectioned side views of propulsion assemblies according to further alternative embodiments of the invention.
- Fig. 15 shows parts of a propulsion assembly for a marine vessel, according to a further embodiment of the invention.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE INVENTION

[0058] Fig. 1 shows a marine vessel 1 in the form of a power boat. It should be noted that the invention is equally applicable to other types of marine vessels, such as ships or sailing yachts. The marine vessel 1 comprises a hull 2 having a bow 3 and a stern 4. The marine vessel 1 further comprises a propulsion assembly 5 according to an embodiment of the invention.

[0059] Reference is made also to fig. 2. The propulsion assembly 5 comprises a first part 51 which is mounted to the vessel, externally thereof. As can be seen in fig. 1, the first part 51 is mounted to a transom of the vessel.

[0060] The propulsion assembly 5 further comprises a second part 52 which is rotatable in relation to the first part around a second part rotation axis RPRA. The second part comprises two propellers 230, adapted to generate a thrust by acting on the water supporting the marine vessel. In some embodiments, the propulsion assembly 5 comprises a single propeller.

[0061] Reference is made also to fig. 3. The first part 51 comprises a first mechanical power provider 511, and a second mechanical power provider 512. The first mechanical power provider 511 comprises a first power supply unit 301, and a second power supply unit 302. Similarly, the second mechanical power provider 512 comprises a first power supply unit 303, and a second power supply unit 304. The power supply units 301-304 are in this embodiment electric motors.

[0062] The first part 51 comprises a mounting bracket 513 for mounting the propulsion assembly to the vessel. The mounting bracket comprises two mounting arm 5131, 5132 for supporting the mechanical power providers 511, 512 and the second part 52. The mounting arms are located on opposite sides of the mechanical power provider and the second part.

[0063] The mounting bracket further comprises a fixing part 5133, for fixing the mounting bracket to the vessel. The mounting arms 5131, 5132 extend, in this example perpendicularly, from the fixing part 5133. The fixing part 5133 may for example be provided with holes for bolts to be extended through holes in a hull of the vessel, e.g. in the transom thereof, for fixing the propulsion assembly to the vessel.

[0064] Reference is made also to fig. 4. The first mechanical power provider 511 comprises a primary first part output shaft 412. The second mechanical power provider 512 comprise a secondary first part output shaft 422. As understood from fig. 3 and fig. 4, the propulsion assembly is adapted to be mounted to the vessel so that the first part output shafts 412, 422 extend substantially perpendicularly to a direction of straight travel of the vessel.

[0065] Reference is made also to fig. 5. The second part comprises a second part input shaft 2152 adapted to drive the one or more propellers 230 (fig. 2). The second part input shaft 2152 extends perpendicularly to respective rotational axes RP of the one or more propellers 230 (fig. 2). The second part input shaft 2152 extends perpendicularly to the first part output shafts 412, 422. The propulsion assembly comprises a first shaft connection 433, 2156 connecting the first part output shafts 412, 422 to the second part input shaft 2152.

[0066] The first shaft connection 433, 2156 is a bevel gear. The bevel gear comprises two bevel gear wheels 433 fixed to a respective of the first part output shafts 412, 422, and a bevel gear wheel 2156 fixed to the second part input shaft 2152.

[0067] As understood from fig. 3 and fig. 4, the mechanical power providers 511, 512 are located on opposite sides of the first shaft connection 433, 2156. As also understood from fig. 3 and fig. 4, the mechanical power providers 511, 512 are located between the mounting arms 5131, 5132 and the shaft connection 433, 2156.

[0068] As indicated in fig. 4, for the rotation of the second part 52 in relation to the fixed part 51, as exemplified below with reference to fig. 6, bearings 241, 242, surrounding the first part output shafts 412, 422 (fig. 4), are located between the fixed part 51 and the second part 52.

[0069] The first mechanical power provider 511 further comprises a first input shaft 4111 (fig. 4). The first input shaft 4111 is adapted to be driven by the first power supply unit 301 of the first mechanical power provider 511 (fig. 2). Alternatively, the first input shaft 4111 may form a power supply output shaft of the first power supply unit 301. The first input shaft 4111 extends perpendicularly to the primary first part output shaft 412. A second shaft connection 4131 connects the first input shaft 4111 to the primary first part output shaft 412.

[0070] The first mechanical power provider 511 further comprises a second input shaft 4112. The first input shaft 4111 and the second input shaft 4112 are located on opposite sides of the primary first part output shaft 412. The second input shaft 4112 is adapted to be driven by the second power supply unit 302 of the first mechanical power provider 511 (fig. 2). Alternatively, the second input shaft 4112 may form a power supply output shaft of the second power supply unit 302. The second input shaft 4112 extends perpendicularly to the primary first part output shaft 412. The second shaft connection 4131 connects the second input shaft 4112 to the primary first part output shaft 412. The second shaft connection is a bevel gear.

[0071] Similarly, the second mechanical power provider 512 further comprises a first input shaft 4211 (fig. 4). The first input shaft 4211 of the second mechanical power provider is adapted to be driven by the first power supply unit 303 of the second mechanical power provider (fig. 2). The first input shaft 4211 of the second mechanical power provider extends perpendicularly to the secondary first part output shaft 422. A third shaft connection 4231 connects the first input shaft 4211 of the second mechanical power provider to the secondary first part output shaft 422.

[0072] The second mechanical power provider 512 further comprises a second input shaft 4212. The first input shaft 4211 and the second input shaft 4212 are located on opposite sides of the secondary first part output shaft 422. The second input shaft 4212 of the second mechanical power is adapted to be driven by the second power supply unit 304 of the of the second mechanical power (fig. 2). The second input shaft 4212 of the second mechanical power extends perpendicularly to the secondary first part output shaft 422. The third shaft connection 4231 connects the second input shaft 4212 of the second mechanical power to the secondary first part output shaft 422. The third shaft connection 4231 is a bevel gear.

[0073] In this embodiment, the input shafts 4111, 4112, 4211, 4212 of the mechanical power providers are each divided into two parts, connected with a respective freewheel 4113, 4213.

[0074] In this embodiment, each first part output shaft 412, 422 is divided into two parts, connected with a coupling 4116, 4216, in this example a flange coupling.

[0075] A suggested in fig. 5, the second part 52 comprises a steering arrangement 2001, 2002 arranged to rotate the thrust generating devices 230 (fig. 2) around a rotational axis of the second part input shaft 2152, for steering a vessel to which the propulsion assembly is mounted.

[0076] For the steering function, the second part comprises a not-steerable part 521, and a steerable part 522. The steerable part 522 comprises the propellers 230. When the second part is rotated so that the propellers 230 are in the water, the steerable part 522 is located under the non-steerable part 521.

[0077] The steering arrangement comprises a steering bearing assembly 2001. The steerable part 522 is arranged to be rotated by means of one or more rotation actuators, e.g. in the form of one or more electrical motors 2002 and a cog engagement.

[0078] As indicated in fig. 3 and fig. 4, rotational axes DSRA1, DSRA2 of the first part output shafts 412, 422 coincide with the second part rotation axis RPRA

[0079] Reference is made also to fig. 6. The second part 52 is rotatable in relation to the first part 51, around the second part rotation axis RPRA, for tilting the second part out of water supporting the vessel. The surface of the water is denoted WL in fig. 6. Thus, the second part 52 is rotatable in relation the mechanical power providers 511, 512. It is understood that each the mechanical power provider 511, 512 is cantilevered from a respective of the mounting arms 5131, 5132.

[0080] The rotation is executed by means of an actuation assembly. In this example, the actuation assembly comprises a hydraulic cylinder 53, which extend between the first part 51 and the second part 52. As mentioned, for the rotation, bearings 241, 242, surrounding the first part output shafts 412, 422 (fig. 4), are located between the mechanical power providers 511, 512 and the second part 52.

[0081] In some embodiments, the steering arrangement 2001, 2002 (fig. 5) may be used to put the steerable part 522 in a position such that it is secured that the entire second part 52 is out of the water.

[0082] The rotatability of the second part 52 around the second part rotation axis RPRA may also be used for a trim function of the propulsion assembly.

[0083] Reference is made to fig. 7, showing an embodiment of the propulsion assembly which is similar to the one described with reference to fig. 1 - fig. 6, but with some differences as follows.

[0084] Each mounting arm 5131, 5132 is located between a respective of the mechanical power providers 511, 512 and the second part 52. Each mounting arm 5131, 5132 is located between a respective of the mechanical power providers 511, 512 and the first shaft connection 433, 2156 (fig. 4). Thus, the second part 52 is located between the mounting arms 5131, 5132.

[0085] Each the mechanical power provider 511, 512 is located on an outer side of a respective of the mounting arms 5131, 5132. Each the mechanical power provider 511, 512 is cantilevered from a respective of the mounting arms 5131, 5132. The first part output shafts 412, 422 (fig. 4) extend through the mounting arms 5131, 5132.

[0086] As in the embodiment described with reference to fig. 1 - fig. 6, the second part 52 is rotatable in relation to the first part 51, around the second part rotation axis RPRA. For the rotation, bearings, surrounding the first part output shafts, are located between the mounting arms 5131, 5132 and the second part 52.

[0087] Reference is made to fig. 8, showing an embodiment of the propulsion assembly which is similar to the one described with reference to fig. 7, but with some differences as follows.

[0088] The first mechanical power provider 511 comprises a single power supply unit 301. Similarly, the second mechanical power provider 512 comprises a single power supply unit 303. Each power supply unit 301, 303 comprises a respective power supply output shaft which forms a respective first part output shaft 412, 422.

[0089] In alternative embodiments, each power supply output shaft is adapted to drive the respective first part output shaft 412, 422. Thereby, a rotational axis of each power supply output shaft may coincide with the rotational axis of the respective first part output shaft 412, 422. For example, the power supply output shaft may be connected with the respective first part output shaft 412, 422 via a coupling, such as a flange coupling.

[0090] Reference is made to fig. 9, showing an embodiment of the propulsion assembly which is similar to the one described with reference to fig. 8, but with some differences as follows.

[0091] The propulsion assembly comprises a single mechanical power provider 511. A single mounting 5131 arm is provided between the mechanical power provider 511 and the second part 52. The mechanical power provider 511 comprises a single power supply unit 301. The power supply unit 301 comprises a power supply output shaft which forms a first part output shaft 412.

[0092] Reference is made to fig. 10, showing parts of an embodiment of a propulsion assembly which is similar to the one described with reference to fig. 9. The propulsion assembly comprises a shaft connection 433, 2156 connecting a first part output shaft 412 to a second part input shaft 2152. Differing from the embodiments in fig. 9, the power supply output shaft 4111 of the power supply unit 301 is adapted to drive the first part output shaft 412 via a gear 44. Thereby, the rotational axis of the power supply output shaft 4111 is parallel with the rotational axis of the first part output shaft 412. However, the power supply output shaft 4111 is offset from the first part output shaft 412.

[0093] Various variations of the invention are possible. Fig. 11 shows an embodiment similar to the one described with reference to fig. 1 - fig. 6, but with a single power supply unit 301, 303 in each mechanical power provider 511, 512. Fig. 12 shows an embodiment similar to the one described with reference to fig. 1 - fig. 6, but with three power supply units in each mechanical power provider. Fig. 13 shows an embodiment, similar to the one described with reference to fig. 1 - fig. 6, in which the propulsion unit is mounted on a downwards facing horizontal surface, such as a lower surface of a swim platform of the vessel. Fig. 14 shows an embodiment, similar to the one described with reference to fig. 1 - fig. 6, in which the propellers are pulling propellers.

[0094] Fig. 15 shows parts of a propulsion assembly for a marine vessel, according to a further embodiment of the invention. The propulsion assembly comprises a first part 51 which is adapted to be mounted to the vessel externally thereof. The first part comprises a mechanical power provider 511 comprising a first part output shaft 412. The propulsion assembly further comprises a second part 52 which comprises one or more propellers 230. The second part comprises a second part input shaft 2152 adapted to be driven by the first part output shaft, and to drive the one or more propellers 230. The second part input shaft 2152 extends in an angle to respective rotational axes RP of the one or more propellers 230 which is larger than 70 degrees and smaller than 110 degrees, in this example 90 degrees. The first part output shaft 412 extends in an angle to the second part input shaft 2152 which is larger than 70 degrees and smaller than 110 degrees, in this example 90 degrees.

[0095] It is to be understood that the present invention is not limited to the embodiments described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the appended claims.

Claims

1. A propulsion assembly (5) for a marine vessel, comprising

    - a first part (51) which is adapted to be mounted to the vessel externally thereof, and

- a second part (52) which comprises one or more propellers (230),
- wherein the first part comprises a mechanical power provider (511, 512) comprising a first part output shaft (412, 422),
- **characterized in that** the second part comprises a second part input shaft (2152) adapted to be driven by the first part output shaft, and to drive the one or more propellers (230),
- wherein the second part input shaft (2152) extends in an angle to respective rotational axes (RP) of the one or more propellers (230) which is larger than 70 degrees and smaller than 110 degrees, for example 90 degrees,
- wherein the first part output shaft (412, 422) extends in an angle to the second part input shaft (2152) which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees.

2. A propulsion assembly according to claim 1, **characterized in that** the propulsion assembly is adapted to be mounted to the vessel so that the first part output shaft extends in an angle to a direction of straight travel of the vessel which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees.

3. A propulsion assembly according to any one of the preceding claims, **characterized in that** the propulsion assembly comprises a shaft connection (433, 2156) connecting the first part output shaft (412, 422) to the second part input shaft (2152), wherein the shaft connection (433, 2156) is a bevel gear.

4. A propulsion assembly according to any one of the preceding claims, **characterized in that** the first part is adapted to be fixed in relation to the vessel, and the second part is rotatable in relation to the fixable part around a second part rotation axis (RPRA).

5. A propulsion assembly according to claim 4, **characterized in that** a rotational axis of the first part output shaft (DSRA1, DSRA2) coincides with the second part rotation axis (RPRA).

6. A propulsion assembly according to any one of claims 4-5, **characterized in that** the second part (52) is rotatable in relation to the first part (51) for tilting the second part out of water supporting the vessel.

7. A propulsion assembly according to any one of claims 4-6, **characterized in that** the second part (52) is rotatable in relation to the first part (51) for a trim function of the propulsion assembly.

8. A propulsion assembly according to any one of the preceding claims, **characterized in that** the first part (51) comprises a mounting bracket (513) for mounting the propulsion assembly to the vessel, which mounting bracket comprises a mounting arm (5131, 5132) for supporting the mechanical power provider (511, 512) and the second part (52).

9. A propulsion assembly according to claim 8, **characterized in that** the propulsion assembly comprises a shaft connection (433, 2156) connecting the first part output shaft (412, 422) to the second part input shaft, wherein the mechanical power provider (511, 512) is located between the mounting arm (5131, 5132) and the shaft connection (433, 2156).

10. A propulsion assembly according to claim 8, **characterized in that** the propulsion assembly comprises a shaft connection (433, 2156) connecting the first part output shaft (412, 422) to the second part input shaft, wherein the mounting arm (5131, 5132) is located between the mechanical power provider (511, 512) and the shaft connection (433, 2156).

11. A propulsion assembly according to any one of the preceding claims, **characterized in that** the mechanical power provider (511, 512) comprises an electric motor (303-304).

12. A propulsion assembly according to any one of the preceding claims, **characterized in that** the mechanical power provider is a first mechanical power provider (511), and the first part output shaft is a primary first part output shaft (412), wherein the first part (51) comprises a second mechanical power provider (512) comprising a secondary first part output shaft (422), wherein the secondary first part output shaft extends in an angle to the second part input shaft which is larger than 70 degrees and smaller than 110 degrees, preferably substantially 90 degrees.

13. A propulsion assembly according to claim 12, **characterized in that** the propulsion assembly comprises a shaft connection connecting the primary first part output shaft and the secondary first part output shaft to the second part input shaft, wherein the mechanical power providers (511, 512) are located on opposite sides of the shaft connection (433, 2156).

14. A propulsion assembly according to any one of claims 12-13, **characterized in that** the first part is adapted to be fixed in relation to the vessel, and the second part is rotatable in relation to the first part around a second part rotation axis, wherein a rotational axis of the secondary first part output shaft (DSRA2) coincides with the second part rotation axis (RPRA).

15. A propulsion assembly according to any one of the preceding claims, **characterized in that** the propulsion assembly comprises a shaft connection (433, 2156) connecting the first part output shaft (412, 422) to the second part input shaft (2152), wherein the mechanical power provider (511) comprises a first power supply unit (301), and a first input shaft (4111),

- wherein the first input shaft (4111) is adapted to be driven by the first power supply unit (301),
- or wherein the first input shaft (4111) forms a power supply output shaft of the first power supply unit (301),
- wherein the first input shaft (4111) extends in an angle to the first part output shaft (412) which is larger than zero degrees and smaller than 180 degrees,
- wherein the shaft connection (433, 2156) is a first shaft connection (433, 2156), wherein the propulsion assembly comprises a second shaft connection (4131) connecting the first input shaft (4111) to the first part output shaft (412, 422).

16. A propulsion assembly according to claim 15, **characterized in that** the mechanical power provider (511) comprises a second power supply unit (302), and a second input shaft (4112),

- wherein the second input shaft (4112) is adapted to be driven by the second power supply unit (302),
- or wherein the second input shaft (4112) forms a power supply output shaft of the second power supply unit (302),
- wherein the second input shaft (4112) extends in an angle to the first part output shaft (412) which is larger than zero degrees and smaller than 180 degrees,
- wherein the second shaft connection (4131) connects the second input shaft (4112) to the first part output shaft (412).

17. A propulsion assembly according to any one of claims 1-15, **characterized in that** the mechanical power provider (511) comprises a power supply unit (301), wherein the power supply unit (301) comprises a power supply output shaft,

- wherein the power supply output shaft forms the first part output shaft (412),
- or wherein the power supply output shaft is adapted to drive the first part output shaft (412), wherein a rotational axis of the power supply output shaft coincides with, or is parallel with, the rotational axis of the first part output shaft (DSRA1).

18. A propulsion assembly according to any one of the preceding claims, **characterized in that** the second part (52) comprises a steering arrangement (2001, 2002) arranged to rotate the one or more thrust generating devices (230) around a rotational axis of the second part input shaft (2152), for steering a vessel to which the propulsion assembly is mounted.

19. A marine vessel comprising a propulsion assembly according to any one of the preceding claims.

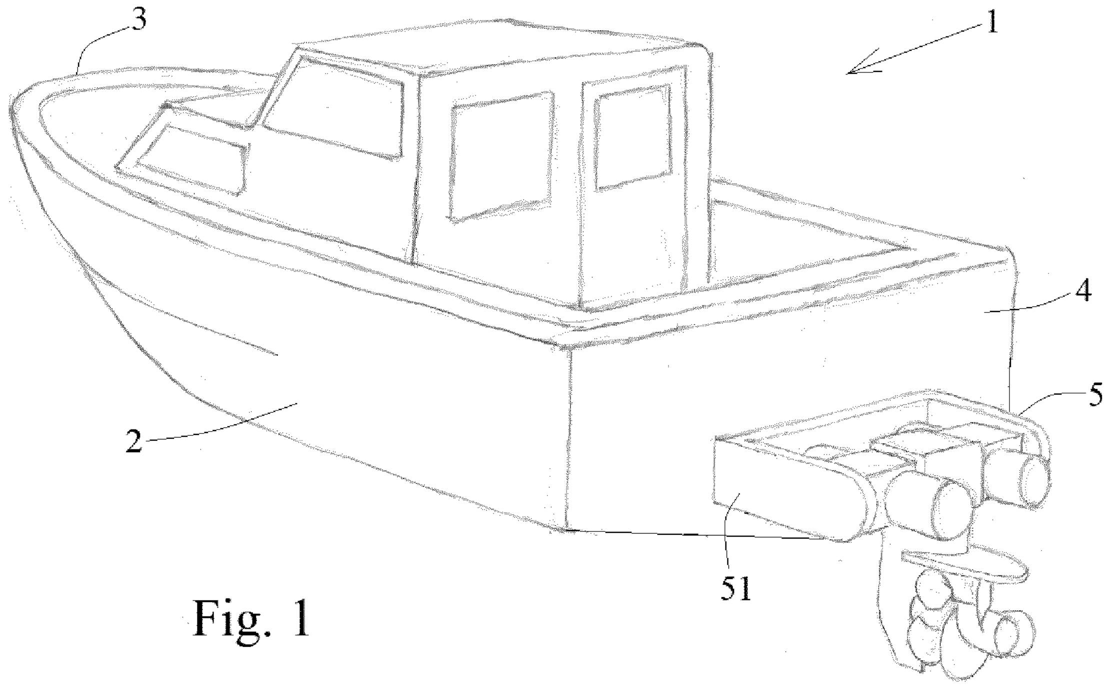


Fig. 1

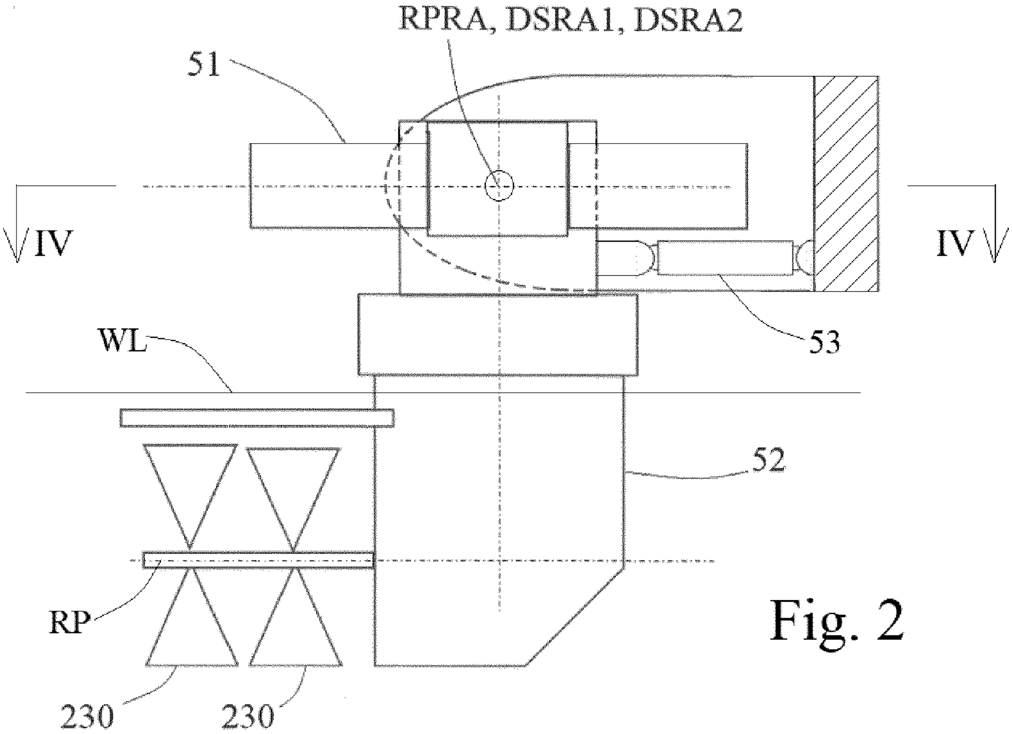


Fig. 2

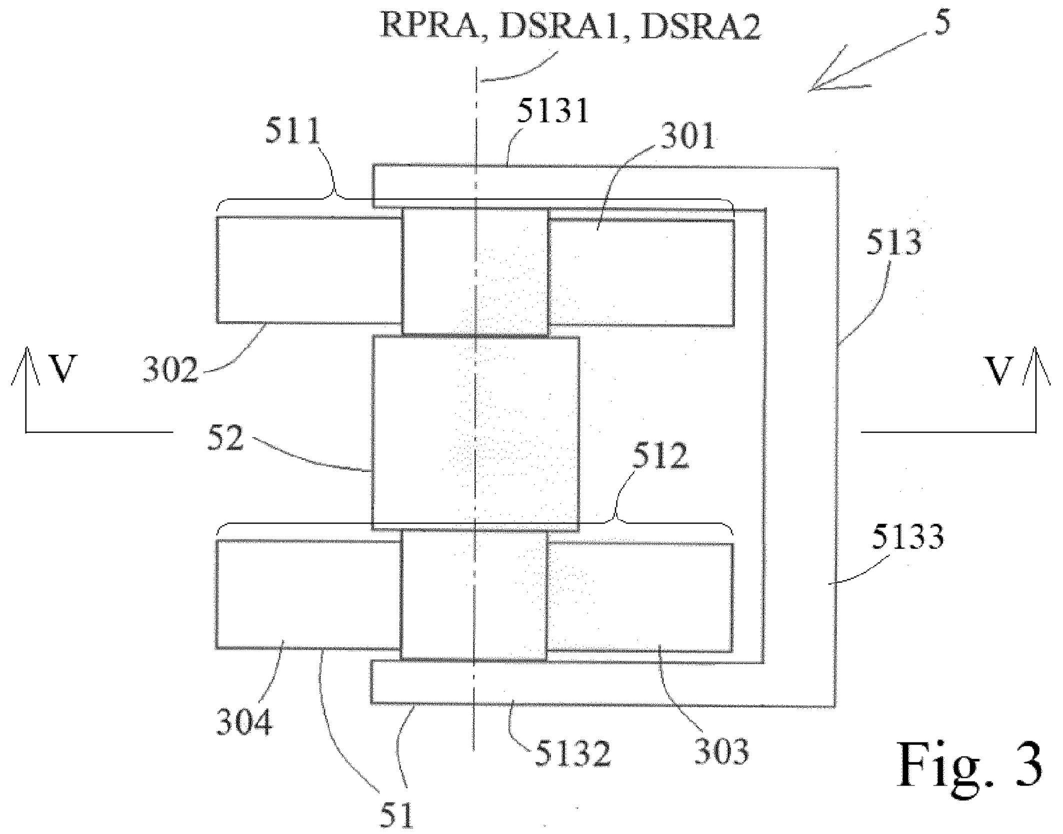
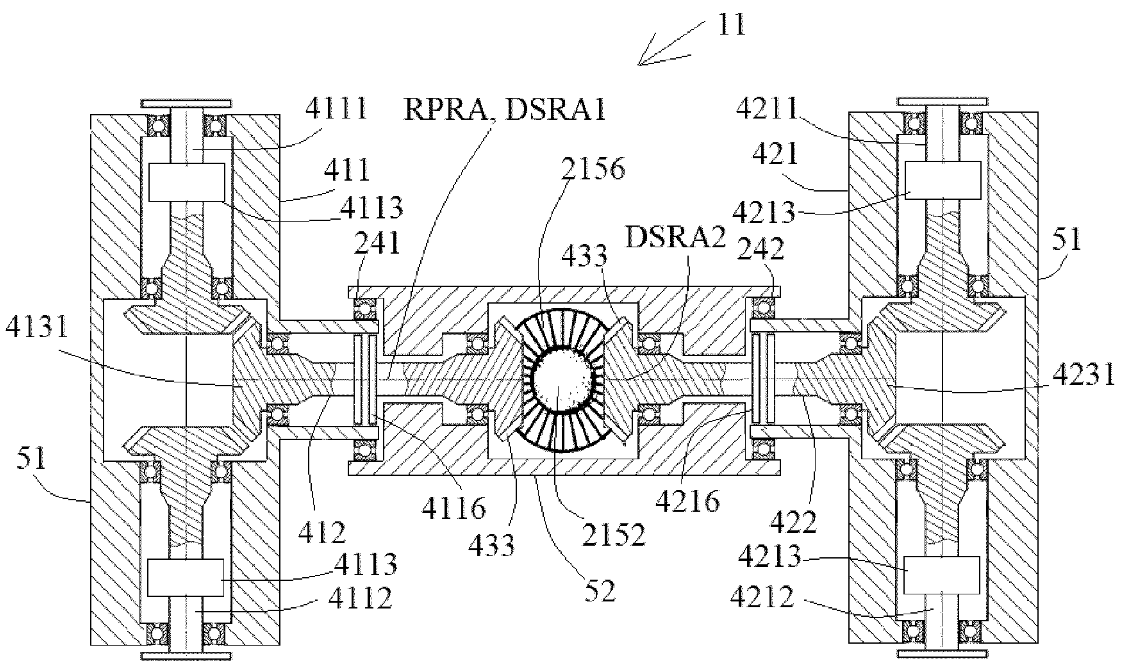

RPRA, DSRA1, DSRA2
5
5131
511
301
513
302
V
V
52
512
5133
304
5132
303
51

Fig. 3


11
4111
RPRA, DSRA1
4211
411
2156
421
4113
4213
241
433
DSRA2
242
51
4131
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412
4116
433
2152
4216
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4113
4112
52
4212

Fig. 4

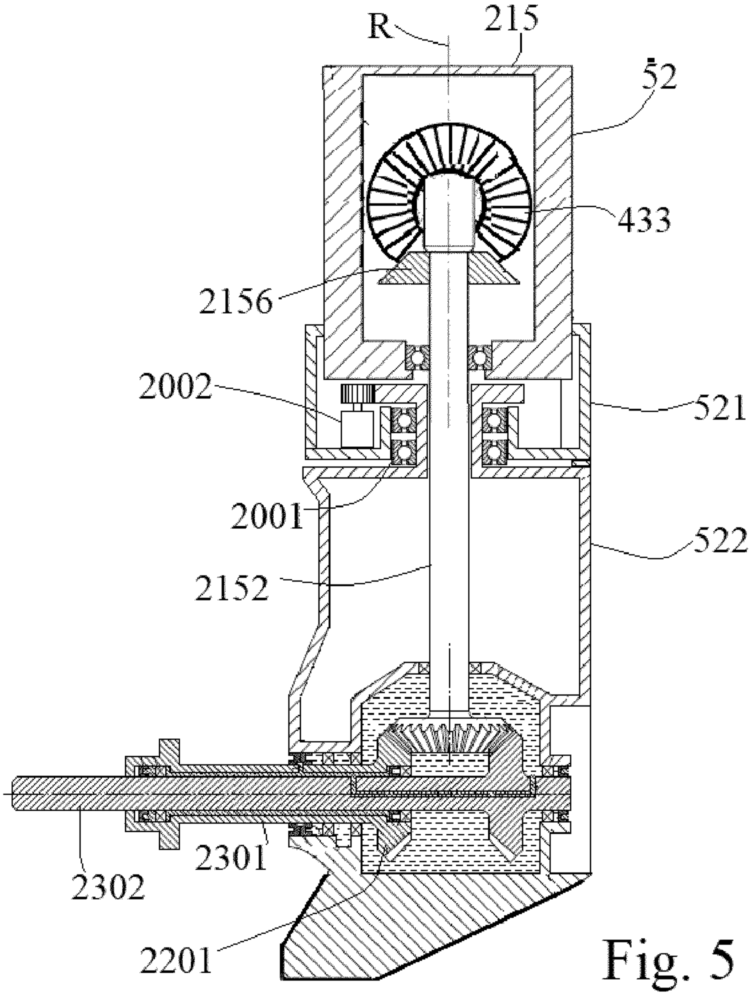

Fig. 5

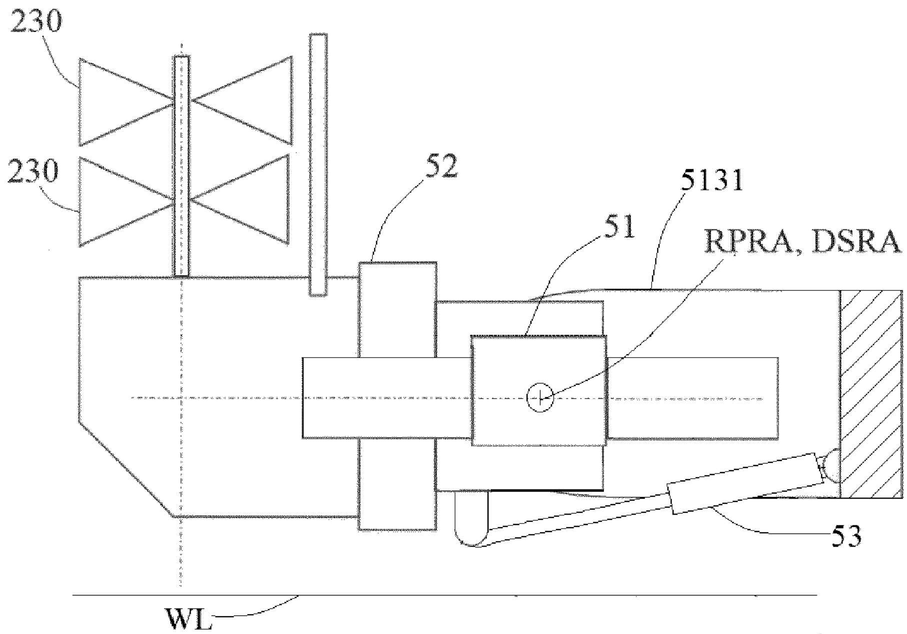
230
230
52
5131
51
RPRA, DSRA
53
WL

Fig. 6

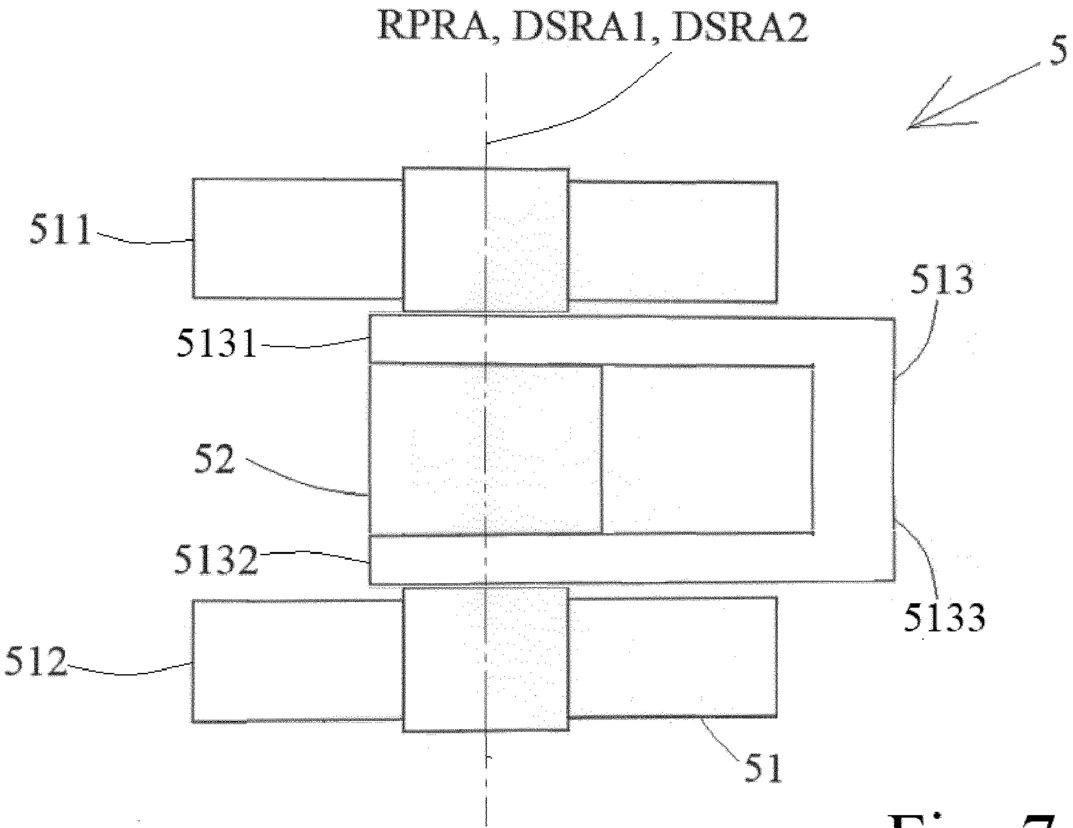
RPRA, DSRA1, DSRA2
5
511
513
5131
52
5132
5133
512
51

Fig. 7

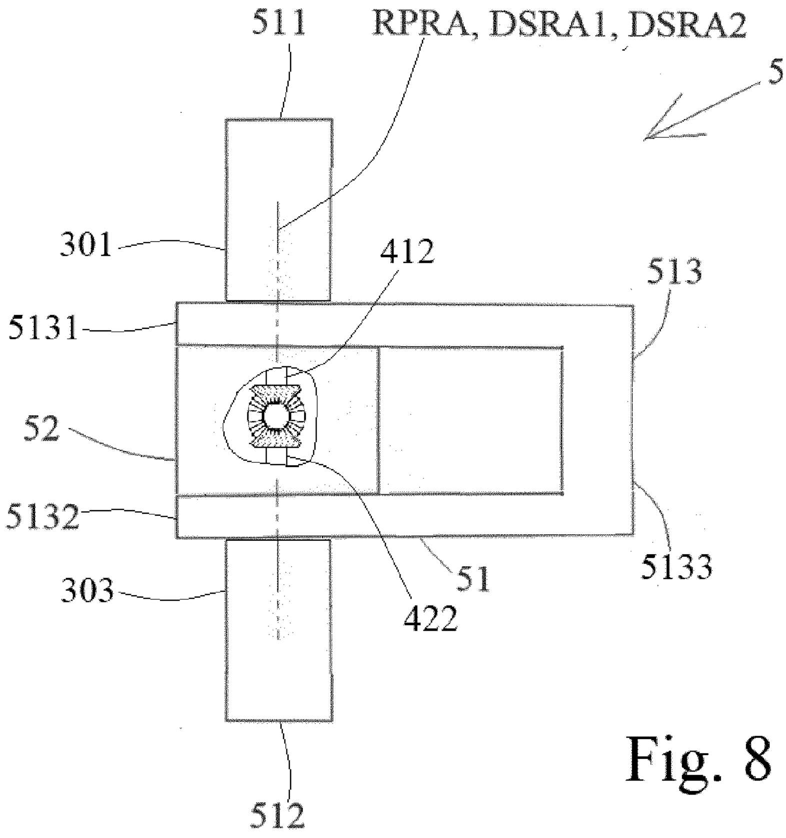
511
RPRA, DSRA1, DSRA2
5
301
412
513
5131
52
5132
303
51
422
5133
512

Fig. 8

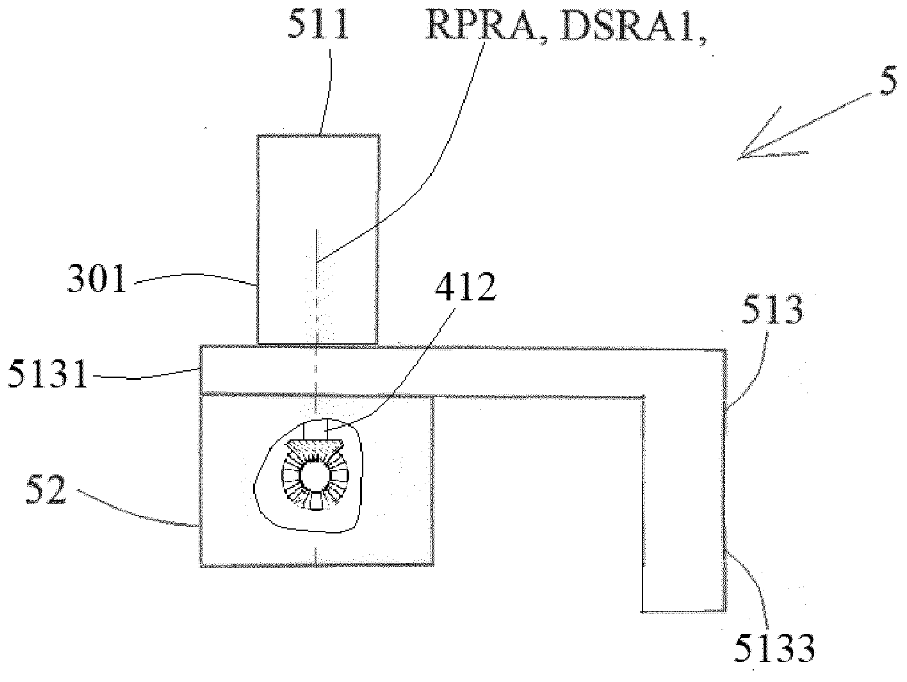
511
RPRA, DSRA1,
5
301
412
513
5131
52
5133

Fig. 9

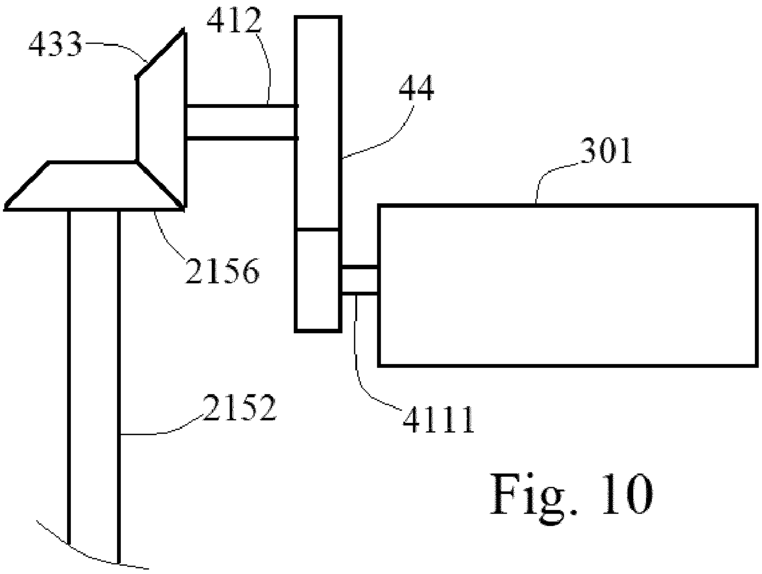
433
412
44
301
2156
2152
4111

Fig. 10

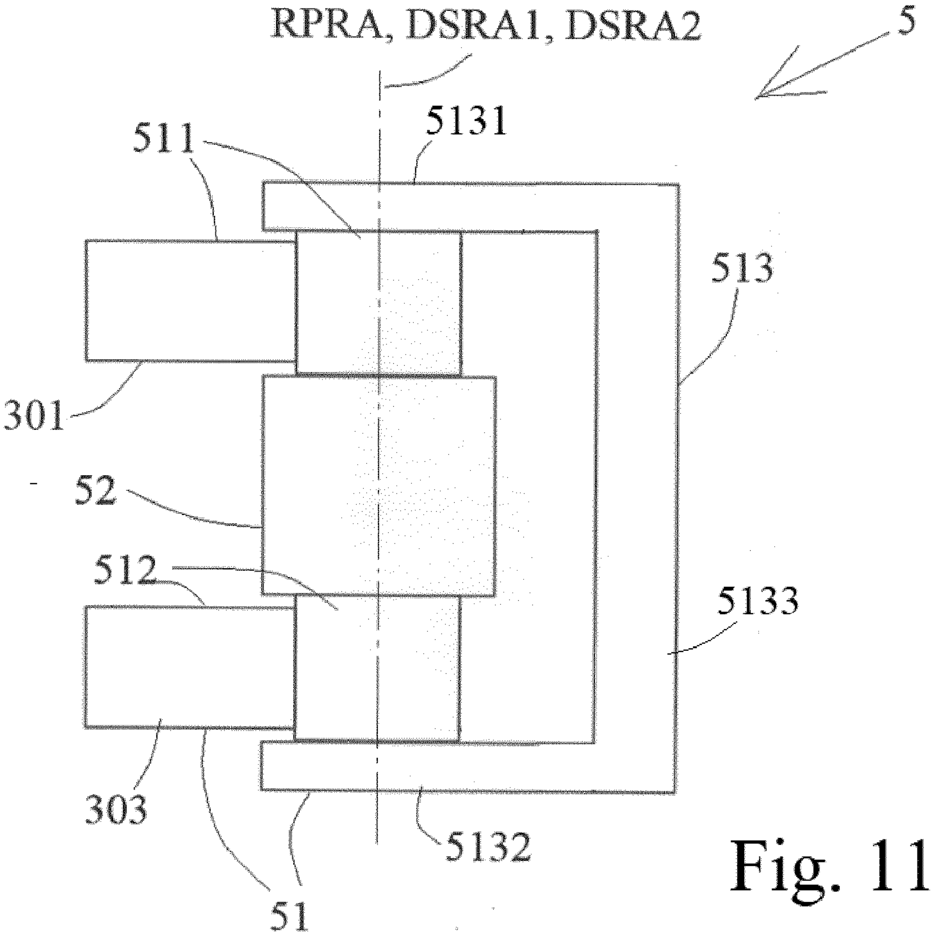
RPRA, DSRA1, DSRA2
5
511
5131
513
301
52
512
5133
303
5132
51

Fig. 11

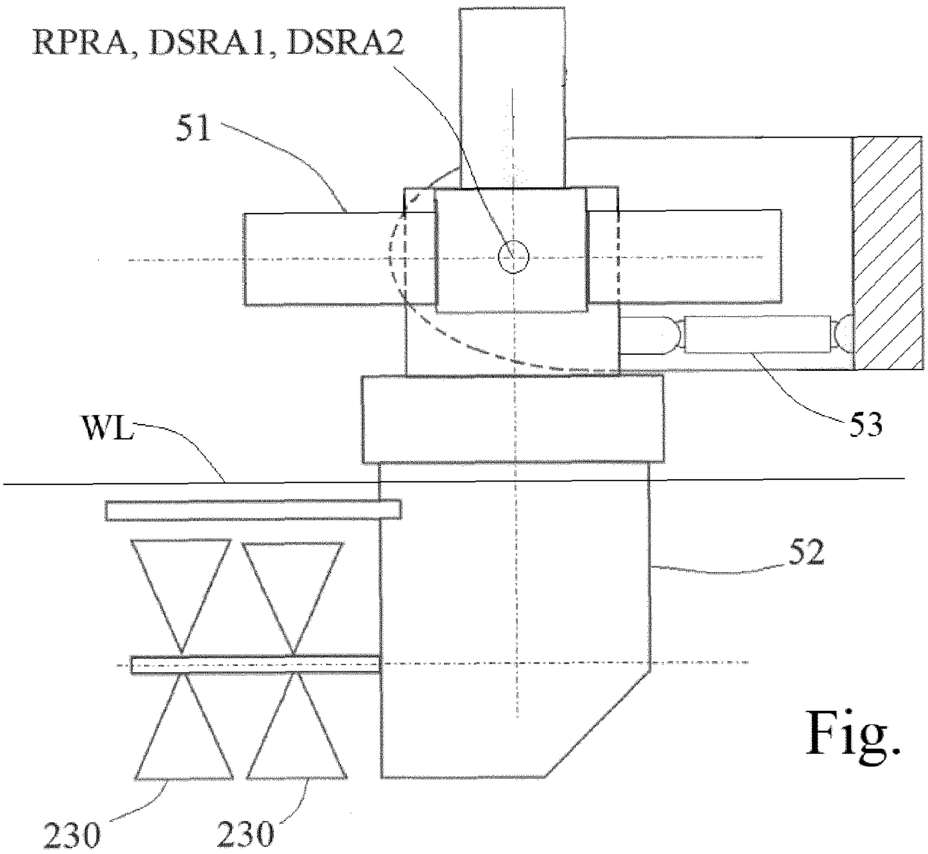

Fig. 12

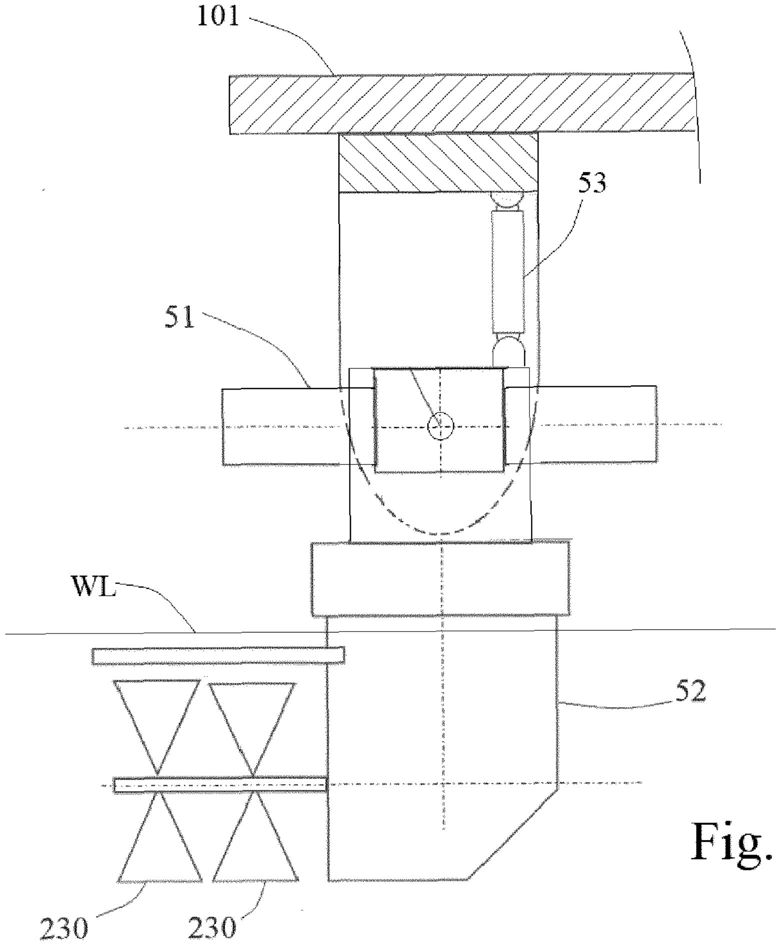

Fig. 13

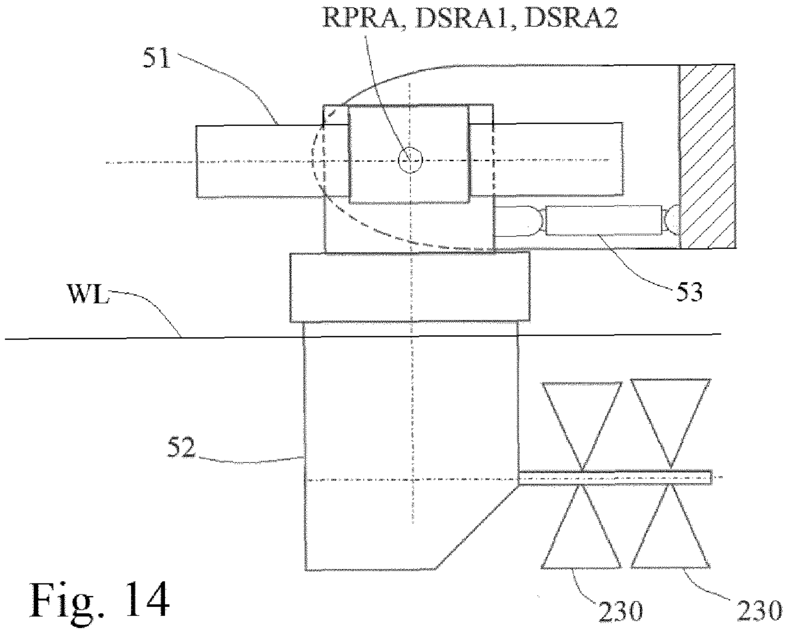

Fig. 14

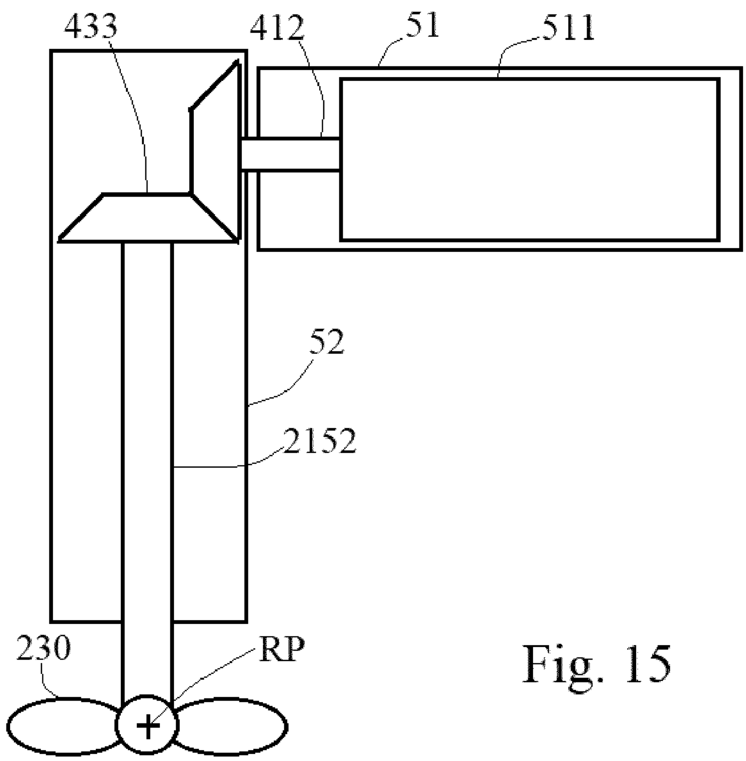

Fig. 15

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 4276

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 450 273 A2 (SUZUKI MOTOR CORP [JP]) 9 May 2012 (2012-05-09) * paragraph [0041] * * paragraph [0042] * * paragraph [0044] * -----	1-10, 12-19	INV. B63H20/00 B63H20/14 B63H21/17 B63H20/22
X	US 2010/248562 A1 (DAIKOKU KEISUKE [JP]) 30 September 2010 (2010-09-30) * paragraph [0024] - paragraph [0025] * * paragraph [0019] - paragraph [0023] * * paragraph [0091] * * figures 2-4, 17, 19-22, 25-29 * -----	1-19	

TECHNICAL FIELDS SEARCHED (IPC)

B63H

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	14 October 2022	Barré, Vincent

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 16 4276

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14-10-2022

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			US 2012115376 A1	10-05-2012
US 2010248562	A1	30-09-2010	NONE	

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