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(54) **Title:** TRANSMISSION DEVICE AND PROPULSION SYSTEM COMPRISING THE TRANSMISSION DEVICE

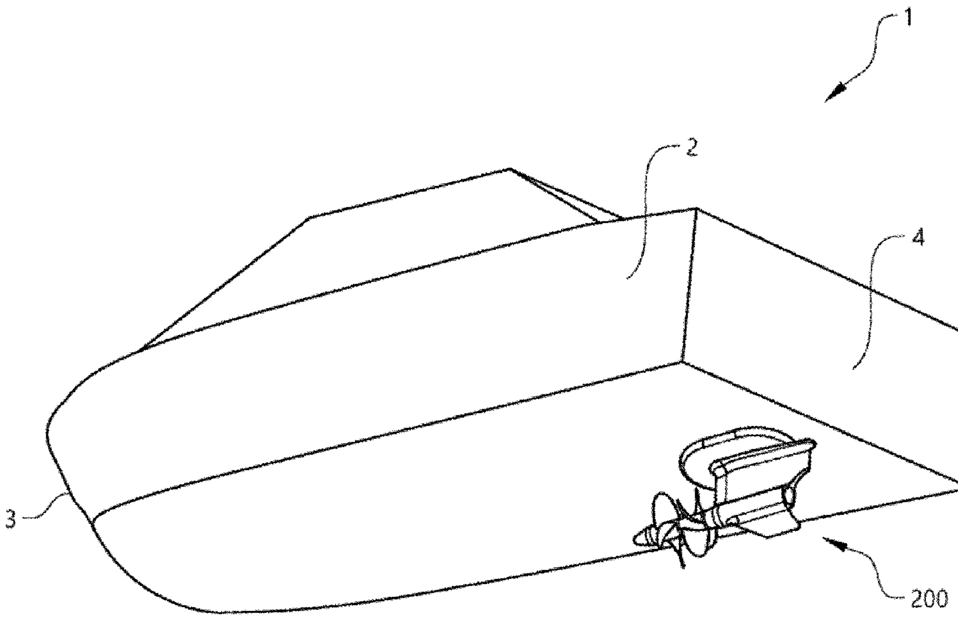

Fig. 5

(57) **Abstract:** Embodiments herein relate to a transmission device (100). The transmission device (100) comprises a first input gear (110a) intended to be connected to a first power unit and a second input gear (110b) intended to be connected to a second power unit, a first output gear (120a) and a second output gear (120b) and an output drive shaft (130). Each one of the first and second output gears (120a, 120b) is selectively connectably arranged to the output drive shaft (130). Each one of the input gears (110a, 110b) is arranged in simultaneous gear engagement with each one of the first and second output gears (120a, 20b). The output gears (120a, 120b) are adapted to rotate in opposite directions when the first and the second output gears (120a, 120b) are driven by one or more of the input gears (110a, 110b). Embodiments further relate to a marine propulsion system (200) comprising the transmission device (100).

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TRANSMISSION DEVICE AND PROPULSION SYSTEM COMPRISING THE TRANSMISSION DEVICE

TECHNICAL FIELD

Embodiments herein relate to a transmission device, especially for marine drives, and a marine propulsion system comprising the transmission device.

BACKGROUND

Marine propulsion systems, e.g. for motor boats, have typically been rather simple. A single combustion engine has usually been connected to a propeller via a transmission for selecting a forward gear or a reverse gear. However, due to harder environmental rules, the requirements on propulsion systems in regards to fuel consumption, emissions and noise steadily increases.

An effective way to reduce fuel consumption, emissions and noise of the propulsion systems is to provide hybrid drives, in which a plurality of power units are connected to the same propeller drive. The power units may be of different types, such as e.g. combustion engines, electric machines and/or combinations thereof.

Known solutions for connecting a plurality of power units to a common propeller drive are usually mechanically complex and comprise a large number of gear wheels for distributing the load from the power units, or comprise drive belts which have a low capability of power transfer. These solutions are therefore often heavy, space consuming, difficult to maintain, have a low efficiency and/or have high production costs.

SUMMARY

The embodiments herein aim to overcome the above mentioned problems relating to the connection of multiple power units to a marine transmission. The embodiments herein in particular aim to provide a transmission for marine use, which has a simple and compact construction and which is cost and power efficient.

This is achieved by means of a transmission device, especially for marine use. The transmission device comprises a first input gear intended to be connected to a first power unit and a second input gear intended to be connected to a second power unit.

The transmission device further comprises a first output gear, a second output gear and an output drive shaft. Each one of the first and second output gears is selectively connectably arranged to the output drive shaft. Each one of the first and the second input gears is arranged in simultaneous gear engagement with each one of the first and second output gears. The output gears being adapted to rotate in opposite directions when the first and the second output gears are driven by one or more of the input gears.

By providing two output gears that are selectively connectable with an output shaft and being arranged in simultaneous gear engagement with a plurality of input gears being connectable to a corresponding power unit, the number of gear wheels required to connect the power units to the transmission device can be reduced. Each power unit transfers its power to the output shaft over the same output gear. The reduction of the number of parts comprised in the transmission device also allows the size of the transmission device to be reduced. A reduction of the number of gear wheels in the transmission also has the benefit that the power losses are reduced, which makes the transmission device more efficient. Having two input gears in simultaneous gear engagement with the first and second output gears further has the benefit that the size of each power unit being connectable to the input gears can be reduced compared to a single power unit with the same combined power as the two smaller power units. The arrangement of the first and second output gears also allows further power units to be added by simply adding an additional input gear between the first and the second output gears, thereby the transmission device may be adapted to different use cases, such as e.g. electrification or hybridization.

Optionally, the transmission device may comprise a third input gear intended to be connected to a third power unit, the third input gear being arranged in simultaneous gear engagement with the first and second output gears. This has the benefit that an additional power unit can be connected to the transmission unit by only adding an additional input gear. Thereby the size of each power unit can be further reduced and/or the performance of a propulsion system may be increased.

Optionally, at least one of said input gears may comprise an input clutch adapted to selectively connect said input gear to its power unit. This has the benefit that the power units, when connected to the input gear can be selectively engaged or disengaged. When a high power is required, all of the available clutches may be engaged such that all available power units drive the output shaft. When a lower amount of power is required, one or more of the available clutches may be disengaged and the corresponding power units may be shut off to save fuel.

Optionally, said input clutch is such that it allows torque transfer from said power unit to said input gear but prevents torque transfer from said input gear to said power unit. Thereby a power unit which is running slower than the other one, e.g. due to malfunction or a lower range of speed, will automatically be disconnected from the transmission device. Thus, a slower power unit does never have to be driven by a faster one, which reduces the load on the faster power unit and thus reduces fuel consumption and wear of the transmission device and power units.

Optionally, said input clutch is a centrifugal clutch or an overrunning clutch. The centrifugal clutch and the overrunning clutch have the advantage that they automatically engage and/or disengage based on the rotational speed of the power unit connected to it.

Optionally, the axes of rotation of the input gears are arranged at an angle of substantially 360°/N from each other around the circumference of the first and the second output gears, where N is the number of input gears, such that an engagement position of the input gears are substantially uniformly distributed around the circumference of the first and the second output gears. This arrangement provides a reduction in reaction forces on the gears in the transmission device, which reduces the load on components such as e.g. gears, gear housings and/or bearings comprised in the transmission device.

Optionally, the first and the second output gears are arranged to engage the input gears at diametrically opposing sides of the input gears. This arrangement also provides a reduction in the reaction forces on the gears in the transmission device and allows the first and second output gears to rotate in opposite directions around the output drive shaft.

Optionally, each one of the input gears and the output gears is a bevel gear, conical gear and/or a hypoid gear. The bevel gears allow a smooth transmission with low noise emissions and allows the torque from the input shaft to be redirected in an angular direction, such as e.g. 90 degrees, towards the output drive shaft.

Optionally, each one of the input gears has a rotation axis, R_{in}, being substantially perpendicular to a rotation axis, R_{out}, of the first and the second output gears.

Optionally, the first output gear is drivingly connectable to the drive shaft via a first output clutch and the second output gear is drivingly connectable to the drive shaft via a second output clutch. The first and the second output clutch may be alternately engageable such that when the first output clutch is engaged, the first output gear drives the output drive shaft in a first direction and when the second output clutch is engaged, the second output gear drives the output drive shaft in a second direction, opposite to said first direction.

Optionally, each one of the first and second output clutches is a disc clutch, a cone clutch and/or a claw clutch.

Also disclosed is a marine propulsion system. The marine propulsion system comprises a first power unit, a second power unit, a propeller drive and the transmission device described above. The transmission device connects the power units to the propeller drive. The first power unit is connected to the first input gear of the transmission device and the second power unit is connected to the second input gear of the transmission device, such that each one of the power units can simultaneously drive the first and the second output gears. The output drive shaft of the transmission device being connected to said propeller drive. This allows for downsizing of the power units, since a plurality of smaller power units having a combined output as a bigger power unit can be connected to the output shaft when maximum power is desired. However, when the output shaft is driven with a reduced power requirement, one of the power units may be disengaged and shut off in order to reduce fuel consumption and emissions.

Optionally, when the transmission device comprises a third input gear, the propulsion system may comprise a third power unit connected to the third input gear of the transmission device. This allows for further adaption of power levels of the propulsion system and/or further hybridization of the propulsion system without having to make substantial modifications to the transmission device.

Optionally, each one of the power units comprises an electric motor, a combustion engine and/or a hydraulic motor. Thereby, the propulsion system may be hybridized and/or electrified which further may reduce emissions and fuel consumption of the propulsion system since the combustion engine may be used to a lesser extent. The power units may comprise, or be, of the same or of different types. In one example, at least one of the power units may comprise a combustion engine and at least a second of the power units may be an electrical motor, thereby making the propulsion system a hybrid propulsion system. At least one of the power units may also comprise both an electric motor and a combustion engine and may thus be a hybrid power unit in itself.

Optionally, the propeller drive comprises single or counter-rotating propellers.

Optionally, the propeller drive comprises a propulsion unit. Using a propulsion unit has the benefits that the maneuverability, onboard comfort, the performance, reliability and fuel efficiency of the propulsion system is increased. The propulsion unit is steerable and provides an immediate and precise reaction to driver commands. The propulsion unit also allows the propellers to be positioned well under the hull to eliminate air intrusion and cavitation and thus provides a more efficient propulsion.

The embodiments herein provide numerous benefits and advantages over existing solutions in that they provide a flexible and effective way to connect a plurality of power units to a common propeller drive. The proposed transmission device has a simple and compact mechanical construction and comprises a limited number of torque transferring parts, such as gears and bearings. The embodiments herein provide an improved means for transferring torque from the power units to an output drive shaft, which drive shaft may be connected to a propeller drive. By connecting the power unit using the first and second output gears the complexity of the transmission is reduced and a switching between forward and reverse mode can be performed in a fast and simple manner. The transmission device can furthermore be made compact, easy to service and cost efficient to produce, due to its reduced number of gears.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, embodiments herein will be described in greater detail by way of example only with reference to attached drawings, in which

Fig. 1 is a schematic illustration of the transmission device according to embodiments herein, seen from a direction perpendicular to an output drive shaft;

Fig. 2 is a schematic illustration of the transmission device of figure 1, seen in a direction of the output drive shaft;

Fig. 3 is a schematic illustration of the transmission device according to further embodiment herein, seen in the direction of the output drive shaft;

Fig. 4 is a schematic illustration of a marine propulsion system comprising the transmission device according to the embodiments herein;

Fig. 5 is a schematic illustration of a marine vessel comprising the marine propulsion system according to embodiments herein.

Still other objects and features of embodiments herein will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits hereof, for which reference should be made to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

DETAILED DESCRIPTION

Fig. 1 shows the transmission device 100 according to embodiments herein. The transmission device 100 comprises a first input gear 110a intended to be connected to a first power unit and a second input gear 110b intended to be connected to a second power unit. The transmission device 100 further comprises a first output gear 120a, a second output gear 120b and an output drive shaft 130. The first and the second output gears 120a, 120b are each selectively connectably arranged to the output drive shaft 130. Selectively connectably shall herein be interpreted as the output gears 120a, 120b being freely rotatably arranged around the output drive shaft 130, and arranged such that a user and/or a control unit may connect or disconnect the first and/or second output gear 120a, 120b to/from the output drive shaft 130 based on a desired mode of operation. The first output gear 120a may e.g. be drivingly connectable to the drive shaft 130 via a first output clutch 140a and the second output gear 120b may be drivingly connectable to the drive shaft 130 via a second output clutch 140b. The first and the second output clutch 140a, 140b may be alternately engageable, such that when the first output clutch 140a is engaged, the first output gear 120a drives the output drive shaft 130 in a first direction and when the second output clutch 140b is engaged, the second output gear 120b drives the output drive shaft 130 in a second direction, opposite to said first direction. The first direction may e.g. be a forward direction and the second direction may be a backward direction or vice versa. Each one of the input gears, such as e.g. the first and the second input gears 110a, 110b, is arranged in simultaneous gear engagement with each one of the first and second output gears 120a, 120b, the output gears 120a, 120b being adapted to rotate in opposite directions when the first and the second output gears 120a, 120b are driven by one or more of the input gears 110a, 110b.

By selecting which of the first and second output clutches 140a, 140b is disengaged and which is engaged, the first and/or the second output gears can be connected to or released from connection with the drive shaft 130, such that the drive shaft 130 is driven in the first or the second direction. Each one of the first and the second output clutches 140a, 140b may be a mechanical clutch, such as e.g. a disc clutch, such as e.g. a dry or a wet disc clutch, a cone clutch and/or a claw clutch. The first and/or the second output clutches 140a, 140b may however also be an electromagnetic clutch. This shall herein be interpreted as the first and the second output clutch 140a, 140b being of the same type or of different types, selected from the group comprising the disc clutch, the cone clutch, the claw clutch and/or the electromagnetic clutch.

The first and the second output clutches 140a, 140b may be individually controlled. The first and the second output clutches 140a, 140b may however also be mechanically connected to each other, such that when the first clutch is engaged the second clutch is disengaged and vice versa. This may e.g. be achieved by mounting a first clutch surface of each one of the first and second output clutches 140a, 140b on a tubular sleeve being slidingly arranged on the drive shaft 130 along the rotation axis R_{out} of the drive shaft 130. The tubular sleeve may be drivingly connectable to the drive shaft 130, e.g. via longitudinal splines arranged on the inner circumference of the tubular sleeve and on the outer circumference of the drive shaft 130. When the first output gear 120a is to be engaged, the tubular sleeve may be displaced along the rotation axis R_{out} towards the first output gear 120a, such that the first clutch surface of the first output clutch 140a engages with a second surface of the first output clutch 140a and engages the first output clutch 140a. By engaging the first output clutch 140a the first output gear 120a becomes drivingly connected to the drive shaft 130. When the second output gear 120b is to be engaged, the tubular sleeve may be displaced along the rotation axis R_{out} towards the second output gear 120b, such that the first clutch surface of the second output clutch 140b engages with a second surface of the second output clutch 140b and engages the second output clutch 140b. By engaging the second output clutch 140b the second output gear 120b becomes drivingly connected to the drive shaft 130. In one embodiment, the output clutches 140a, 140b may e.g. be a cone clutch, a first conical surface of the first output clutch 140a may be arranged on a first longitudinal end of the tubular sleeve and a first conical surface of the second output clutch 140b may be arranged on a second longitudinal end of the tubular sleeve, such that the first conical surfaces may respectively engage their corresponding second conical surfaces of the first and second output clutches 140a, 140b when the tubular sleeve is displaced towards the respective output gear 120a, 120b. Although fig. 1 discloses the output clutches 140a, 140b being arranged on a side of the output gears 120a, 120b facing away from the other output gear 120b, 120a, the first and the second output clutches 140a, 140b may also be arranged in between the output gears 120a, 120b on a side of the output gears 120a, 120b facing towards the other output gear 120b, 120a.

In order to make a shifting from a forward drive to a backward drive smoother, the clutch may be combined with a synchronization arrangement.

In some embodiments, the transmission device 100 may comprise a third input gear (not shown in fig. 1 intended to be connected to a third power unit, the third input gear being arranged in simultaneous gear engagement with the first and second output gears 120a, 120b. The transmission device 100 may also comprise more than three input gears, such as e.g. a fourth input gear, wherein each input gear may be connectable to a respective power unit. The embodiments described in the following relating to the first and second input gears 110a, 110b are also applicable to any further input gears, such as e.g. the third input gear 110c shown in fig. 3.

The power units may be directly connected to the input gears, e.g. via a drive shaft. At least one of, preferably each one of, said input gears 110a, 110bmay comprise or may be connected to an input clutch 111 adapted to selectively connect said input gear 110a, 110b to a respective power unit. Said input clutch 111 may e.g. be such that it allows torque transfer from said power unit to said input gear 110a, 110b, but prevents torque transfer from said input gear 110a, 110b to said power unit. The input clutch 111 allowing torque transfer from said power unit to said input gear 110a, 110b, but preventing torque transfer from said input gear 110a, 110b to said power unit may also be referred to as an overrunning clutch. The one or more input clutch(es) 111 may e.g. be selected from the group comprising centrifugal clutch, hydraulic clutch, overrunning clutch, a disc clutch, a cone clutch and/or a claw clutch. The input clutch 111 may e.g. be arranged between a first drive shaft portion connected to the input gear 110a, 110b and a second drive shaft portion connectable to the respective power unit. The one or more input clutch(es) 111 allows one or more of the power units to be disconnected from its respective input gear while the remaining one or more of the power units stay connected to their respective input gears and drive the first and the second output gears 120a, 120b. Thus, the input clutch(es) 111 allows an individual engagement and/or disengagement of the power units from the transmission device 100. Different types of input clutches may be comprised in or may be connected to each of the input gears.

The input gears 110a, 110b each have an axis of rotation, herein also referred to as a rotation axis R_{in}. The rotation axis R_{in} may be arranged, at least substantially, perpendicular to a rotation axis R_{out} of the drive shaft 130 and/or the first and the second output gears 120a, 120b. The first and the second output gears 120a, 120b may have the same rotation axis as the drive shaft 130 and may thus be referred to as being concentrically arranged with the drive shaft 130. The axes of rotation R_{in} of the input gears 110a, 110b may be evenly or non-evenly distributed around the circumference of the first and the second output gears. When the axes of rotation R_{in} of the input gears 110a, 110b are evenly distributed, they may be arranged at an angle of substantially 360°/N from each other around the circumference of the first and the second output gears 120a, 120b, where N is the number of input gears 110a, 110b. Thereby an engagement position of the input gears 110a, 110b are substantially uniformly distributed around the circumference of the first and the second output gears 120a, 120b. The axes of rotation R_{in} of the input gears 110a, 110b being arranged at an angle of substantially 360°/N from each other shall herein be interpreted as being arranged at 360°/N or as close to 360°/N as allowable by the number of gear teeth of the output gears and the number of input gears. Due to the number of gear teeth sometimes not being evenly dividable by N, an angular deviation from 360°/N may occur. Hence, if the transmission device 100 comprises two input gears they may be arranged at an angle of 360°/2=180° from each other, if the transmission device 100 comprises three input gears they may be arranged at an angle of 360°/3=120° from each other, if the transmission device 100 comprises four input gears they may be arranged at an angle of 360°/4=90° from each other, etc. Thereby, reduced reaction forces on the transmission device 100 may be achieved. In the examples described above it is assumed that the number of gear teeth of the output gears 120a, 120b is evenly dividable by the number of input gears 110a, 110b. It shall however be understood that some deviation from the angles stated may occur due to the number of gear teeth of the output gears 120a, 120b not being evenly dividable by the number of input gears 110a, 110b.

The axes of rotation R_{in} of the input gears 110a, 110b may in some embodiments also be non-evenly distributed, such that they may be arranged at an angle of 360°/N±M° from each other, where M is in the range of 0° to 90°.
The first and the second output gears 120a, 120b may be arranged to engage the input gears 110a, 110b at diametrically opposing sides of the input gears 110a and 110b. Thereby the teeth of the first output gear 120a and the teeth of the second output gear 120b are arranged so that they face each other and will engage the plurality of input gears 110a, 110b at diametrically opposing sides of the input gears 110a, 110b and 110c, such that the input gears 110a, 110b will drive the first output gear 120a in a first direction around the rotation axis R_{out} of the drive shaft 130 and will drive the second output gear 120b in a second direction around the rotation axis R_{out} of the drive shaft 130. Diametrically opposite sides shall herein be interpreted as the contact points between the first and the second output gears on each of the input gears 110a, 110b being arranged substantially at a 180° angle from each other around the circumference of the input gear 110a, 110b. By engaging either the first or the second output clutch 140a, 140b the drive shaft will be connected to either one of the output gears 120a, 120b. The drive shaft 130 may thus be rotated in either the first or the second direction around its rotation axis R_{out} without having to change the direction of rotation of the input gears 110a, 110b, depending on which of the output clutches 140a, 140b that is engaged. Each one of the input gears and/or the output gears may e.g. be a bevel gear, a conical gear and/or a hypoid gear. However, due to the number of gear teeth of the input and/or output gears sometimes not being evenly dividable by 2, some angular deviation from the 180° angle may occur. Substantially at a 180° angle shall thus be interpreted as 180° or as close to 180° as allowable by the number of gear teeth of the output gears and the number of input gears.

Fig. 2 shows the transmission device 100 seen in a direction of the rotation axis R_{out} of the output shaft 130, according to an example herein. In the example disclosed in fig. 2, the transmission device 100 comprises a first input gear 110a and a second input gear 110b arranged in line with each other, which may also be referred to as the rotation axes R_{in} of the input gears 110a, 110b being concentrically arranged. The first and the second input gears 110a, 110b engage the output gears 120a, 120b on diametrically opposite sides of the output gears 120a, 120b. The rotation axes R_{in} may be arranged, at least substantially, perpendicular to a rotation axis R_{out} of the drive shaft 130 and/or the first and the second output gears 120a, 120b. Substantially perpendicular shall herein be interpreted as being arranged at an angle of 90°±10°. The rotation axes R_{in} may be arranged at an angle of 90° to the rotation axis R_{out} of the drive shaft 130, however some deviation from 90° may be present due to the diametrical pitch of the output gears 120a, 120b. The first and the second output gears have the same rotation axis R_{out} as the drive shaft 130 and may thus be referred to as being concentrically arranged with the drive shaft 130. Since the transmission device 100 according to the embodiment shown in fig. 2 comprises two input gears 110a, 110b they are arranged at an angle of 360°/2=180° from each other. Thereby, reduced reaction forces on the gears, the gear housing and/or the bearings of the transmission device 100 may be achieved. According to the example shown in herein, the input gears 110a, 110b each comprise an input clutch for selectively connecting the input gears 110a, 110b to a respective power unit (not shown in fig. 2). The input clutches 111 may be of the types described for the input clutch in relation to fig. 1.

Fig. 3 shows the transmission device 100 seen in the direction of the rotation axis R_{out} of the output shaft 130, according to a further example herein. In the example disclosed in fig. 3, the transmission device 100 comprises a first input gear 110a, a second input gear 110b and a third input gear 110c arranged at an angle of 360°/3=120° from each other. The first, second and third input gears 110a, 110b, 110c engage the output gears 120a, 120b on diametrically opposite sides of the output gears 120a, 120b. The rotation axes R_{in} may be arranged, at least substantially, perpendicular to the rotation axis R_{out} of the drive shaft 130 and/or the first and the second output gears 120a, 120b. Thereby, the reduced reaction forces within the transmission device 100 may be maintained with the increased number of input gears. According to the example shown in herein, the input gears 110a, 110b, 110c each comprise an input clutch 111 for selectively connecting the input gears 110a, 110b, 110c to a respective power unit (not shown in fig. 3). The input clutches 111 may be of the types described for the input clutch in relation to fig. 1.

Fig. 4 shows a marine propulsion system 200 according to embodiments herein. The marine propulsion system comprises a first power unit 210a, a second power unit 210b, a propeller drive 220 and the transmission device 100. The transmission device 100 connects the first and the second power units 210a, 210b to the propeller drive 220. The first power unit 210a is connected to the first input gear 110a of the transmission device 100 and the second power unit 210b is connected to the second input gear 110b of the transmission device 100, such that each one of the power units 210a, 210b can simultaneously drive the first and the second output gears 120a, 120b. The output drive shaft 130 of the transmission device 100 is connected to said propeller drive 220. Thereby the propeller drive 220 can be driven by the first and/or the second power units. The direction of rotation of the propeller drive 220 may be selected by selectively engaging the first or the second output clutch 120a, 120b.

When the transmission device 100 comprises a third input gear 110c, the propulsion system may further comprise a third power unit connected to the third input gear 110c of the transmission device 100. Correspondingly, if the transmission device 100 comprises more than three input gears 110, the propulsion system 200 may comprise an equal number of power units as the number of input gears 110 comprised in the transmission device 100.

Each one of the power units 210a, 210b may comprise or may be an electric motor, which may also be referred to as an electric machine, a combustion engine, an electric generator, a hydraulic motor and/or a hydraulic pump. The power units 210a, 210b may comprise, or be, of the same or of different types. In one embodiment, such as the embodiment shown in fig. 4, at least one of the power units 210a, 210b may be a combustion engine and at least a second of the power units 210a, 210b may be an electrical motor, thereby making the propulsion system 200 a hybrid propulsion system 200. In the embodiment shown in fig. 4 the first power unit 210a is the combustion engine and the second power unit 210b is the electric motor. At least one of the power units 210a, 210b may also comprise both an electric motor and a combustion engine and may thus be a hybrid power unit in itself. In other words the power units may be selected and combined independently of each other The same applies to any additional power units connected to the transmission device, such as e.g. a third power unit connected to the third input gear 110c as described in relation to fig. 3.

However, in a further embodiment, all of the power units comprised in the propulsion system, such as e.g. the power units 210a, 210b may be combustion engines. According to yet a further embodiment all of the power units 210a, 210b may be electrical motors.

Each power unit, such as the power units 210a, 210b may thus be selected from the group of combustion engine, electric motor or hybrid power unit comprising both an electric motor and a combustion engine irrespectively of the other power units comprised in the marine propulsion system 200.

The power units, such as e.g. the power units 210a, 210b may be directly connected to their respective input gears 110a, 110b, 110c, e.g. by means of an elastic coupling, or may be disengageably connectable to their respective input gears 110a, 110b, 110c, e.g. by means of a disc clutch, such as e.g. a dry or a wet plate clutch, a centrifugal clutch, an overrunning clutch and/or an electromagnetic clutch.

Using a centrifugal clutch or an overrunning clutch for connecting the power units, such as e.g. the power units 210a, 210b to their respective input gears, such as e.g. the input gears 110a, 110b, has the benefit that the engagement and disengagement of the power units 210 can be performed in a simple manner, since the clutches will automatically disengage once the rotational speed of the corresponding power unit is below the rotational speed of the input gear. This further has the benefit that, in case of a failure of one of the power units, such as e.g. the power unit 210a, such as the one or more remaining power units, such as e.g. the power unit 210b is not forced to drive the failed power unit. This of course also applies if the rotational speed of one or more of the power units, such as e.g. the power unit 210a is intentionally reduced.

However, if the clutch connects an electric motor to one of the input gears 110a, 110b, 110c, it might instead be beneficial to use a clutch which does not automatically disengage when the rotational speed of the electric motor is below the rotational speed of the input gear 110a, 110b, 110c. By keeping the clutch engaged the electric motor can, when it is driven by the one or more further power units 210a, 210b, be used as a generator for charging or recharging one or more batteries.

The propeller drive 220 may comprise one or more propellers. The propeller(s) may be arranged in either a pulling or pushing configuration. Pulling configuration shall herein be interpreted as being mounted in a forward facing direction when mounted on a marine vessel, while pushing configuration shall be interpreted as being mounted in a rearward facing direction when mounted on a marine vessel. Having counter-rotating propellers reduce vibrations of the propulsion system. By having propellers in a pulling configuration, the propellers can work in undisturbed water which increases the performance of the propulsion system 200. The propeller drive 220 may comprise a second transmission device (not shown) arranged to transfer the rotation of the output shaft 130 towards the one or more propellers. The second transmission device (not shown) may be arranged substantially outside of a hull of a marine vessel when the propulsion system 200 is arranged on the marine vessel. The second transmission device (not shown) may comprise at least one prop shaft for driving the propeller, a gear, such as an angular gear, configured to transfer the rotation of the output shaft 130 towards the propeller and may be rotatably arranged in regards to the hull of the marine vessel to provide steering capability.

The propeller drive 220 may further comprise a propulsion unit. The propulsion unit may comprise a fixed pitch propeller mounted on a steerable gondola, which gondola is arranged to rotate the propeller around a vertical axis, such as e.g. the rotation axis R_{out}. Using a propulsion unit has the benefits that the maneuverability, onboard comfort, the performance, reliability and fuel efficiency of the propulsion system is increased. Due to the layout of the propulsion unit installation the size of an engine compartment in the marine vessel 1 may be reduced, creating considerably more usable space onboard the marine vessel 1. The steerable propulsion units provide an immediate and precise reaction to driver commands. The propulsion unit also allows the propellers to be positioned well under the hull to eliminate air intrusion and cavitation.

Fig. 5 shows an overview of a marine vessel 1, such as e.g. a boat or a ship, according to some embodiments herein. The marine vessel 1 comprises a hull 2 having a forward facing bow 3 and a backward facing stern 4. The marine vessel 1 further comprises the marine propulsion system 200 according to the embodiments described herein mounted in the hull 2 of the marine vessel 1.

CLAIMS

1. A transmission device (100), especially for marine use, comprising
   a first input gear (110a) intended to be connected to a first power unit and a second input gear (110b) intended to be connected to a second power unit,
   a first output gear (120a) and a second output gear (120b) and
   an output drive shaft (130),

   each one of the first and second output gears (120a, 120b) being selectively connectably arranged to the output drive shaft (130),
   each one of the first and the second input gears (110a, 110b) being arranged in simultaneous gear engagement with each one of the first and second output gears (120a, 120b),
   the output gears (120a, 120b) being adapted to rotate in opposite directions when the first and the second output gears (120a, 120b) are driven by one or more of the input gears (110a, 110b).

2. The transmission device (100) according to claim 1, wherein the transmission device (100) comprises a third input gear (110c) intended to be connected to a third power unit, the third input gear (110c) being arranged in simultaneous gear engagement with the first and second output gears (120a, 120b).

3. The transmission device (100) according to any of the previous claims, wherein at least one of said input gears (110a, 110b, 110c) comprises an input clutch (111) adapted to selectively connect said input gear (110a, 110b, 110c) to its power unit.

4. The transmission device (100) according to claim 3, wherein said input clutch is such that it allows torque transfer from said power unit to said input gear (110a, 110b, 110c) but prevents torque transfer from said input gear (110a, 110b, 110c) to said power unit.

5. The transmission device (100) according to claim 3 or 4, wherein said at least one input clutch (111) is a centrifugal clutch, an overrunning clutch, a disc clutch, a cone clutch, a claw clutch and/or a magnetic clutch.

6. The transmission device (100) according to any of the previous claims, wherein the axes of rotation of the input gears (110a, 110b, 110c) are arranged at an angle of

substantially 360°/N from each other around the circumference of the first and the second output gears (120a, 120b), where N is the number of input gears (110a, 110b, 110c), such that an engagement position of the input gears (110a, 110b, 110c) are substantially uniformly distributed around the circumference of the first and the second output gears (120a, 120b).

7. The transmission device (100) according to any of the previous claims, wherein the first and the second output gears (120a, 120b) are arranged to engage the input gears (110a, 110b) at diametrically opposing sides of the input gears (110a, 110b, 110c).

8. The transmission device (100) according to any of the previous claims, wherein each one of the input gears and the output gears is a bevel gear, conical gears and/or a hypoid gear.

9. The transmission device (100) according to any of the previous claims, wherein each one of the input gears (110a, 110b, 110c) has a rotation axis (R_{in}) being substantially perpendicular to a rotation axis (R_{out}) of the first and the second output gears (120a, 120b).

10. The transmission device (100) according to any of the previous claims, wherein the first output gear (120a) is drivingly connectable to the drive shaft (130) via a first output clutch (140a) and the second output gear (120b) is drivingly connectable to the drive shaft (130) via a second output clutch (140b),

the first and the second output clutch being alternately engageable such that when the first output clutch (140a) is engaged, the first output gear (120a) drives the output drive shaft (130) in a first direction and when the second output clutch (140b) is engaged, the second output gear (120b) drives the output drive shaft (130) in a second direction, opposite to said first direction.

11. The transmission device (100) according to claim 10, wherein each one of the first and the second output clutches (140a, 140b) is a disc clutch, a cone clutch, a magnetic clutch and/or a claw clutch.

12. A marine propulsion system (200) comprising a first power unit (210a), a second power unit (210b), a propeller drive (220) and the transmission device (100)

according to any of the claims 1 to 11 connecting the power units (210a, 210b) to the propeller drive (220), wherein the first power unit (210a) is connected to the first input gear (110a) of the transmission device (100) and the second power unit (210b) is connected to the second input gear (110b) of the transmission device (100), such that each one of the power units (210a, 210b) can simultaneously drive the first and the second output gears (120a, 120b), the output drive shaft (130) of the transmission device (100) being connected to said propeller drive (220).

13. The marine propulsion system (200) according to claim 12, when dependent on claim 2, wherein the propulsion system comprises a third power unit (210c) connected to the third gear (110c) of the transmission device (100).

14. The marine propulsion system (200) according to any of the claims 12 or 13, wherein each one of the power units (210a, 210b, 210c) comprises an electric motor, a combustion engine and/or a hydraulic motor.

15. The marine propulsion system (200) according to any of the claims 12 to 14, wherein the propeller drive (220) comprises single or counter-rotating propellers.

16. The marine propulsion system (200) according to any of the claims 12 to 15, wherein the propeller drive (220) comprises a propulsion unit.

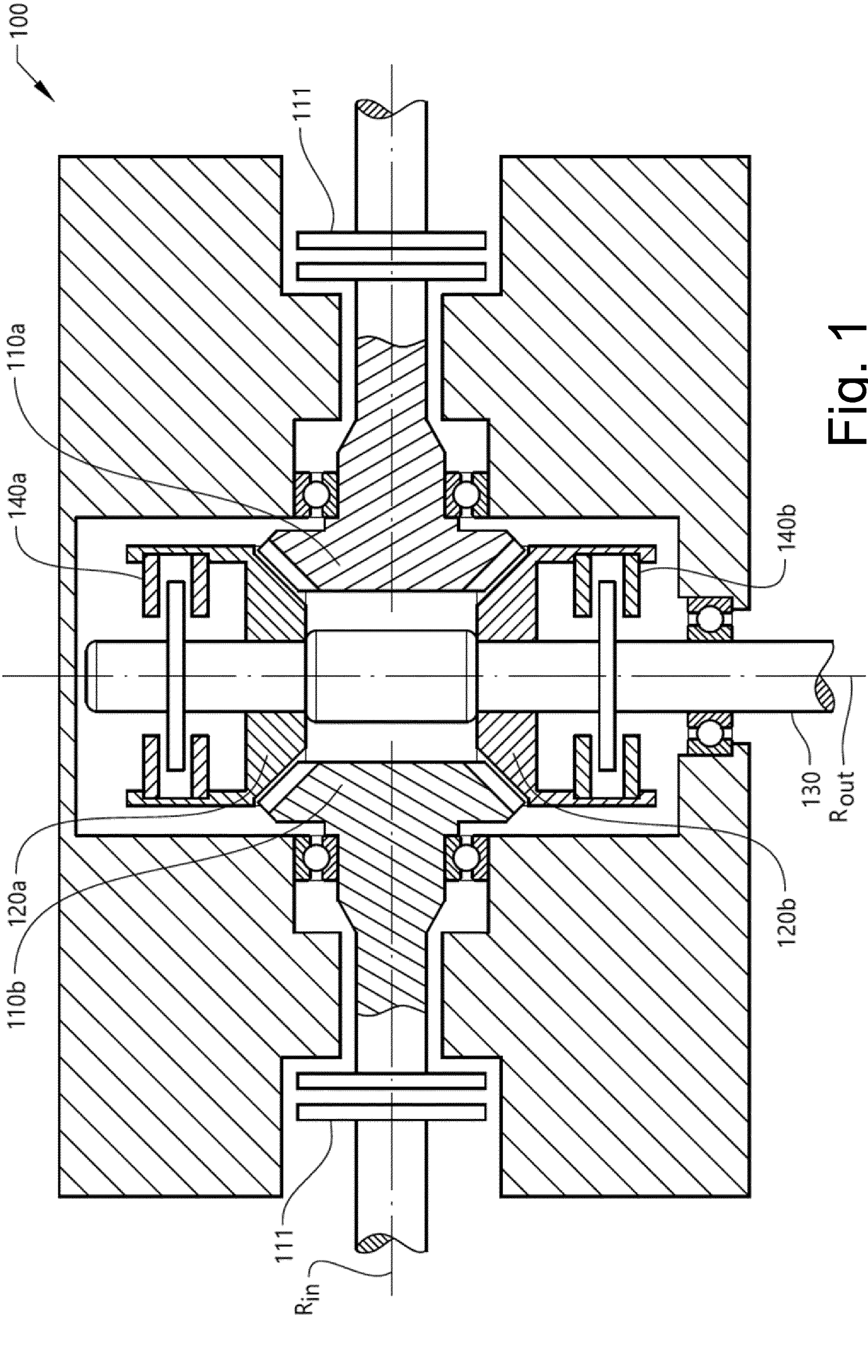

Fig. 1

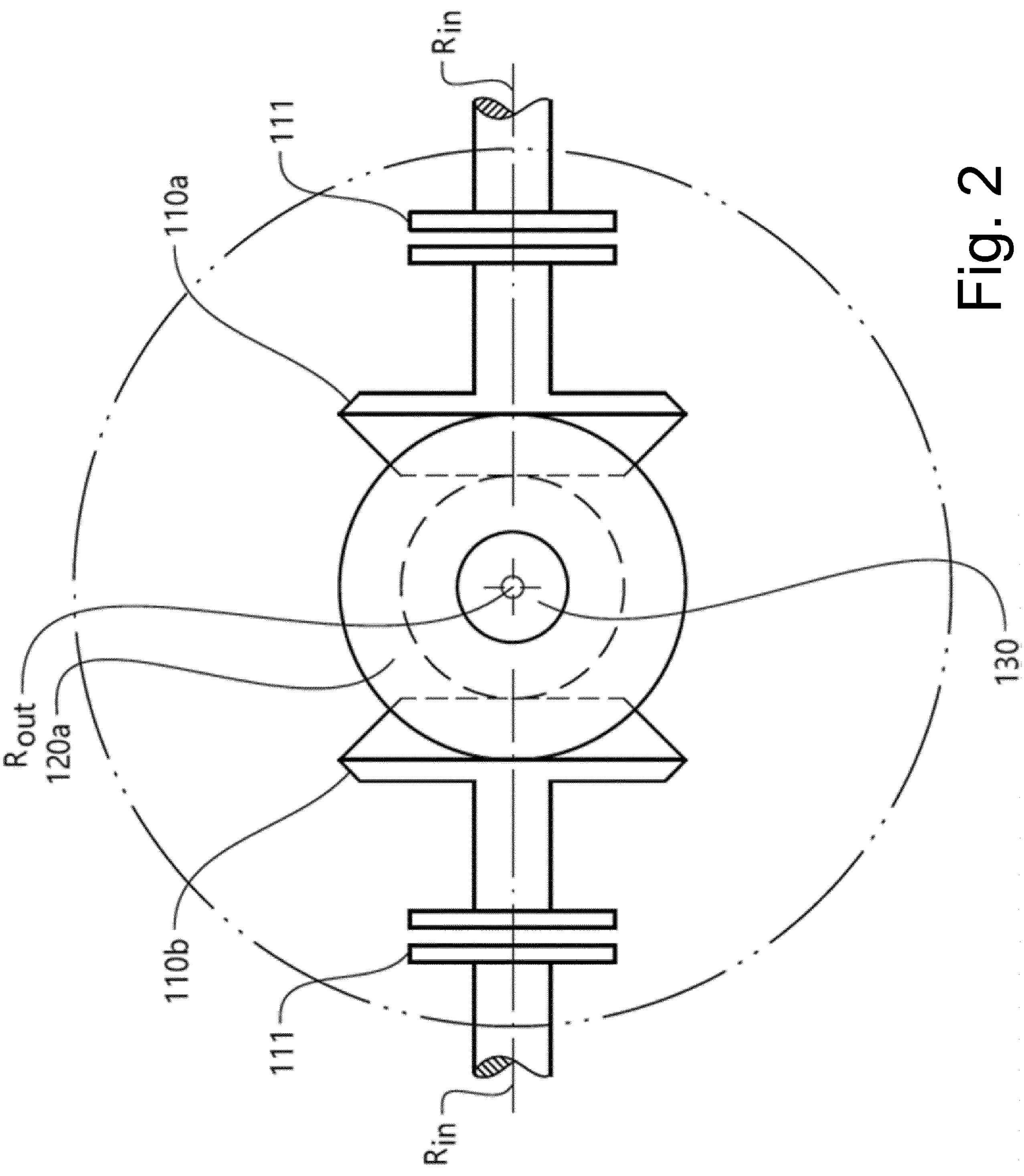

Fig. 2

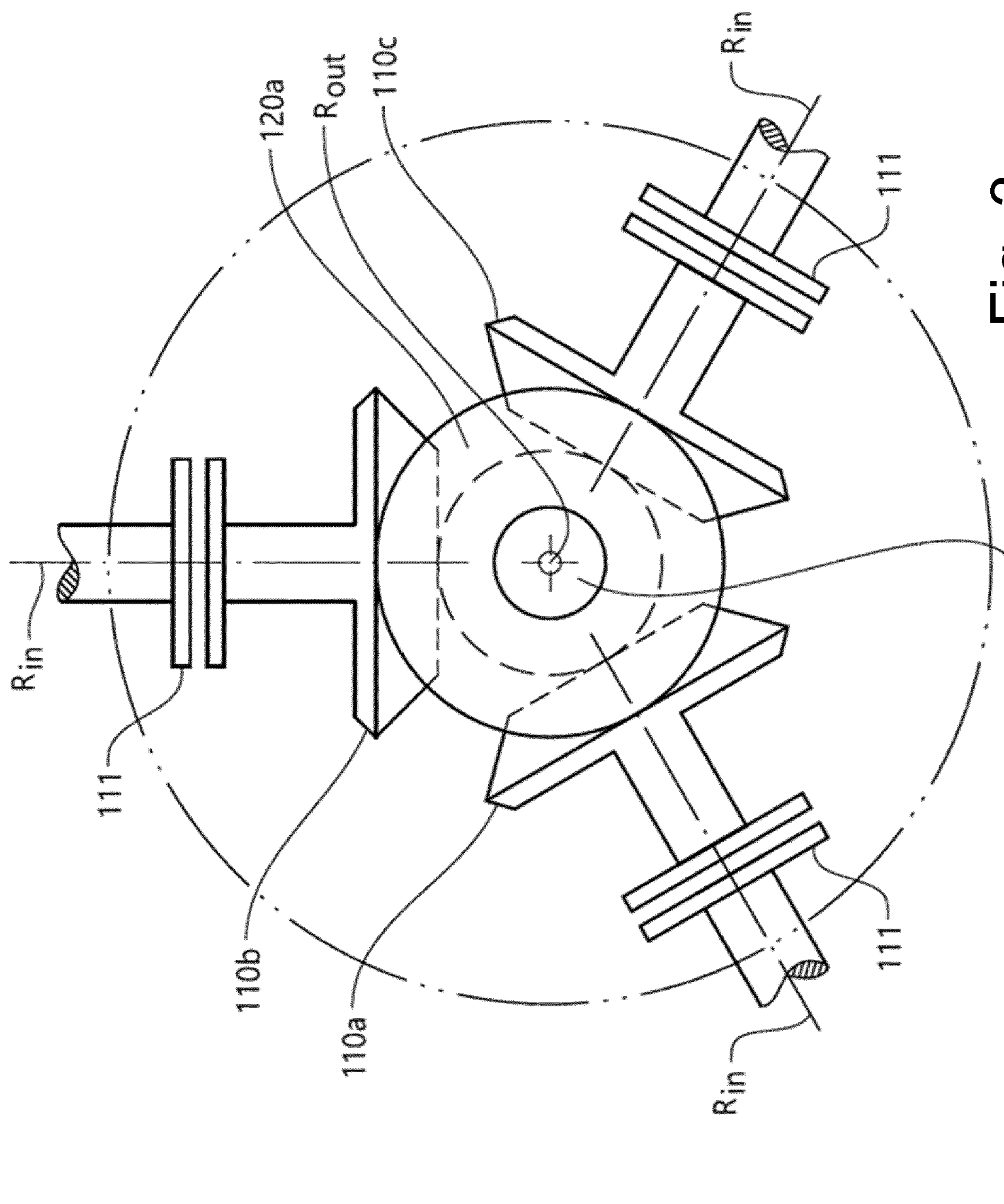

Fig. 3

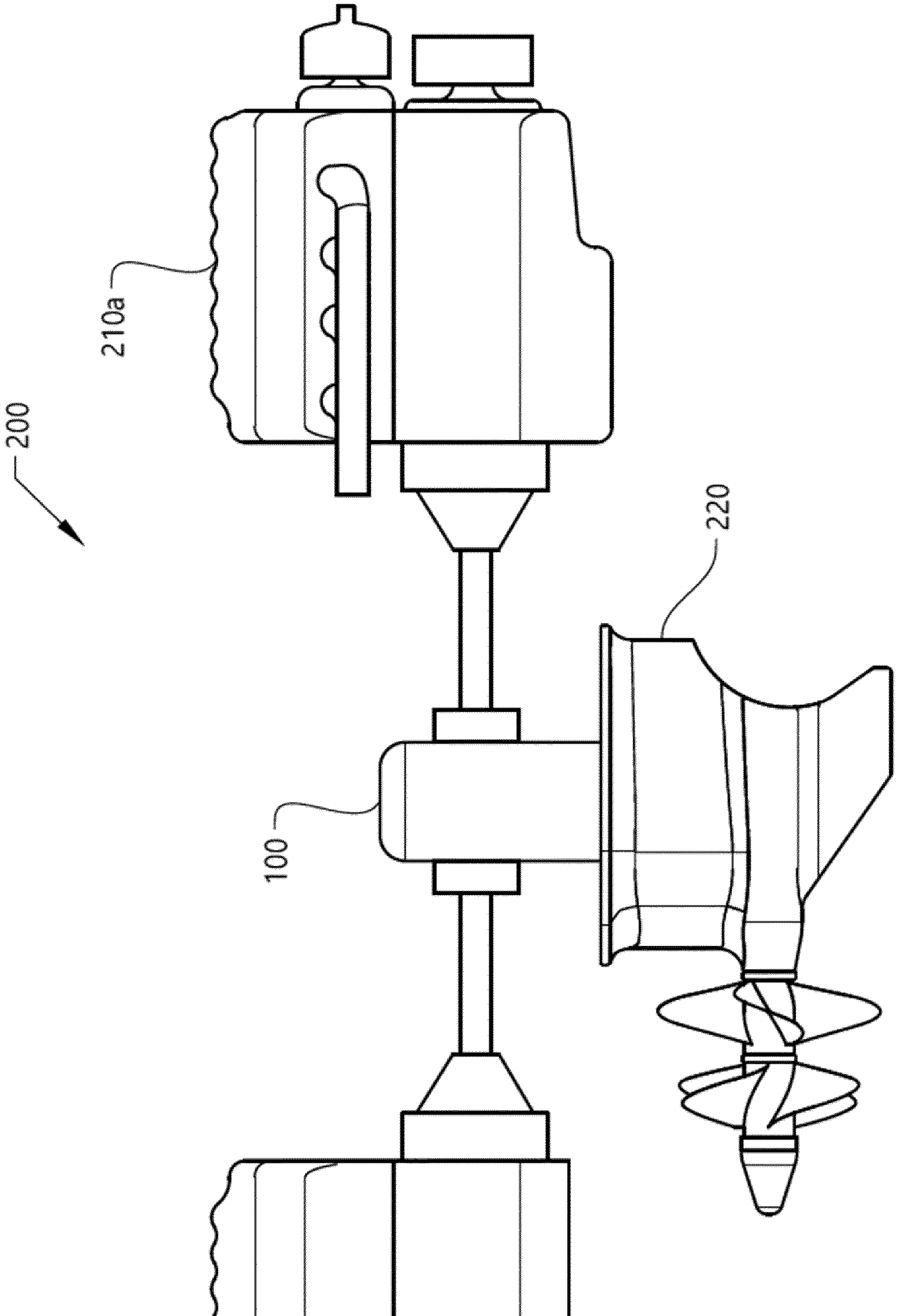

Fig. 4

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/079309

A. CLASSIFICATION OF SUBJECT MATTER
INV. B63H23/16 B63H23/30 B63H21/20
ADD. B63H23/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 858 204 C (KLOECKNER HUMBOLDT DEUTZ AG) 4 December 1952 (1952-12-04) page 2, line 1 - page 2, line 63; figures 1-3	1-16
A	WO 98/29301 A1 (VOLVO PENTA AB [SE]) 9 July 1998 (1998-07-09) page 3, line 26 - page 13, line 35; figures 1-5	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 June 2019	24/06/2019

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2018/079309

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
DE 858204	C	04-12-1952	NONE			
WO 9829301	A1	09-07-1998	DE	69704959	D1	28-06-2001
			EP	0946388	A1	06-10-1999
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