



(11)

EP 4 682 046 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.01.2026 Bulletin 2026/04

(51) International Patent Classification (IPC):
B63H 21/38 ^(2006.01) **B63H 23/02** ^(2006.01)
B63H 23/30 ^(2006.01)

(21) Application number: **24189087.0**

(52) Cooperative Patent Classification (CPC):
B63H 21/38; B63H 21/386; B63H 23/02;
B63H 23/30

(22) Date of filing: **17.07.2024**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

• **ZF PADOVA S.r.l**
35030 Caselle di Selvazzano (PD) (IT)

(72) Inventors:
• **Caracristi, Mattia**
35030 Caselle di Selvazzano (PD) (IT)
• **Zottele, Michele**
38123 Trento (IT)

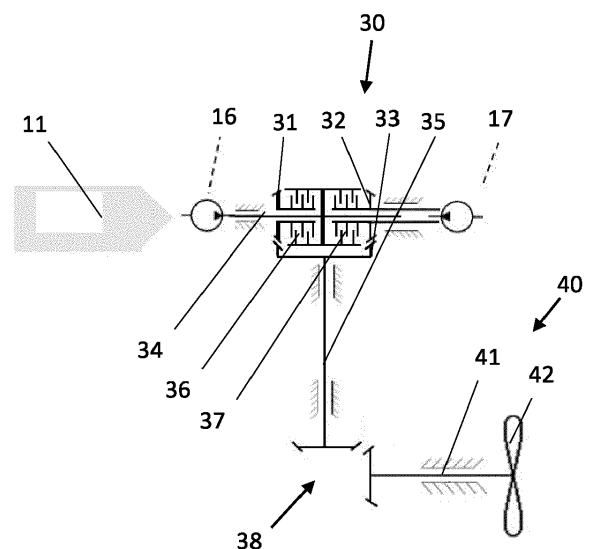
(71) Applicants:
• **ZF Friedrichshafen AG**
88046 Friedrichshafen (DE)

(74) Representative: **ZF Friedrichshafen AG**
Gewerblicher Rechtsschutz
Löwentalerstraße 20
88046 Friedrichshafen (DE)

(54) **LUBRICATION ARRANGEMENT FOR A WATER VEHICLE**

(57) A lubrication arrangement for a water vehicle is provided. A transmission input shaft (34) is configured for being driven by a drive motor (11). A transmission output shaft (35) is configured for being mechanically linked to a propulsion element (42) for a propulsion of the water vehicle. A shift element (36, 37) is configured for providing and removing a mechanical link between the transmission input shaft (34) and the transmission output shaft (35). A lubrication pump device (17) is mechanically linked to the transmission output shaft (35) and is configured for being driven by the propulsion element (42) via the transmission output shaft (35) for lubricating the shift element (36, 37) in a sailing mode of the water vehicle when the shift element (36, 37) is disengaged.

FIG. 1



Description

Technical field

[0001] The present invention refers to a lubrication arrangement for a water vehicle, a drive apparatus with such a lubrication arrangement, and a water vehicle with such a drive apparatus.

Prior art

[0002] Lubrication arrangements for water vehicles are known. A lubrication pump may be driven by a lubrication motor. The lubrication pump may be configured for lubricating elements of a drive apparatus of the water vehicle. DE 102012 218 910 A1 relates to a marine propulsion apparatus with a main engine and an auxiliary engine for driving a primary oil pump and a secondary oil pump supplying oil to a lubrication arrangement.

Description of the invention

[0003] It is an object of the present invention to provide an improved lubrication arrangement for a water vehicle. The object is solved by a lubrication arrangement comprising the features of claim 1. Advantageous further developments are subject-matter of the dependent claims.

[0004] In a first aspect, a lubrication arrangement is provided for a water vehicle. The lubrication apparatus comprises a transmission input shaft, a transmission output shaft, a shift element, and a lubrication pump device. The transmission input shaft is configured for being driven by a drive motor. The transmission output shaft is configured for being mechanically linked to a propulsion element for a propulsion of the water vehicle. The propulsion element may be formed as a propeller, for example as a non-foldable propeller, a fixed propeller, a fixed pitch propeller or a feathering propeller. The shift element is configured for providing and removing a mechanical link between the transmission input shaft and the transmission output shaft. The lubrication pump device is mechanically linked to the transmission output shaft. The lubrication pump device is configured for being driven by the propulsion element via the transmission output shaft for lubricating the shift element in a sailing mode of the water vehicle when the shift element is disengaged. Therefore, an effective operation of the shift element is ensured, even without the drive motor driving the lubrication pump device.

[0005] When two elements are mechanically linked, the elements are directly or indirectly coupled to each other such that a movement of one element causes a reaction of the other element. For example, a mechanical link may be provided by a frictional engagement or a positive locking. The mechanical link may correspond to a meshing of corresponding gears of the two elements. Between the elements, further elements like one or more

spur gear stages may be present. A permanent torque-proof connection is a connection in which the two elements are rigidly coupled with each other. The elements may be formed as separate elements torque-proofly connected with each other or may be formed integrally. The torque-proof connection between the two elements may be providable selectively by a shift element, for example a sliding sleeve, a clutch, or a brake. The torque-proof connection may be provided if the shift element is engaged. The torque-proof connection may be removed if the shift element is disengaged.

[0006] The water vehicle may be formed as a ship, for example as a sailing boat. The water vehicle may be configured for being used in water, for example a sea, a lake, or a river. The water vehicle may comprise a hull. The hull may form at least partially a boundary line between the water vehicle and the water. The water vehicle may comprise one or more sails for utilizing wind for a propulsion of the water vehicle. The water vehicle may comprise a drive apparatus. The drive apparatus may be configured for providing a driving force driving the propulsion element. The drive apparatus may comprise a drive motor, e.g. an electric motor or a combustion engine. The water vehicle may provide at least one driving mode, which may be one of a sailing mode, a combustion mode, and an electric mode. In the sailing mode, a propulsion of the water vehicle is generated by wind. In the combustion mode and the electric mode, the propulsion of the water vehicle is generated by the drive motor. When the shift element is disengaged, the water vehicle may be operable in the sailing mode, only.

[0007] The lubrication pump device may comprise an input shaft. The lubrication pump may be configured for being driven, e.g. at the input shaft, by a propulsion of the propulsion element, for example during a movement of the water vehicle within the water. The lubrication pump device may be configured for being driven by a drag effect or hydrodynamic effect of the propulsion element being moved through the water. The lubrication pump device may be configured for lubricating elements, for example at least one of gears, bearings, shafts, and shift elements, e.g. clutches, of the drive apparatus. The lubrication pump device may be configured for lubricating the elements of the drive apparatus without the drive motor being driven, for example during sail cruising of the water vehicle, when the water vehicle is driven in the sailing mode. Therefore, sufficient lubrication of elements of the drive apparatus can be ensured, even if the water vehicle is driven in the sailing mode and without the drive motor being driven.

[0008] The lubrication pump device may be formed as a fluid pump, e.g. as an oil pump. The lubrication pump device may be formed as a gear pump. The lubrication pump device may be formed as a trailing pump. The lubrication pump device may be configured for providing a fluid output, e.g. a fluid flow and a fluid pressure, e.g. at a fluid output element of the lubrication pump device. The fluid output element may comprise a fluid transmission

interface. The fluid output element may be formed as a hose connector, or a pipe connector. The lubrication pump device may be fluidly connected to a storage area, e.g. an oil sump. The lubrication pump device may be configured for lubricating elements, e.g. a clutch, of the drive apparatus.

[0009] If two elements are fluidly connected, a fluid, e.g. oil, may be guided from one element to another element. The fluid connection may be formed with low leakage, such that the fluid is guided substantially completely from one element to the other element. The fluid connection may be formed by a channel, a pipe, a tube, a sleeve, or the like. The fluid direction may be formed as a direct fluid connection without any additional elements being fluidly provided between the fluidly connected elements. The fluid connection may be formed as an indirect fluid connection via additional elements in between. Under a fluid flow direction, a direction of the fluid is understood, in which it moves to reach elements to which the fluid is supposed to be supplied.

[0010] The shift element may be constituted by at least one of a first shift element and a second shift element. The shift element may be operable by pressurized fluid. The shift element may be formed as a clutch, e.g. a multi-disc clutch. The shift element may provide an engaged state, in which the respective shift element provides a torque-proof connection between two elements. The shift element may provide a disengaged state, in which the respective shift element removes the torque-proof connection between the two elements.

[0011] The transmission input shaft may be arranged in a horizontal direction. The horizontal direction may be coincident with a longitudinal direction of the water vehicle when at least one of the lubrication arrangement and the drive apparatus is installed in the water vehicle and the water vehicle is placed on water. The transmission output shaft may be supported rotatably about a transmission output axis. The transmission output shaft may be arranged transversely, e.g. perpendicularly, to at least one of a driveshaft of the drive motor and the transmission input shaft. The transmission output shaft may be arranged in a vertical direction. The vertical direction may be coincident to a gravitational direction when at least one of the lubrication arrangement and the drive apparatus is installed in the water vehicle and the water vehicle is placed on water.

[0012] The lubrication arrangement may be configured for guiding fluid to elements of the drive apparatus of the water vehicle. The lubrication arrangement may be configured for guiding multiple kinds of fluids. The fluid may be formed by at least one of oil, water, and coolant. The lubrication arrangement may comprise transmitting elements, e.g. at least one of pipes, hoses, tubes, channels, or the like for transmitting the fluid. The lubrication arrangement may comprise guiding elements, e.g. at least one of valves, branching elements and filters, for guiding the fluid. The lubrication arrangement may comprise storage areas, e.g. an oil sump, or the like for storing

the fluid. The lubrication arrangement may be configured for lubricating and operating elements, e.g. shift elements, as clutches, of the drive apparatus.

[0013] In one embodiment of the lubrication arrangement, the lubrication arrangement may comprise a main pump device that is configured for being driven by the transmission input shaft and for operating the shift element. The main pump device may comprise an input shaft. The input shaft of the main pump device may be mechanically linkable to the driveshaft of the drive motor via a shift element. The input shaft of the main pump device may be mechanically linked to the driveshaft of the drive motor. The input shaft of the main pump device may be torque-proofly connectable to the driveshaft of the drive motor via a shift element. The input shaft of the main pump device may be torque-proofly connected to the driveshaft of the drive motor. The main pump device may be formed as a fluid pump, e.g. as an oil pump. The main pump device may be formed as a gear pump. The main pump device may be configured for providing a fluid output, e.g. a fluid flow and a fluid pressure, e.g. at a fluid output element of the main pump device. The fluid output element may comprise a fluid transmission interface. The fluid output element may be formed as a hose connector, or a pipe connector. The main pump device may be fluidly connected to the storage area, e.g. the oil sump. The main pump device may be configured for lubricating elements of the drive apparatus. The main pump device may be configured for providing fluid output, e.g. oil pressure, for operating the at least one shift element, e.g. the clutch. The main pump device may be configured for lubricating as well as operating the shift element or the first shift element and the second shift element.

[0014] The lubrication pump device may be fluidly connected to the fluid storage area, e.g. an oil sump. A filter device may be interposed between the lubrication pump device and the fluid storage area. The filter device may be formed as an oil filter. The lubrication pump device may be fluidly connected to a non-return valve. The non-return valve may be fluidly connected to at least one of the first shift element and the second shift element for providing lubrication of at least one of the first shift element and the second shift element.

[0015] The main pump device may be fluidly connected to the fluid storage area. A filter device may be interposed between the main pump device and the fluid storage area. The filter device may be formed as an oil filter. The main pump device may be fluidly connected to a pressure relief valve. The pressure relief valve may be configured for providing a fluid flow when the fluid comprises a minimum fluid pressure, e.g. 2 bar, or higher. The pressure relief valve may be fluidly connected to a heat exchanger. The heat exchanger may be formed as a cooling unit, e.g. an oil cooling unit. The heat exchanger may be fluidly connected to at least one of the first shift element and the second shift element for providing lubrication of at least one of the first shift element and the second shift element.

[0016] The main pump device may be fluidly connected to a shift valve. The shift valve may be configured for providing pressurized fluid to at least one of the first shift element and the second shift element for operating at least one of the first shift element and the second shift element. The shift valve may comprise a first solenoid and a second solenoid. The first solenoid may be configured for providing pressurized fluid to the first shift element. The second solenoid may be configured for providing pressurized fluid to the second shift element. At least one of the first solenoid and the second solenoid may be configured for being electrically operated. At least one of the shift valves, the first shift element and the second shift element may be fluidly connected to the fluid storage area, e.g. for outputting pressurized fluid, e.g. after engaging at least one of the first shift element and the second shift element. By outputting pressurized fluid from one of the first shift element and the second shift element, the respective shift element may be disengageable.

[0017] In one embodiment of the lubrication arrangement, the main pump device and the lubrication pump device may be arranged coaxially to the transmission input shaft. This has the advantage that the lubrication arrangement provides a compact arrangements space.

[0018] In one embodiment of the lubrication arrangement, the lubrication arrangement may comprise a transmission module having a first input gear, a second input gear and an output gear. The output gear may be torque-proofly connected to the transmission output shaft. The first input gear may be torque-proofly connectable to the transmission input shaft via a first shift element. The second input gear may be torque-proofly connectable to the transmission input shaft via a second shift element. The first input gear and the second input gear may be arranged coaxially to each other and may be in engagement with the output gear such that the output gear is drivable by the first input gear in a first rotational direction and such that the output gear is drivable by the second input gear in a second rotational direction opposite to the first rotation direction.

[0019] The transmission module may be formed as a reverse transmission. The first input gear and the second input gear may be arranged at opposing sides of the transmission output shaft transverse, e.g. perpendicular, to the transmission output axis. The first input gear and the second input gear may be arranged coaxially to the transmission input shaft. At least one of the first input gear and the second input gear may be formed as a pinion. At least one of the first input gear and the second input gear may be formed as a bevel gear. The output gear may be formed as a bevel gear or a crown gear. The number of teeth of the output gear may be larger than the number of teeth of one of the first input gear at the second input gear. The first input gear and the second input gear may comprise the same pitch diameter. The first input gear and the second input gear may comprise the same number of teeth. The pitch diameter of the first input gear

may be larger or smaller than the pitch diameter of the second input gear. In this case, the transmission output shaft may be inclined with respect to the vertical direction.

[0020] At least one of the first shift element and the second shift element may be operable by pressurized fluid. At least one of the first shift element and the second shift element may provide an engaged state, in which the respective shift element provides a torque-proof connection between the respective two elements. At least one of the first shift element that the second shift element may provide a disengaged state, in which the respective shift element removes the torque-proof connection between the respective two elements. The first shift element and the second shift element may be arranged in an axial direction of the transmission input shaft between the first input gear and the second input gear.

[0021] The input shaft of the lubrication pump device may be mechanically linkable to the second input gear via a shift element. The input shaft of the lubrication pump device may be mechanically linked to the second input gear. The input shaft of the lubrication pump device may be connectable torque-proofly to the second input gear via a shift element. The input shaft of the lubrication pump device may be torque-proofly connected to the second input gear. The input shaft of the lubrication pump device may be torque-proofly connected to an intermediate shaft being torque-proofly connected to the second input gear. The input shaft of the lubrication pump device may form the intermediate shaft on an end side of the input shaft in an axial direction of the input shaft. The transmission input shaft may be supported rotatably at the intermediate shaft, e.g. via a bearing unit which may comprise a conic bearing. The intermediate shaft may be rotatably supported at the stationary element, e.g. via a bearing unit which may comprise a double bearing. The lubrication pump device may be mechanically linked to the propulsion element via the second input gear, the output gear, the transmission output shaft, an output transmission, and a propulsion shaft.

[0022] In one embodiment of the lubrication arrangement, the first shift element and the second shift element may be formed as friction clutches and may be arranged coaxially to each other. At least one of the first shift element and the second shift element may be formed as a multi-disc clutch. At least one of the lubrication pump device and the main pump device may be configured for lubricating discs, e.g. friction discs or plates, of at least one of the first shift element at the second shift element.

[0023] In one embodiment of the lubrication arrangement, the input shaft of the lubrication pump device may be torque-proofly connected to the second input gear. This has the advantage that the lubrication pump device is always driven when the propulsion element is driven. Accordingly, a suitable lubrication of elements of the drive apparatus is ensured. Moreover, the mechanical link between the input shaft of the lubrication pump and the propulsion element is provided cost efficiently.

[0024] In a second aspect, a drive apparatus is pro-

vided for a water vehicle. The driver apparatus comprises a lubrication arrangement according to one of the preceding embodiments. Further features, advantages, and effects of the second aspect may arise from the first aspect. Features, advantages, and effects of the second aspect may also constitute features, advantages, and effects for the first aspect. The drive apparatus comprises a drive motor and a propulsion element. The drive motor is configured for driving the transmission input shaft. The propulsion element is configured for being mechanically linkable to the transmission output shaft.

[0025] The drive apparatus may be used for the water vehicle. The drive apparatus may be configured for a propulsion of the water vehicle. The drive motor may be formed as an electric motor or a combustion engine. The propulsion element may be formed as a propeller, for example as a non-foldable propeller, a fixed propeller, a fixed pitch propeller or a feathering propeller.

[0026] In one embodiment of the drive apparatus, the drive apparatus may comprise a propulsion module having the propulsion shaft and the propulsion element. The propulsion element may be torque-proofly connected to the propulsion shaft being rotatably supported at a stationary element. The stationary element may be formed by the hull of the water vehicle or a housing of the drive apparatus. This has the advantage that the propulsion element may be supported rotatably, e.g. by a bearing unit, in a stable manner by the propulsion shaft. The propulsion shaft may extend from an inner side of the water vehicle through the hull to an outside of the water vehicle into the water. This has the advantage that the bearing unit may be positioned within the water vehicle and separated from the water. This leads to a high lifetime of the drive apparatus.

[0027] In one embodiment of the drive apparatus, the propulsion element comprises a fixed propeller. This can ensure that every time that the water vehicle is moved within the water, e.g. in the sailing mode, the propulsion element is propelled, e.g. by the drag effect. Thus, driving the lubrication pump device and lubrication of elements of the drive apparatus is ensured as long as the water vehicle is moved through the water.

[0028] In one embodiment of the drive apparatus, the drive apparatus may comprise the output transmission having an input bevel gear and an output bevel gear. The input bevel gear may be configured for being mechanically linkable to the transmission output shaft. The output bevel gear may be configured for being mechanically linkable to the propulsion shaft.

[0029] The input bevel gear may be mechanically linkable to the transmission output shaft via a shift element. The input bevel gear may be mechanically linked to the transmission output shaft. The input bevel gear may be torque-proofly connectable to the transmission output shaft via a shift element. The input bevel gear may be torque-proofly connected to the transmission output shaft. The output bevel gear may be mechanically linkable to the propulsion shaft via a shift element. The output

bevel gear may be mechanically linked to the propulsion shaft. The output bevel gear may be torque-proofly connectable to the propulsion shaft via a shift element. The output bevel gear may be torque-proofly connected to the propulsion shaft. The transmission output shaft and the propulsion shaft may be arranged transversely, for example perpendicularly, to each other. The output transmission may provide a transmission ratio from the input bevel gear to the output bevel gear of 1, >1 or <1.

[0030] In one embodiment of the drive apparatus, the transmission output shaft, the output transmission, and the propulsion module may be formed as a POD drive. A POD drive or an azimuth thruster may comprise a housing called POD. The transmission output shaft, the output transmission, and the propulsion module may be housed at least partially by the housing. The housing may be fluidly sealed. The housing may be attached to the hull. The transmission output shaft may extend from an inside of the hull to an inside of the housing. The propulsion shaft may extend from an inside of the housing to an outside, e.g. water. The propulsion element may be arranged at the outside of the housing, e.g. within the water. The POD drive may be pivotable around the transmission output axis.

[0031] In one embodiment of the drive apparatus, the lubrication pump device may be configured for being driven at its input shaft in two different rotational directions and for providing a fluid output with a single flow direction. The single flow direction may be constituted by an unidirectional flow.

[0032] The lubrication pump device may comprise a reversible pump creating the unidirectional flow independent of a rotation direction of its input shaft. A reversible pump may be configured for providing the single flow direction independent of a rotational direction of its input shaft. The reversible pump may provide the single fluid direction for the case that its input shaft is driven in the first rotational direction, e.g. a clockwise direction, as well as for the case that its input shaft is driven in that second rotational direction, e.g. a counterclockwise direction.

[0033] The lubrication pump device may comprise a bidirectional pump and a flow direction control unit being configured for providing the unidirectional flow. A bidirectional pump may be configured for providing a first flow direction of the fluid output and a second flow direction of the fluid output opposite to the first flow direction depending on a rotational direction of its input shaft. The bidirectional pump may be configured for providing the first flow direction for the case that its input shaft is driven in the first rotational direction, e.g. the clockwise direction, e.g. at a first fluid output element. The bidirectional pump may be configured for providing the second flow direction for the case that its input shaft is driven in the second rotational direction, e.g. the counterclockwise direction, e.g. at a second fluid output element.

[0034] The flow direction control unit may be configured for providing the single flow direction out of the first flow direction and the second flow direction. The flow

direction control unit may comprise a first valve and the second valve. At least one of the first valve and the second valve may be configured for preventing a fluid flow when a closing condition is present. For the first valve, the closing condition may be present if the input shaft of the bidirectional pump device is driven in the second rotational direction. For the second valve, the closing condition may be present if the input shaft of the bidirectional pump device is driven in the first rotational direction.

[0035] At least one of the first valve and second valve may be formed as a non-return valve. At least one of the first valve and the second valve may be formed as a solenoid valve. The first valve may be fluidly connected to the first fluid output element of the bidirectional pump device. The second valve may be fluidly connected to the second fluid output element of the bidirectional pump device. Each of the first valve and second valve may be fluidly connected to a common fluid flow path. The fluid flow path may be integrated in the lubrication arrangement. The fluid flow path may constitute a fluid connection between the lubrication pump device and the non-return valve or the at least one of the first shift element and the second shift element.

[0036] The lubrication pump device may comprise two unidirectional pumps and a non-return valve for each of the unidirectional pumps for creating the unidirectional flow. Each unidirectional pump may be configured for providing a flow direction only for a distinct rotational direction of its input shaft. A first unidirectional pump may be configured for providing the first flow direction if its input shaft is driven in the first rotational direction, e.g. the clockwise direction. A second unidirectional pump may be configured for providing the second flow direction if its pump shaft is driven in the second rotational direction, e.g. the counterclockwise direction. The respective unidirectional pump may be configured for not providing any fluid flow if the respective input shaft is driven in any other rotational direction. The first unidirectional pump and the second unidirectional pump may be arranged coaxially. The input shaft of the first unidirectional pump and the input shaft of the second unidirectional pump may be torque-proofly connected to each other. The first unidirectional pump and the second unidirectional pump may comprise one common input shaft.

[0037] The first unidirectional pump may be fluidly connected to a first non-return valve. The second unidirectional pump may be fluidly connected to a second non-return valve. The first non-return valve and the second non-return valve may be fluidly connected to the common fluid flow path. The fluid flow path may be integrated in the lubrication arrangement. The fluid flow path may constitute a fluid connection between the lubrication pump device and the at least one of the first shift element and the second shift element.

[0038] In a third aspect, a water vehicle comprising a drive apparatus according to one of the preceding embodiments and aspects is provided. Further features,

advantages, and effects of the third aspect may arise from one of the preceding aspects. Features, advantages, and effects of the third aspect may also constitute features, advantages, and effects for one of the preceding aspects. The drive apparatus is configured for a propulsion of the water vehicle. The drive apparatus may be mounted or installed to a stationary element, e.g. a hull, of the water vehicle. The water vehicle may be formed as a ship, for example as a sailing boat. The water vehicle may provide at least the sailing mode, and one driving mode of the combustion mode and the electric mode. In the sailing mode, a propulsion of the water vehicle is generated by wind.

15 Brief description of the drawings

[0039]

Figure 1 shows a schematic sketch of a sectional view of an embodiment of a drive apparatus with a lubrication arrangement according to an embodiment.

Figure 2 shows a sectional view of an embodiment of the drive apparatus with the lubrication arrangement of Figure 1.

Figure 3 shows an oil flow diagram of an embodiment of the drive apparatus with the lubrication arrangement of Figures 1 and 2.

Figure 4 shows a schematic sketch of an embodiment of a water vehicle with the drive apparatus of Figures 1 to 3.

35 Detailed description of embodiments

[0040] Figure 1 shows a schematic sketch of a sectional view of an embodiment of a drive apparatus with a lubrication arrangement. The lubrication arrangement is configured for being used in a water vehicle and comprises a transmission input shaft 34, a first shift element 36, a second shift element 37, a transmission output shaft 35, and a lubrication pump device 17. The water vehicle is formed by a sailing boat having sails and a drive apparatus with a drive motor 11, an electric motor in the present embodiment, a transmission module 30, an output transmission 38, and a propulsion module 40. The propulsion module 40 comprises a propulsion shaft 41 and a propulsion element 42, which is formed as a fixed propeller. The water vehicle comprises two driving modes: a sailing mode in which wind provides a propulsion for the water vehicle, and an electric mode in which the drive motor 11 provides a propulsion for the water vehicle.

[0041] The first shift element 36 and the second shift element 37 are formed as multi-disc clutches in the present embodiment. The transmission input shaft 34

is configured for being driven by the drive motor 11. The transmission output shaft 35 is configured for being mechanically linked to a propulsion element 42 for a propulsion of the water vehicle. The first shift element 36 and the second shift element 37 are configured for providing and removing a mechanical link between the transmission input shaft 34 and the transmission output shaft 35. The lubrication pump device 17 is mechanically linked to the transmission output shaft 35 and is configured for being driven by the propulsion element 42 via the transmission output shaft 35 for lubricating the first shift element 36 and the second shift element 37 in the sailing mode of the water vehicle. This lubrication also takes place when the first shift element 36 and the second shift element 37 are disengaged. If the water vehicle is moved through water, the propulsion element 42 is driven by a drag effect. Thus, lubrication of the first shift element 36 and the second shift element 37 is ensured as long as the water vehicle is moved through water.

[0042] In the following further details of the lubrication arrangement, the drive apparatus and the water vehicle are described. The lubrication arrangement further comprises a main pump device 16. The main pump device 16 is configured for lubricating the first shift element 36 and the second shift element 37 as well as operating the first shift element 36 and the second shift element 37. An input shaft of the main pump device 16 is mechanically linked to a driveshaft of the drive motor 11. Thus, the main pump device 16 is configured for being driven by the drive motor 11. The input shaft of the main pump 16 is arranged coaxially with an input shaft of the lubrication pump device 17.

[0043] The transmission module 30 is arranged in an axial direction between the main pump device 16 and the lubrication pump device 17. The transmission module 30 comprises a first input gear 31, which is formed as a bevel gear, a second input gear 32, which is formed as a bevel gear, and an output gear 33, which is formed as a crown gear. The input shaft of the lubrication pump device 17 is torque-proofly connected to the second input gear 32.

[0044] The first input gear 31 and the second input gear 32 are arranged at opposing sides of the transmission output shaft 35 perpendicular to a rotation axis of the transmission output shaft 35. The transmission input shaft 34 is arranged perpendicularly to the transmission output shaft 35. The first input gear 31 and the second input gear 32 are arranged coaxially to the transmission input shaft 34. The output gear 33 is torque-proofly connected to the transmission output shaft 35. The first input gear 31 is torque-proofly connectable to the transmission input shaft 34 via the first shift element 36. The second input gear 32 is torque-proofly connectable to the transmission input shaft 34 via a second shift element 37. The first input gear 31 and the second input gear 32 are in engagement with the output gear 33. Accordingly, the output gear 33 is drivable by the first input gear 31 in a first rotational direction, e.g. a clockwise direction, and is drivable by the second input gear 32 in a second rota-

tional direction, e.g. a counterclockwise direction, opposite to the first rotation direction. The transmission module 30 is formed as a reverse transmission.

[0045] The output transmission 38 comprises an input bevel gear and an output bevel gear. The input bevel gear is torque-proofly connected to the transmission output shaft 35. The output bevel gear is torque-proofly connected to the propulsion shaft 41. The transmission output shaft 35 and the propulsion shaft 41 are arranged perpendicularly with respect to each other. The propulsion element 42 is torque-proofly connected to the propulsion shaft 41. The transmission output shaft 35 and the propulsion shaft 41 are rotatably supported at a stationary element of the water vehicle. Thus, the propulsion element 42 is rotatably supported via the propulsion shaft 41.

[0046] Figure 2 shows a sectional view of an embodiment of the drive apparatus with the lubrication arrangement of Figure 1. The input shaft of the lubrication pump device 17 is torque-proofly connected to an intermediate shaft being torque-proofly connected to the second input gear 32. The transmission input shaft 34 is supported rotatably at the intermediate shaft via a bearing unit, a conic bearing at present. The intermediate shaft is rotatably supported at the stationary element, via a bearing unit, a double-row ball bearing at present. The lubrication pump device 17 is mechanically linked to the propulsion element 42 via the second input gear 32, the output gear 33, the transmission output shaft 35, the output transmission 38, and the propulsion shaft 41. Moreover, the first input gear 31, the first shift element 36, and the second shift element 37 are shown.

[0047] Figure 3 shows an oil flow diagram of an embodiment of the drive apparatus with the lubrication arrangement of Figures 1 and 2. The lubrication pump device 17 is fluidly connected to a fluid storage area 59, which is formed as an oil sump. A filter device 57, which is formed as an oil filter, is interposed between the lubrication pump device 17 and the fluid storage area 59. The lubrication pump device 17 is fluidly connected to a non-return valve 55. The non-return valve 55 is fluidly connected to the first shift element 36 and the second shift element 37 for providing lubrication for discs, e.g. friction discs, of the first shift element 36 and the second shift element 37.

[0048] The main pump device 16 is fluidly connected to the fluid storage area 59. A filter device 57 is interposed between the main pump device 16 and the fluid storage area 59. The main pump device 16 is fluidly connected to a pressure relief valve 56. The pressure relief valve 56 provides a fluid flow when the fluid comprises a minimum fluid pressure or higher. The pressure relief valve 56 is fluidly connected to a heat exchanger 53, which is formed as an oil cooler. The heat exchanger 53 is fluidly connected to the first shift element 36 and the second shift element 37 for providing lubrication of the first shift element 36 and the second shift element 37.

[0049] In addition, the main pump device 16 is fluidly

connected to a shift valve. The shift valve provides pressurized fluid to the first shift element 36 and the second shift element 37 for operating the first shift element 36 and the second shift element 37. The shift valve comprises a first solenoid 51 and a second solenoid 52. The first solenoid 51 provides pressurized fluid to the first shift element 36. The second solenoid 52 provides pressurized fluid to the second shift element 37. The shift valve, the first shift element 36, and the second shift element 37 are fluidly connected to the fluid storage area 59. Thus, pressurized fluid is output after engaging at least one of the first shift element 36 and the second shift element 37.

[0050] Figure 4 shows a schematic sketch of an embodiment of a water vehicle with the drive apparatus of Figures 1 to 3. The water vehicle is formed as a sailboat and comprises a hull 8, wherein the drive apparatus is mounted inside of the hull 8. The water vehicle comprises a sail for its propulsion by wind. The propulsion module 40 with the propulsion shaft 41 and the propulsion element 42 is arranged at a lower side of the hull 8.

List of reference signs

[0051]

8	Hull	
11	Drive motor	
16	Main pump device	
17	Lubrication pump device	
30	Transmission module	
31	First input gear	
32	Second input gear	
33	Output gear	
34	Transmission input shaft	
35	Transmission output shaft	
36	First shift element	
37	Second shift element	
38	Output transmission	
40	Propulsion module	
41	Propulsion shaft	
42	Propulsion element	
51	First solenoid	
52	Second solenoid	
53	Heat exchanger	
55	Non-return valve	
56	Pressure relieve valve	
57	Filter device	
59	Fluid storage area	

Claims

1. A lubrication arrangement for a water vehicle, wherein the lubrication arrangement comprises a transmission input shaft (34) being configured for being driven by a drive motor (11), a transmission output shaft (35) being configured for being mechanically linked to a propulsion element (42) for propulsion of the water vehicle, a shift element (36, 37) being config-

ured for providing and removing a mechanical link between the transmission input shaft (34) and the transmission output shaft (35), and a lubrication pump device (17) being mechanically linked to the transmission output shaft (35) and being configured for being driven by the propulsion element (42) via the transmission output shaft (35) for lubricating the shift element (36, 37) in a sailing mode of the water vehicle when the shift element (36, 37) is disengaged.

2. The lubrication arrangement according to claim 1, **characterized in that** the lubrication arrangement comprises a main pump device (16) that is configured for being driven by the transmission input shaft (34) and for operating the shift element (36, 37).

3. The lubrication arrangement according to one of the preceding claims, **characterized in that** the main pump device (16) and the lubrication pump device (17) are arranged coaxially to the transmission input shaft (34).

4. The lubrication arrangement according to one of the preceding claims, **characterized in that** the lubrication arrangement comprises a transmission module (30) having a first input gear (31), a second input gear (32) and an output gear (33), wherein the output gear (33) is torque-proofly connected to the transmission output shaft (35), the first input gear (31) is torque-proofly connectable to the transmission input shaft (34) via a first shift element (36) and the second input gear (32) is torque-proofly connectable to the transmission input shaft (34) via a second shift element (37), and the first input gear (31) and the second input gear (32) are arranged coaxially to each other and are in engagement with the output gear (33) such that the output gear (33) is drivable by the first input gear (31) in a first rotational direction and is drivable by the second input gear (32) in a second rotational direction opposite to the first rotation direction.

5. The lubrication arrangement according to claim 4, **characterized in that** the first shift element (36) and the second shift element (37) are formed as friction clutches and are arranged coaxially to each other.

6. The lubrication arrangement according to claim 4 or 5, **characterized in that** an input shaft of the lubrication pump device (17) is torque-proofly connected to the second input gear (32).

7. A drive apparatus for a water vehicle, wherein the drive apparatus comprises a lubrication arrangement according to one of claims 1 to 6, a drive motor (11) being configured for driving the transmission input shaft (34), and a propulsion element (42) being

configured for being mechanically linkable to the transmission output shaft (35).

8. The drive apparatus according to claim 7, **characterized in that** the drive apparatus comprises a propulsion module (40) having a propulsion shaft (41) and the propulsion element (42), wherein the propulsion element (42) is torque-proofly connected to the propulsion shaft (41) being rotatably supported at a stationary element.

5
10
9. The drive apparatus according to claim 7 or 8, **characterized in that** the propulsion element (42) comprises a fixed propeller.

15
10. The drive apparatus according to claim 8 or 9, **characterized in that** the drive apparatus comprises an output transmission (38) having an input bevel gear and an output bevel gear, the input bevel gear being configured for being mechanically linkable to the transmission output shaft (35) and the output bevel gear being configured for being mechanically linkable to the propulsion shaft (41).

20
11. The drive apparatus according to claim 10, **characterized in that** the transmission output shaft (35), the output transmission (38) and the propulsion module (40) are formed as a POD drive.

25
12. The drive apparatus according to one of claims 7 to 11, **characterized in that** the lubrication pump device (17) is configured for being driven at its input shaft in two different rotational directions and for providing a fluid output with a single flow direction.

30
35
13. A water vehicle comprising a drive apparatus according to one of the claims 7 to 12 being configured for propulsion of the water vehicle.

40

45

50

55

FIG. 1

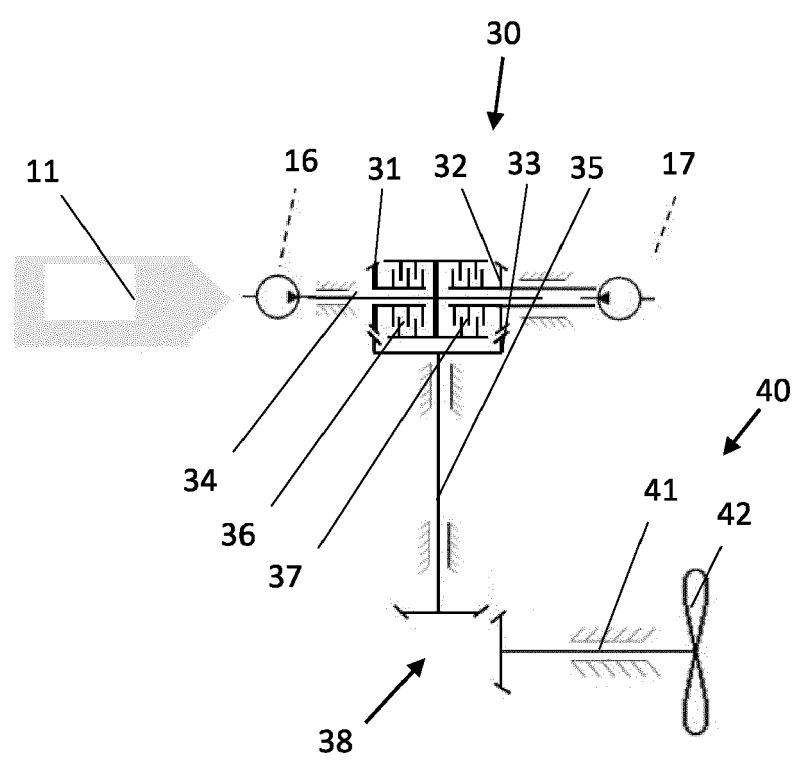


FIG. 2

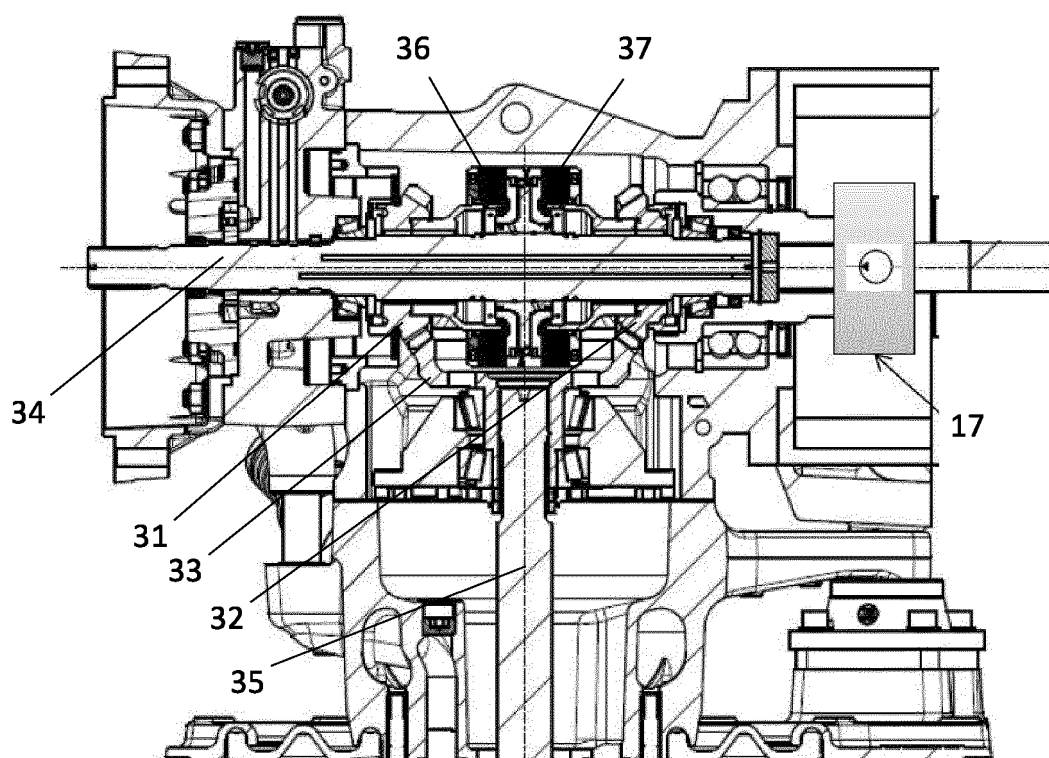


FIG. 3

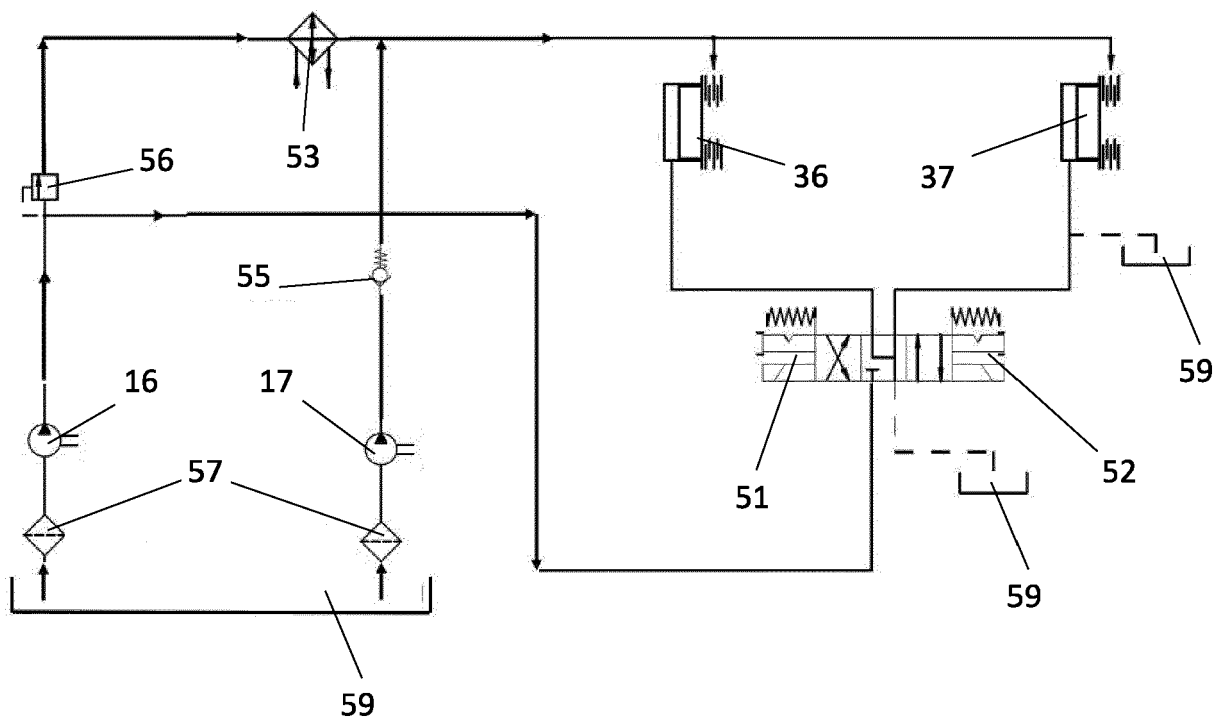
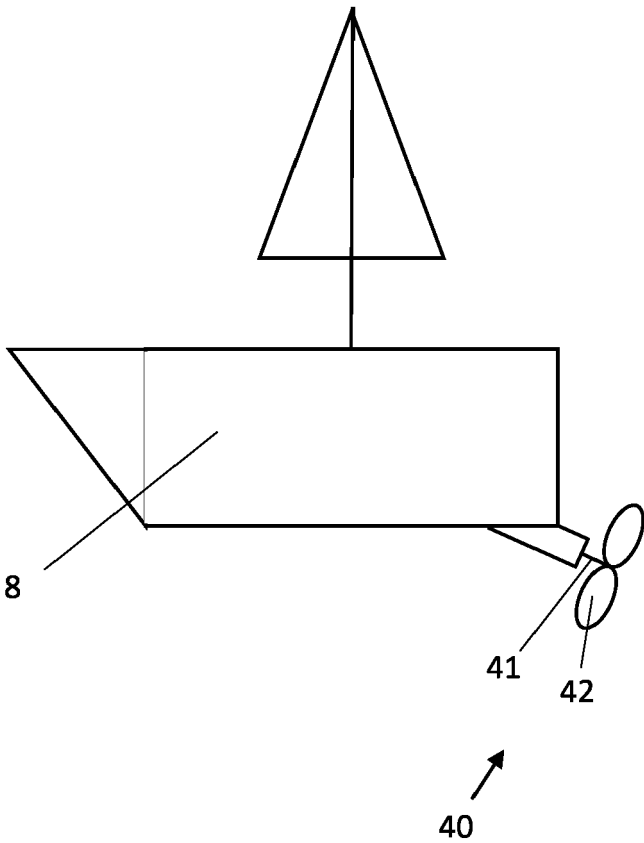


FIG. 4





EUROPEAN SEARCH REPORT

Application Number

EP 24 18 9087

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	US 7 896 716 B2 (YANMAR CO LTD [JP]) 1 March 2011 (2011-03-01)	1,2,4-13	INV. B63H21/38
Y	* column 3, line 40 - column 9, line 21; claims; figures *	3	B63H23/02 B63H23/30

X	WO 2022/263076 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]; ZF PADOVA SRL [IT]) 22 December 2022 (2022-12-22)	1,4-13	
Y	* page 1, last paragraph; claims; figures *	3	
	* pages 5-8 *		

The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			B63H
Place of search		Date of completion of the search	Examiner
The Hague		30 January 2025	Knoflachner, Nikolaus
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone			
Y : particularly relevant if combined with another document of the same category			
A : technological background			
O : non-written disclosure			
P : intermediate document			
T : theory or principle underlying the invention			
E : earlier patent document, but published on, or after the filing date			
D : document cited in the application			
L : document cited for other reasons			
.....			
& : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P34C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 24 18 9087

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-01-2025

10

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
US 7896716	B2	01-03-2011	EP	1967448 A2		10-09-2008
			JP	4836836 B2		14-12-2011
			JP	2008223811 A		25-09-2008
			US	2008220669 A1		11-09-2008

WO 2022263076	A1	22-12-2022	EP	4355650 A1		24-04-2024
			US	2024278895 A1		22-08-2024
			WO	2022263076 A1		22-12-2022

15

20

25

30

35

40

45

50

55

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 102012218910 A1 [0002]