



(12)

EUROPEAN PATENT APPLICATION

- (43)

Date of publication:
02.04.2025 Bulletin 2025/14
- (21)

Application number: 23200469.7
- (22)

Date of filing: 28.09.2023
- (51)

International Patent Classification (IPC):
B63H 5/08 (2006.01) B63H 5/10 (2006.01)
B63H 5/125 (2006.01) B63H 21/17 (2006.01)
B63H 23/30 (2006.01)
- (52)

Cooperative Patent Classification (CPC):
B63H 21/20; B63H 5/10; B63H 5/125; B63H 23/30;
B63H 2005/1254; B63H 2005/1256;
B63H 2005/1258; B63H 2021/205

- (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:
KH MA MD TN
- (71)

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MARINE POD DRIVE

(57) The present invention relates to a marine pod drive (1, 2) with a first propeller (11) and a second propeller (21), which are arranged at a pod (5). The marine pod drive (1, 2) comprising a first drive machine (10, 210), which drives the first propeller (11) and a second drive machine (20), which drives the second propeller (21). The first drive machine (10, 210) is operatively connected to the first propeller (11) via a drive train (3) comprising a vertical shaft (15) and a lower bevel gear unit (16). The second drive machine (20) is an electric motor, which is arranged inside a housing (4) of the pod (5). The first propeller (11) is arranged at a trailing end of the pod (5) and the second propeller (21) is arranged at a leading end of the pod (5).

The invention further relates to a ship (100, 200) with such a marine pod drive (1, 2).

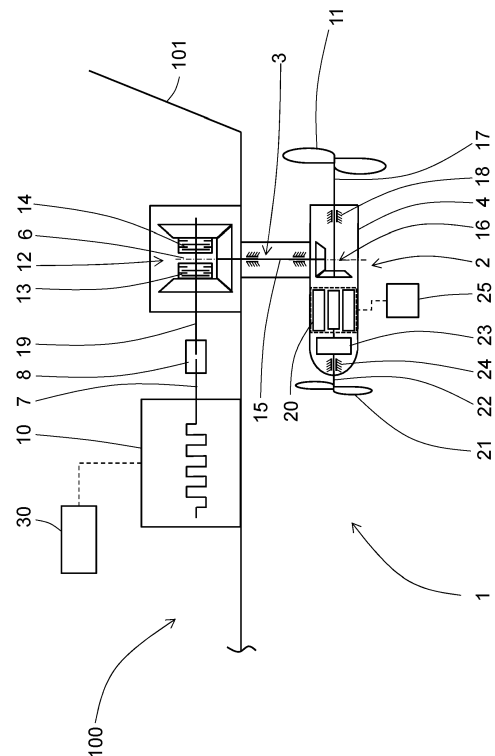


Fig. 1

Description

[0001] The present invention relates to a marine pod drive with two propellers and to a ship with such a marine pod drive.

[0002] Different marine pod drives with two propellers are known from prior art, wherein a first propeller and a second propeller can be driven by one or two drive machines. Conventional marine pod drives with two propellers comprise a drive machine, typically a combustion engine, which is mounted inside a hull of a ship. The power from the drive machine is transmitted via a drive train with shafts and transmission elements to the propellers, which are arranged at one end of the pod. The pod is positioned underneath the hull. It can be mounted to the bottom of the hull by means of a strut.

[0003] In recent years there is an increasing demand for marine drive units with electric drive machines for environmental and efficiency reasons. For these reasons several marine drive units have been proposed in form of electric drives. In the EP 4 215 434 A1 a pod propulsion system with counter rotating propellers has been disclosed, wherein a first electric motor is arranged to drive a first propeller and wherein a second electric motor is arranged to drive a second propeller. The first and the second electric motors are housed within a pod underneath the hull of the marine vessel. The first and the second electric motors can be operated either independently or interdependently.

[0004] The purpose of the present invention is to provide an improved marine pod drive with two propellers with compact outline dimensions and a high level of reliability. The marine pod drive shall have a wide range of applicability.

[0005] These purposes are achieved by a marine pod drive according to claim 1 and by a ship according to claim 8. Further embodiments are claimed in dependent claims.

[0006] The present invention provides a marine pod drive with a first propeller and a second propeller, wherein the first propeller is arranged at a trailing end of the pod and the second propeller is arranged at a leading end of the pod, so that the first propeller works as a pushing propeller and the second propeller works as a pulling propeller. In other words there is one propeller arranged at each end of the pod, one as a front propeller and the other as a rear propeller. Both propellers can be arranged coaxially to each other, to achieve high efficiencies.

[0007] The pod is arranged underneath a hull of a ship. The marine pod drive comprises a first drive machine which drives the first propeller and a second drive machine which drives the second propeller. The first drive machine is operatively connected to the first propeller via a mechanical drive train comprising a vertical shaft, a lower bevel gear unit and a first propeller shaft. That means, that the first drive machine is positioned in a position above the pod and the power of the first drive machine is transmitted to the first propeller via said

mechanical drive train to the first propeller. Preferably the first drive machine is located inside the hull of the ship. Whereas the second drive machine is an electric motor which is arranged inside a housing of the pod.

[0008] The first drive machine may be arranged inside the hull with a vertical or a horizontal alignment, i.e. with a vertical or horizontal motor shaft or crank shaft. In embodiments with a horizontally arranged crank shaft or motor shaft, the drive train comprises an upper bevel gear unit which is arranged at an upper end of the vertical shaft to connect a horizontal drive shaft with the vertical shaft. In an embodiment with a vertically arranged first drive machine, the motor shaft can be connected to the vertical shaft without an upper bevel gear unit. Particularly in embodiments with a vertically arranged first drive machine, the first drive machine may at least partially be arranged inside a strut of the pod, which is attached to the hull. The terms horizontal and vertical refer to a marine pod drive mounted in an operating position on a ship in calm water, with the water surface being a horizontal plane. However, the terms horizontal and vertical do not limit the corresponding direction to an exact direction but include deviations from an exact horizontal or vertical direction up to an angle of 15 degrees.

[0009] There are several benefits of the new combination of a first drive machine inside the hull and a second drive machine in form of an electric motor in the pod. Such an arrangement of the first and second drive machine allows for independent control and operation of the first and second propeller. In particular, the first and the second drive machines can be operated completely disconnected, so that they are not influencing each other. The first and the second drive machines can be of different size and power rating. Preferably the first drive machine is a main drive machine with higher power rating than the second drive machine. The higher power rating of the first drive machine can be set so, as to meet maximum power demands of the marine pod drive. The smaller electric second drive machine inside the housing of the pod allows for a very compact and streamlined housing of the pod, what increases the hydrodynamic efficiency of the marine pod drive.

[0010] When both propellers are driven, they can be driven in counter rotating directions. Pods with counter rotating propellers provide higher efficiencies over pods with a single propeller. The first propeller is fixed to a first propeller shaft and the second propeller is fixed to a second propeller shaft. The first propeller shaft and the second propeller shaft can both be supported by rolling bearings in the housing of the pod.

[0011] In different embodiments the first drive machine can be either a combustion engine or an electric motor. An embodiment with a combustion engine as the first drive machine and an electric motor as the second drive machine is called hybrid version, whereas an embodiment with each one electric motor as first and second drive machines is an all-electric version.

[0012] In the hybrid version, i.e. when the first drive

machine is a combustion engine, the drive train between the first drive machine and the first propeller may comprise a forward clutch and a reverse clutch to allow operation of the first propeller in forward, reverse and neutral. Said clutches can be arranged in an upper gearbox together with the upper bevel gear unit, as known from conventional marine drive units. In another embodiment of the hybrid version, the reverse propulsion can be effected by the electric second drive machine and the second propeller only, so that a simple drive train without any switchable clutch can be installed for the first propeller.

[0013] Further aspects of the invention belong to different operating modes of the proposed marine pod drive. One aspect is a method to operate the marine pod drive in a so-called Eco-mode, wherein the first drive machine is only running, when the power requirement exceeds a maximum power from the second drive machine. The second drive machine in the pod allows cruising with low noise and zero emission, when only the electric motor, i.e. the second drive machine is operating. This is necessary to be allowed to enter protected areas, where ships are forbidden, which are driven by a combustion engine. Another advantage of the pure electric mode is, that there is no mechanical wear in the drive train, which increases its service life.

[0014] In other operating phases the second drive machine can be operated together with the first drive machine in a booster mode. This way the power of both drive machines can be applied to reach a maximum power of the marine pod drive. The all-electric marine pod drive has the additional benefits of lower maintenance costs and no fuel costs compared to a pod drive with a combustion engine.

[0015] In the all-electric version the first and the second propeller can be used for recharging electric batteries, from the hydrogenation effect, when the corresponding electric motor is operating in a generator mode. The effect of hydrogenation can be used during sailing, when both drive machines are switched to a generator mode and the first and the second propellers are driven by the water streaming through the propeller areas of both propellers. Hence, the propellers drive the motor shafts of the electric motors and generate electric energy, which can be stored in batteries on board of the ship. Such an operation mode can be called a charge mode from sailing cruising.

[0016] With the hybrid version of the marine pod drive a corresponding charge mode from sailing cruising is also possible, by means of the second propeller and the second drive machine, which is the electric machine. The hybrid version of the marine pod drive additionally allows recharging in a charge mode from the combustion engine. In the charge mode from the combustion engine, the combustion engine is used to drive the ship by means of the first propeller, while the motor shaft of the electric motor being rotated by the effect of the water streaming through the propeller area of the second propeller which

is coupled to the electric motor. Consequently electric energy is generated by operating the electric motor as a generator.

[0017] The all-electric version and the hybrid version can both be operated in a mode, where only the first drive machine is operative. As an example this mode can be used to save electric energy in the batteries for later operations in the Eco-mode as described above.

[0018] In one embodiment of the all-electric version the first drive machine is an electric motor, which is operated in a high voltage range, for example in a voltage range of 360 to 400V. The second drive machine can be operated in a low voltage range, for example with a nominal voltage of 48 Volt. Such a configuration can beneficially be used in a marine pod drive with the first drive machine as a main drive and the second drive machine as an auxiliary drive to achieve the benefits mentioned above.

[0019] A speed reduction gear can be arranged between the second drive machine and the second propeller. The rotation speed of the motor shaft of the second drive machine can be matched to a desired rotation speed of the second propeller in a simple manner by means of the speed reduction gear. Preferably, such a speed reduction gear is a planetary gear, which allows for compact design and a relatively high reduction ratio.

[0020] For an independent control of the first and second propeller operation, a first control unit can be provided to control the first drive machine and a second control unit can be provided for the control of the second drive machine. Hence, there can be separate control units to control the drive units of both propellers. Each control unit may comprise several control devices with electronic components like processors, memories for storing data and/or software, interfaces and further communication means. The two independent drive machines and control units provide redundancy and a high reliability. In this regard the second drive machine can be a backup solution in case of a failure or lack of the first drive machine. The first and the second control units can be both connected to a control system of the ship. An appropriate drive mode in every situation can be determined and selected by the control system, depending on command signals from one or more control heads or other HMI on the ship. Consequently corresponding commands for the operation of the first and second drive machines can be transmitted to the first and second control unit.

[0021] The proposed marine pod drive can be used as a saildrive for sailing boats and ships. The invention will be further and more particularly described in the following, by way of example only, and with reference to the accompanying figure.

Fig. 1 shows a hybrid version of a marine pod drive according to the invention in a schematic drawing and

Fig. 2 shows an all-electric version of a marine pod

drive according to the invention in a schematic drawing.

[0022] The marine pod drive 1 as shown in Fig. 1 is mounted on a ship 100. A first drive machine 10 in form of a combustion engine is mounted inside a hull 101 of the ship 100. The marine pod drive 1 further comprises a first propeller 11 and a second propeller 21, which are arranged at a pod 5. The first propeller 11 is arranged at a trailing end of the pod 5 and the second propeller 21 is arranged at a leading end of the pod 5, so that the first propeller 11 works as a pushing propeller and the second propeller 21 acts as a pulling propeller. The first propeller 11 is fixed to a first propeller shaft 17, which is supported by a bearing 18 in a housing 4 of the pod 5. The second propeller 21 is fixed to a second propeller shaft 22, which is supported by bearing 24 in the housing 4. Both bearings can be roller or needle bearings, as an example. Each propeller shaft 17, 22 can be supported in more than one bearing inside the housing 4. The steerable pod 5 is mounted underneath the hull 101. The pod 5 can be rotated about a vertical rotation axis 6 to steer the ship 100 in a desired heading. However, other embodiments of the invention can comprise a non-steerable pod, i.e. a pod which is non-rotatably attached to the hull of a ship.

[0023] A first drive machine 10 drives the first propeller 11 and a second drive machine 20 drives the second propeller 21. The first drive machine 10 is operatively connected to the first propeller 11 via a mechanical drive train 3. Drive train 3 comprises an upper bevel gear unit 12 which is arranged at an upper end of a vertical shaft 15 to connect a horizontal drive shaft 19 with the vertical shaft 15. The horizontal drive shaft 19 is the input shaft of the upper bevel gear unit 12. The horizontal drive shaft 19 is drivingly connected to a crank shaft 7 of the first drive machine 10 by means of a coupling 8. The vertical shaft 15 is coupled to a first propeller shaft 17 by a lower bevel gear unit 16. At the upper bevel gear unit 12 there is a forward clutch 13 and a reverse clutch 14 provided, to allow operation of the first propeller 11 in forward, in reverse and in a neutral operation mode. Said clutches 13 and 14 are pressure operated clutches, as known from conventional pod drive units with combustion engines as a main drive.

[0024] The second drive machine 20 is an electric motor, which is arranged inside the housing 4 of the pod 5. The second drive machine 20 comprises a stator which is fixed to the housing 4 and a rotor, which is coupled to the second propeller shaft 22. A speed reduction gear 23 is arranged between the second drive machine 20 and the second propeller shaft 22 inside the housing 4 of the pod 5. The speed reduction gear 23 reduces high rotational speeds of the electric motor shaft to appropriate rotational speeds at the second propeller 21.

[0025] A first control unit 30 is provided to control the first drive machine 10, 210, and wherein a second control unit 25 is provided for the control of the second drive

machine 20.

[0026] The Fig. 2 shows a marine pod drive 2 in an all-electric version. This means, that the first drive machine 210 and the second drive machine 20 are both electric motors. The first drive machine 210 in this embodiment is a high voltage electric machine with a nominal voltage range of 360 to 400V. The second drive machine 20 is a low voltage machine with a nominal voltage of 48 Volt. The motor shaft 209 of the first drive machine 210 is connected to the input shaft 19 of the upper bevel gear unit 12 by coupling 8. The other components of the all-electric version are the same as in the hybrid version described above. Therefore, these components refer to the same referral numbers and are not further described here. In such an embodiment the second drive machine 20 provides a backup solution in case of failure or lack of the first drive machine 210. The all-electric version requires significantly lower costs for maintenance compared to conventional pod drives with a combustion engine and to the hybrid version.

Referrals

[0027]

1	marine pod drive - hybrid version
2	marine pod drive - all-electric version
3	drive train
4	housing
5	pod
6	rotation axis
7	crank shaft
8	coupling
10	first drive machine - combustion engine
11	first propeller
12	upper bevel gear unit
13	forward clutch
14	reverse clutch
15	vertical shaft
16	lower bevel gear unit
17	first propeller shaft
18	bearing
19	horizontal drive shaft
20	second drive machine
21	second propeller
22	second propeller shaft
23	speed reduction gear
24	bearing
25	second control unit
30	first control unit
100	ship
101	hull
200	ship
209	motor shaft
210	first drive machine - electric motor

Claims

1. Marine pod drive (1, 2) with a first propeller (11) and a second propeller (21), wherein the first propeller (11) is arranged at a trailing end of the pod (5) and wherein the second propeller (21) is arranged at a leading end of the pod (5),
the marine pod drive (1, 2) further comprising a first drive machine (10, 210) which drives the first propeller (11) and a second drive machine (20) which drives the second propeller (21), wherein the first drive machine (10, 210) is operatively connected to the first propeller (11) via a drive train (3) comprising a vertical shaft (15) and a lower bevel gear unit (16), and wherein the second drive machine (20) is an electric motor which is arranged inside a housing (4) of the pod (5). 5
2. Marine pod drive (1, 2) according to claim 1, wherein the drive train (3) comprises an upper bevel gear unit (12) which is arranged at an upper end of the vertical shaft (15) to connect a horizontal drive shaft (19) with the vertical shaft (15). 10
3. Marine pod drive (1, 2) according to claim 1 or 2, wherein the first drive machine (10, 210) is a combustion engine, and wherein the drive train (3) comprises a forward clutch (13) and a reverse clutch (14). 15
4. Marine pod drive (1, 2) according to one of the claims 1 or 2, wherein the first drive machine (10, 210) is an electric motor. 20
5. Marine pod drive (1, 2) according to claim 4, wherein the first drive machine (10, 210) is a high voltage electric machine with a nominal voltage range of 360 to 400V, and wherein the second drive machine (20) is a low voltage machine with a nominal voltage of 48 Volt. 25
6. Marine pod drive (1, 2) according to one of the preceding claims, wherein a speed reduction gear (23) is arranged between the second drive machine (20) and the second propeller (21). 30
7. Marine pod drive (1, 2) according to one of the preceding claims, wherein a first control unit (30) is provided to control the first drive machine (10, 210), and wherein a second control unit (25) is provided for the control of the second drive machine (20). 35
8. Ship (100, 200) with a hull (101) and with a marine pod drive (1, 2) according to one of the preceding claims, wherein the first drive machine (10, 210) is located inside the hull (101). 40

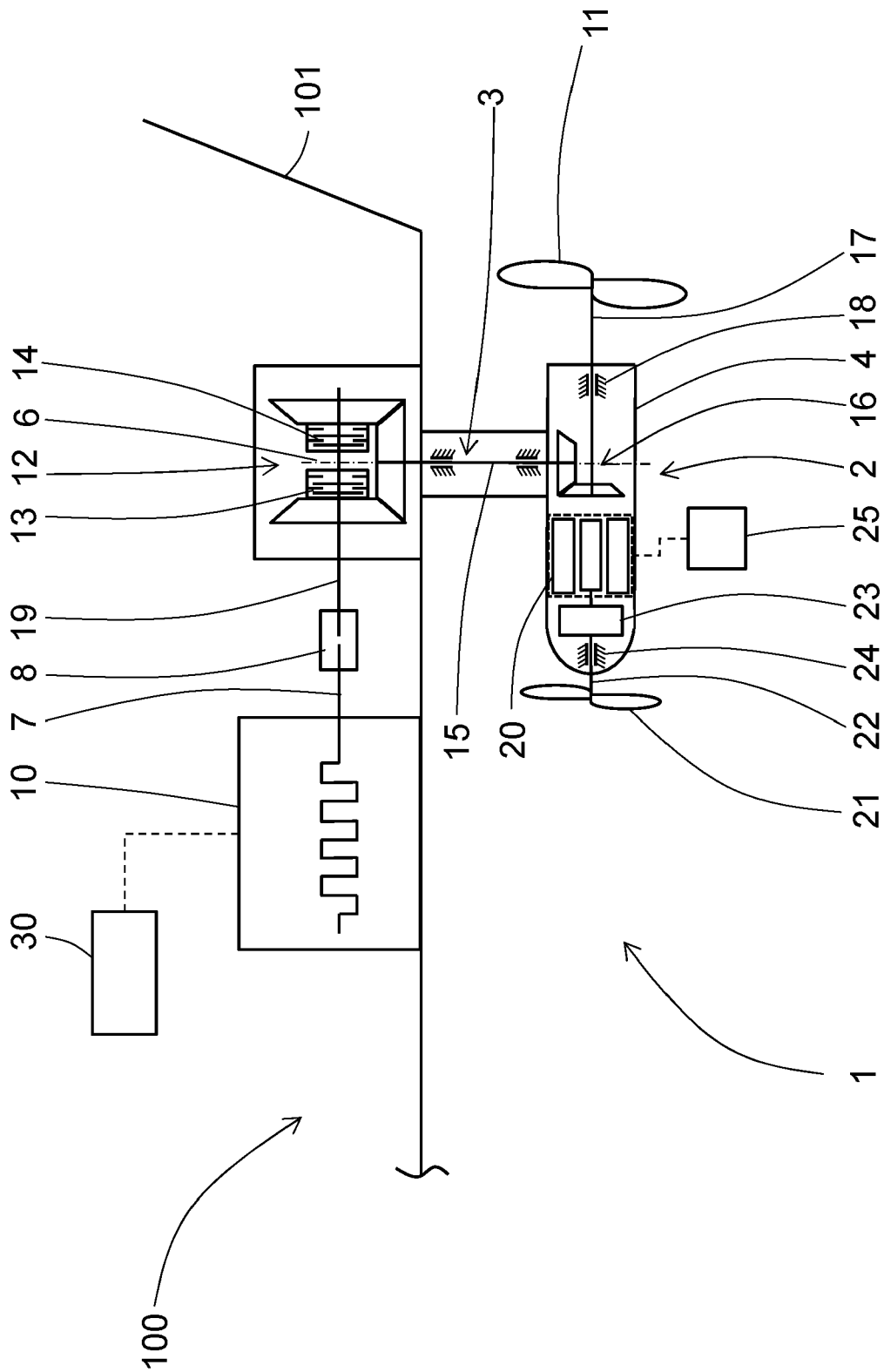


Fig. 1

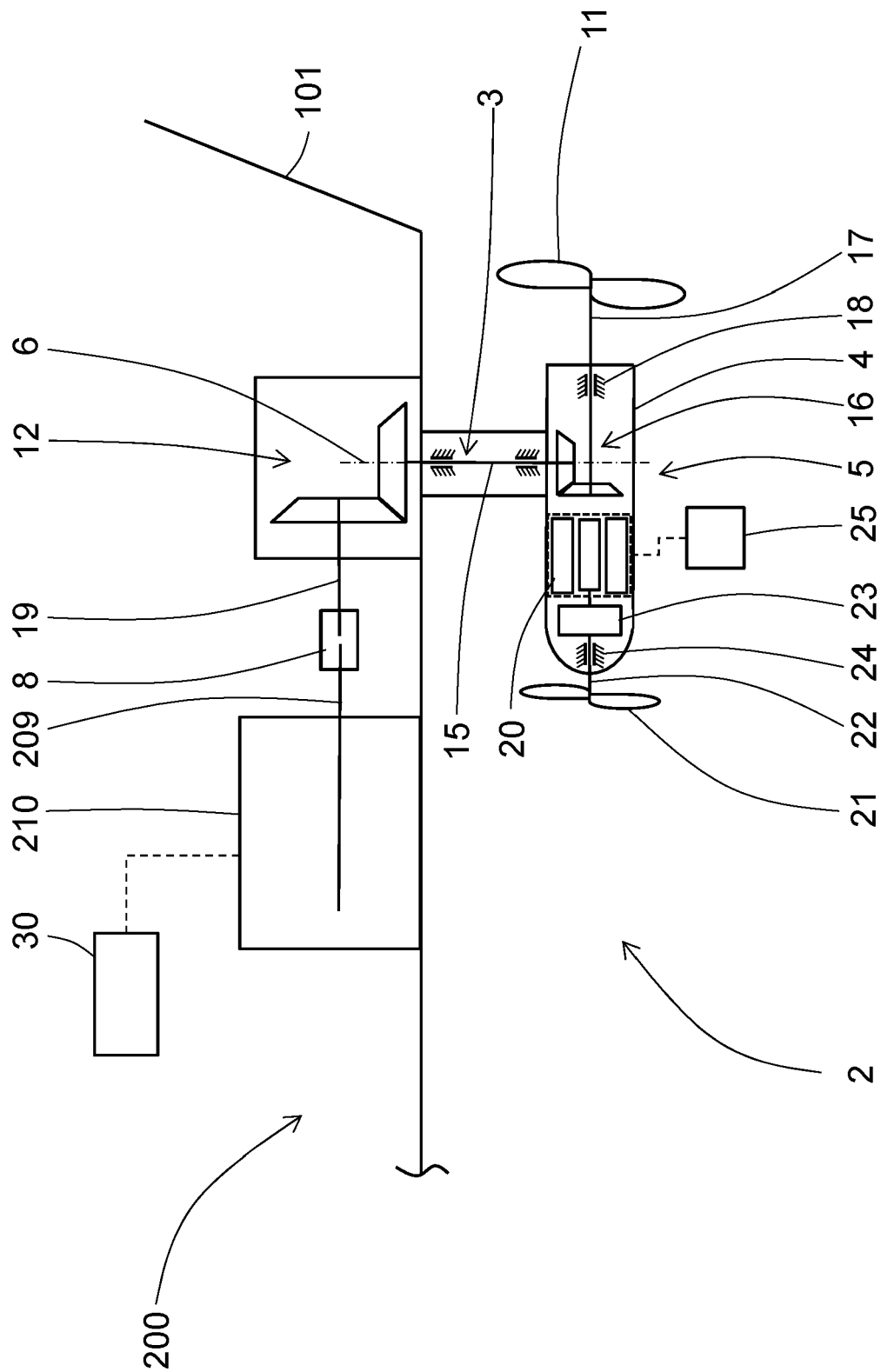


Fig. 2



EUROPEAN SEARCH REPORT

Application Number

EP 23 20 0469

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		14 March 2024	Ibarrondo, Borja
CATEGORY OF CITED DOCUMENTS			
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