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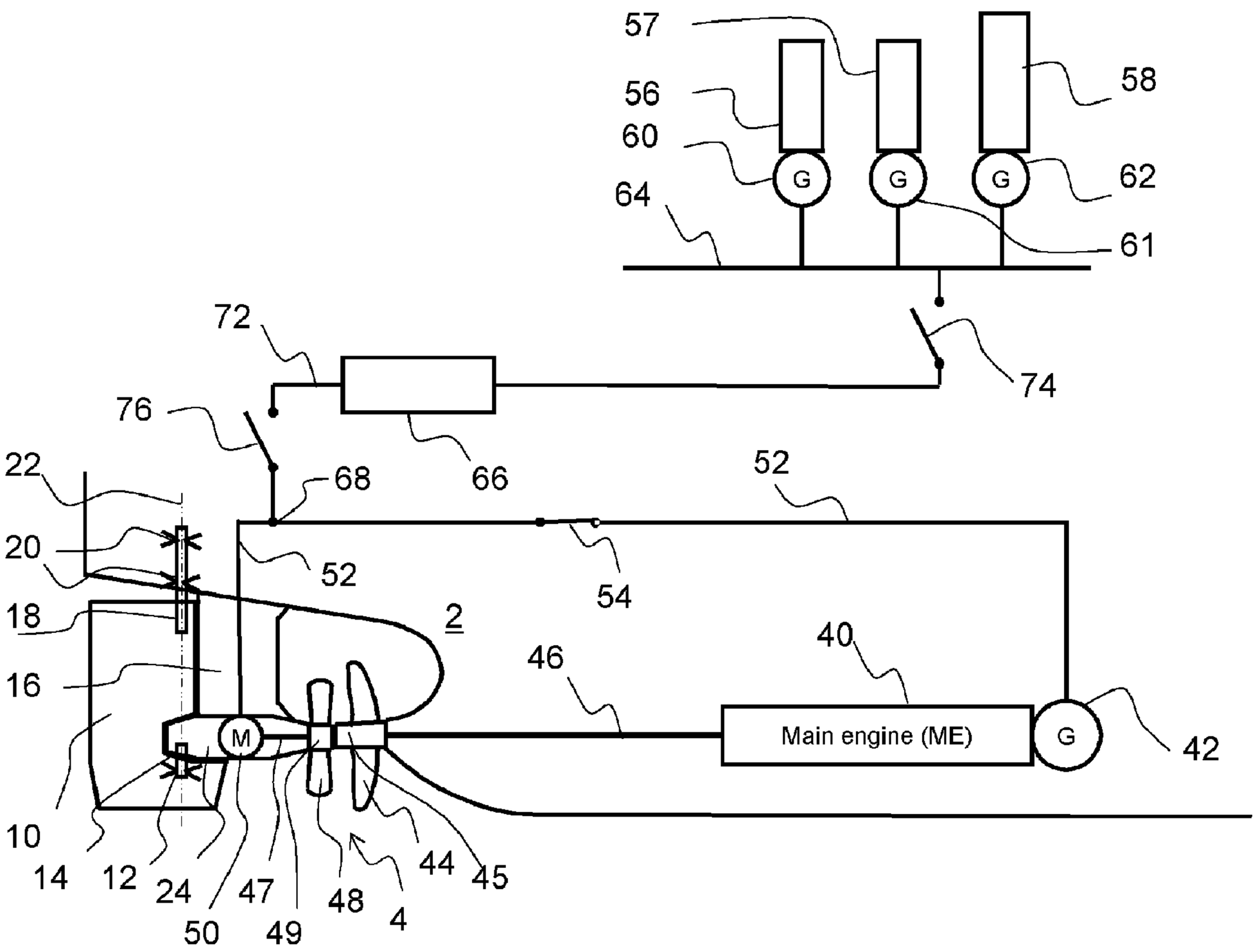
(54) **Titre : DISPOSITIF POUR DIRIGER UN NAVIRE ET ALIMENTER SON SYSTEME DE PROPULSION EN ENERGIE**
(54) **Title: ARRANGEMENT FOR STEERING A SHIP AND FOR SUPPLYING POWER TO ITS PROPULSION SYSTEM**



(57) **Abrégé/Abstract:**
Arrangement for steering and supplying propulsion power to a contra rotating propellers (CRP) propulsion system in a marine vessel, which arrangement comprises a first propeller driven by a rotating power unit and a second propeller driven by an AC motor

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(57) **Abrégé(suite)/Abstract(continued):**
whereby the second propeller is rotated in the opposite direction as the first propeller, and an AC generator coupled to mechanical output shaft of the power unit and driven by a rotating power unit, whereby the AC generator is electrically connected to the AC motor. According the arrangement the AC motor and the AC generator have the same electrical frequency, another electrical power source is electrically connectable to the AC motor parallel to the AC generator, the shaft of the second propeller is mounted rotatable in a support structure which is attached to a hull of the marine vessel, and a rudder, which is supported in a manner allowing pivotal movement of the rudder relative to the support structure.

ABSTRACT

Arrangement for steering and supplying propulsion power to a contra rotating propellers (CRP) propulsion system in a marine vessel, which arrangement comprises a first propeller driven by a rotating power unit and a second propeller driven by an AC motor whereby the second propeller is rotated in the opposite direction as the first propeller, and an AC generator coupled to mechanical output shaft of the power unit and driven by a rotating power unit, whereby the AC generator is electrically connected to the AC motor. According the arrangement the AC motor and the AC generator have the same electrical frequency, another electrical power source is electrically connectable to the AC motor parallel to the AC generator, the shaft of the second propeller is mounted rotatable in a support structure which is attached to a hull of the marine vessel, and a rudder, which is supported in a manner allowing pivotal movement of the rudder relative to the support structure.

ARRANGEMENT FOR STEERING A SHIP AND FOR SUPPLYING POWER TO ITS PROPULSION SYSTEM

Field of the invention

The present invention relates to an arrangement for steering and supplying propulsion power to a contra rotating propellers (CRP) propulsion system in a marine vessel

Background of the invention

The propulsion power of the large ships or marine vessels is generated by rotating power unit, whose energy source is oil, gas, nuclear power. The rotating power unit may be a diesel engine, gas turbine or nuclear power reactor rotating turbine. The mechanical output shaft is either directly or via a gear coupled to the shaft of the propeller or the rotating power unit drives a generator, which supplies electric power to the propeller motors of the ship. Furthermore, several different combinations of these two main manners to drive the propeller have been utilized.

The power and energy efficiency of the marine vessel necessitate that the propulsion power is generated as economically as possible in different operation modes. The overall energy consumption should therefore be optimized. That means that the electric energy must be generated using the most economical power production system that is available on board and that the electric energy is utilized as efficiently as possible when supplying the electric energy to the devices and motors using the electric energy.

As is well-known in the art the propulsion devices consume the majority of the energy expended in the marine vessels. Further, the propulsive force or thrust is generated using simultaneously different kind of engines or motors. Therefore it is important that these cooperate so that when producing the required propulsive power and steering their combined energy consumption is as low as possible. At the same time the total energy consumption and the generation of electricity must be as efficient as possible. While it is important that the total energy of the vessel is generated effectively and the electric power is supplied and used to all the electric power consuming devices effectively in different operating situations, the efficiency of the propulsion unit is of supreme importance as most of the energy is used when moving straight ahead under constant conditions.

Publication WO 02/072418 suggests a CRP-propeller arrangement where one propeller is driven by a main engine and another propeller is driven by an electric motor. The shafts of the first and second propellers are coaxial and the shaft of the first propeller is arranged in the hollow shaft of the second propeller. The main engine drives the first propeller coupled to the shaft of the main engine and the generator arranged to the shaft of the main engine supplies electric power to a motor that drives the second propeller. In addition, there are other engines that rotate generators that supply power to the motor.

Summary of the invention

An object of the invention is to create a new and cost-effective arrangement to supply electric power in a ship or marine vessel.

In one aspect, the present invention provides an arrangement for steering and supplying propulsion power to a contra rotating propellers (CRP) propulsion system in a marine vessel, which arrangement comprises a first propeller driven by a rotating power unit and a second propeller driven by an AC motor whereby the second propeller is rotated in the opposite direction as the first propeller, and an AC generator coupled to mechanical output shaft of the power unit and driven by a rotating power unit, whereby the AC generator is electrically connected to the AC motor, characterized in that the arrangement comprises that

- (i) the AC motor and the AC generator have the same electrical frequency,
- (ii) another electrical power source is electrically connectable to the AC motor parallel to the AC generator,
- (iii) the shaft of the second propeller is mounted rotatable in a support structure which is attached to a hull of the marine vessel, and
- (iv) a rudder, which is supported in a manner allowing pivotal movement of the rudder relative to the support structure.

In another aspect, the present invention provides an arrangement for steering and supplying propulsion power to a contra rotating propeller (CRP) propulsion system in a marine vessel, which arrangement comprises:

a first propeller driven by a rotatable power unit;

a second propeller driven by an AC motor, whereby the second propeller will rotate in an opposite direction relative to the first propeller; and

an AC generator coupled to a mechanical output shaft of the rotatable power unit to be driven by the rotatable power unit, the AC generator being electrically connected to the AC motor, wherein:

(i) the AC motor and the AC generator have a same electrical frequency;

(ii) another electrical power source is provided which is configured to be electrically connectable to the AC motor in parallel to the AC generator;

(iii) a shaft of the second propeller is rotatably mounted in a support structure which is attached to a hull of the marine vessel; and

(iv) a rudder is supported in a manner allowing pivotal movement of the rudder relative to the support structure.

The rudder can be supported to the hull of the marine vessel. Hubs of the first propeller and the second propeller can form a continuous streamlined shape.

The arrangement for steering and supplying propulsion power to a contra rotating propellers (CRP) propulsion system in a marine vessel comprises a first propeller driven by a rotating power unit and a second propeller driven by an AC motor whereby the second propeller is rotated in the opposite direction as the first propeller, and an AC generator coupled to mechanical output shaft of the power unit and driven by a rotating power unit, whereby the AC generator is electrically connected to the AC motor. The arrangement comprises that (i) the AC motor and the AC generator have the same electrical frequency, (ii) another electrical power source is electrically connectable to the AC motor parallel to the AC generator, (iii) the shaft of the second propeller is mounted rotatable in a support structure which is attached to a hull of the marine vessel, and (iv) a rudder, which is supported in a manner allowing pivotal movement of the rudder relative to the support structure.

According to one embodiment of the invention the rudder is supported to the hull of the marine vessel.

According to one embodiment of the invention that hubs of the first propeller and the second propeller form a continuous streamlined shape.

When using the arrangement of the invention there is more freedom in ship's general arrangement and hull design. The electric power generators can be positioned in a more advantageous way and the hydrodynamic efficiency of the vessel is thereby improved.

The energy is generated by the most efficient way in different operation situations and when fulfilling varying power demand of the vessel. Thereby the electrical losses of the marine vessel also are minimized compared to conventional electrical propulsion systems.

Brief description of the drawings

The invention will be described in more detail in the following by referring to the appended figures, in which

- Figure 1 shows an embodiment of the invention,

Detailed description of the invention

Figure 1 shows a schematic diagram of an embodiment of the invention. A CRP (contra rotating propellers) propulsion arrangement 4 is installed in the aft portion of the marine vessel 2. The CRP-propulsion arrangement comprises a forward propeller 44 and the aft propeller 48 that are arranged to rotate in the opposite directions that is well-known to the men skilled in the art. A main rotating power unit 40 that is e.g. a two-stroke diesel engine drives a propulsion power ac generator 42, whose rotor is fastened to the one output shaft of the rotating power unit 40. A main propeller 44 of the vessel is fastened onto another output shaft 46 of the rotating power unit 40. Though the generator 42 and the propeller 44 are on the opposite sides of the rotating power unit 40 in the embodiment shown in the figure 1, the generator may as well be on the same side of the rotating power unit 40 as the propeller 44. Opposite to the main propeller 44 is arranged a second propeller 48 which is fixed to the output shaft 47 of an ac motor 50 and driven by the ac motor 50. The main or the forward propeller 44 is fitted with bearings (not shown) to the hull of the vessel. The second or the aft propeller 48 is supported with the ac motor 50 is installed to a pod-like housing 24 that is supported to the hull of the vessel by a support arm or strut 16. The propulsion ac generator 42 is connected to the ac motor 50 by an electrical power connection 52. Thereby the ac current generated by the ac generator 42 is directly supplied to the ac motor 50. A circuit breaker 54 is arranged on the electrical power connection 52 by which the connection between the ac motor 50 and the propulsion ac generator 42 can

be switched on and switched off. When the circuit breaker 54 is switched on, the ac motor 50 and the propulsion ac generator 42 have the same frequency.

A rudder 10 is arranged in the stern of the vessel 2. The rudder 10 is supported via a first rudder shaft 18 to the hull of the vessel 2 and via a second rudder shaft 14 to the housing 24. The first rudder shaft 18 is supported via bearings 20 that allow the pivotal movement of the rudder 10 to the hull. The second rudder shaft 14 is on the same vertical axial line 22 as the first rudder shaft 18 and the rudder 10 is allowed to have pivotal movement to the housing 24 and to the support strut 16. The second rudder shaft 14 is fixed to the housing 24 and the rudder 10 is supported thereto via a bearing 12. The rudder 10 is turned around the vertical axial line by a control unit well-known in the art.

The propellers 44 and 48 are designed to have a high efficiency in a CRP mode. The hub 45 of the propeller 44 and the hub 49 of the propeller 48 are formed to have a streamlined shape. The propellers are arranged to the axial line and their common outer surface form a streamlined entirety. The pod-like housing 24, the supporting strut 16 and the rudder 10 also form a streamlined shape.

Three auxiliary rotating power units 56, 57 and 58 are coupled to three generators 60, 61 and 62, which are via electrical power connections connected to a main switchboard or a main bus 64 of the ship. The switchboard 64 is connected to the electric distribution mains of the vessel and the generators 60, 61 and 62 supply the electric power to the consumers. The auxiliary rotating power units 56, 57 and 58 are preferably four-stroke diesel engines having lower power than the rotating power unit 40. They may also be gas turbines or waste heat recovery systems, for example. The auxiliary rotating power units 56, 57 and 58 can be located in a suitable space in the hull of the vessel and they need not be positioned near the propellers 44 or 48 of the vessel or near the other consumers of the electric power. A frequency converter 66 is coupled between the main switchboard 64 and the junction 68 of the electrical power connection 52 via an electrical power connection 70 and via an electrical power connection 72 connecting, respectively. There is a second circuit breaker 74 between the main switchboard 64 and the frequency converter 66 and a third circuit breaker 76 between the frequency converter 66 and the junction 68.

The propulsion system shown in the figure 1 can be operated and controlled in several ways depending on the operation mode.

In one mode the propulsion power is generated by the main rotating power unit 40. The main rotating power unit 40 is functioning at full power and the ac generator 42 is directly connected to the ac motor 50. The circuit breaker 54 is switched on and also the circuit breakers 74 and 76 are switched on and the frequency converter 66 is connected between the main switchboard 64 and the junction 68 of the line 52. The ac motor 50 is totally supplied from the ac generator 42 via the electrical power connection 52. As the ac generator 42 is directly connected to the ac motor 50 via the electrical power connection 52, the ac generator 42 and the ac motor has the same frequency. When the ac generator 42 and the ac motor 50 has the same number of poles they are thereby rotating essentially on the same rotational speed, in the case of synchronous machines the speed is the same and in the case of asynchronous machines the speed differs on the amount of the slip. When the ac generator 42 and the ac motor 50 have different pole numbers, their rotational speeds differ from each other on the basis of the pole numbers of the machines. Correspondingly the rotational speeds of the aft and forward propellers differ on the same way as they are fastened to the shafts of the machines.

In a second mode the propulsion power is generated by the auxiliary rotating power units 56, 57 and 58 and the main rotating power unit 40. The ac motor is supplied both from the ac generators 50 and ac generators 60, 61 and 62 via the frequency converter 66 and from the ac generator 42 via the electrical power connection 52. The circuit breakers 74 and 76 are switched on and the electric power is supplied to ac motor 50 via the frequency converter 66 and via the main switchboard from the generators 60, 61 and 62. The power and frequency supplying the electric energy from the generators 60, 61 and 62 to the ac motor 50 is controlled by the frequency converter 66. Depending on the power demand of the propulsion system and the power demand of the other electric power users in the vessel, the frequency converter may also supply electric power to the main switch board 64 via the frequency converter 66.

The propulsion power of the marine vessels according to the invention is generated by rotating power unit, whose energy source is oil, gas, nuclear power. The rotating power unit may be a diesel engine, gas turbine or nuclear power reactor rotating turbine. Further,

waste heat recovery system may be used that utilizes the exhaust gases of main engines by turbochargers.

The ac generator may also be connected to the shaft of the main engine via a gear. Between the second propeller and the ac motor rotating it there may be different kind of gear arrangements. These modifications allow many varieties that are in scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An arrangement for steering and supplying propulsion power to a contra rotating propeller (CRP) propulsion system in a marine vessel, which arrangement comprises:

a first propeller driven by a rotatable power unit;

a second propeller driven by an AC motor, whereby the second propeller will rotate in an opposite direction relative to the first propeller; and

an AC generator coupled to a mechanical output shaft of the rotatable power unit to be driven by the rotatable power unit, the AC generator being electrically connected to the AC motor, wherein:

(i) the AC motor and the AC generator have a same electrical frequency;

(ii) another electrical power source is provided which is configured to be electrically connectable to the AC motor in parallel to the AC generator;

(iii) a shaft of the second propeller is rotatably mounted in a support structure which is attached to a hull of the marine vessel; and

(iv) a rudder is supported in a manner allowing pivotal movement of the rudder relative to the support structure.

2. The arrangement according to claim 1, wherein the rudder is supported by the hull of the marine vessel.

3. The arrangement according to claim 1 or 2, wherein hubs of the first propeller and the second propeller form a continuous streamlined shape.

4. The arrangement according to any one of claims 1 to 3, further comprising:

a first circuit breaker configured to connect or disconnect the AC generator to the AC motor.

5. The arrangement according to claim 4, further comprising:

a second circuit breaker configured to connect or disconnect the frequency converter to the AC motor; and

a third circuit breaker configured to connect or disconnect the frequency converter to a main bus of the marine vessel.

6. The arrangement according to claim 5, wherein the first, second and third circuit breakers are closed.

7. The arrangement according to claim 6, wherein during a first mode, the AC motor is connected to receive full propulsion power from the AC generator.

8. The arrangement according to claim 6 or 7, wherein during a second mode the AC motor is connected to receive propulsion power partly from the AC generator and the another electrical power source.

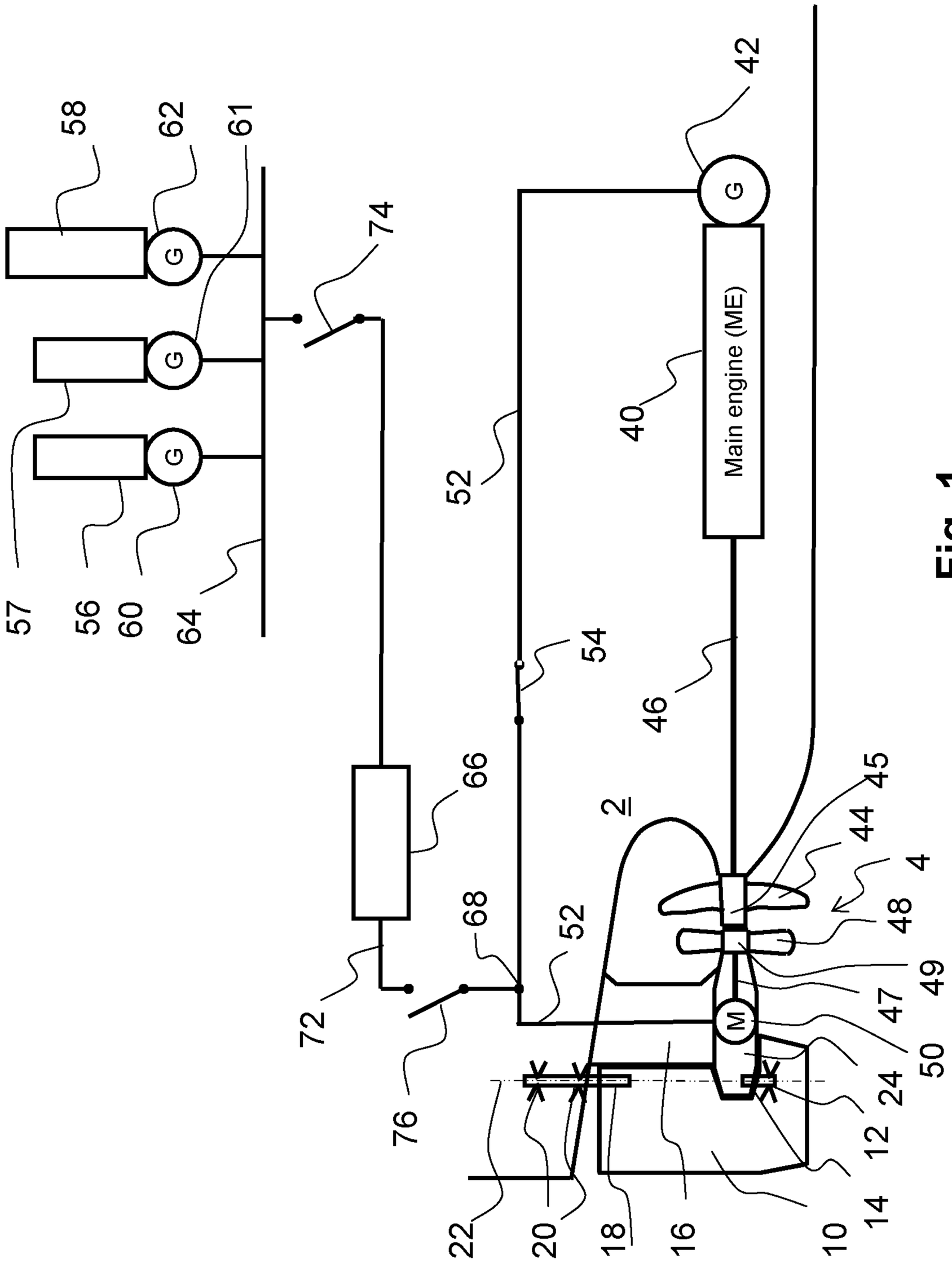
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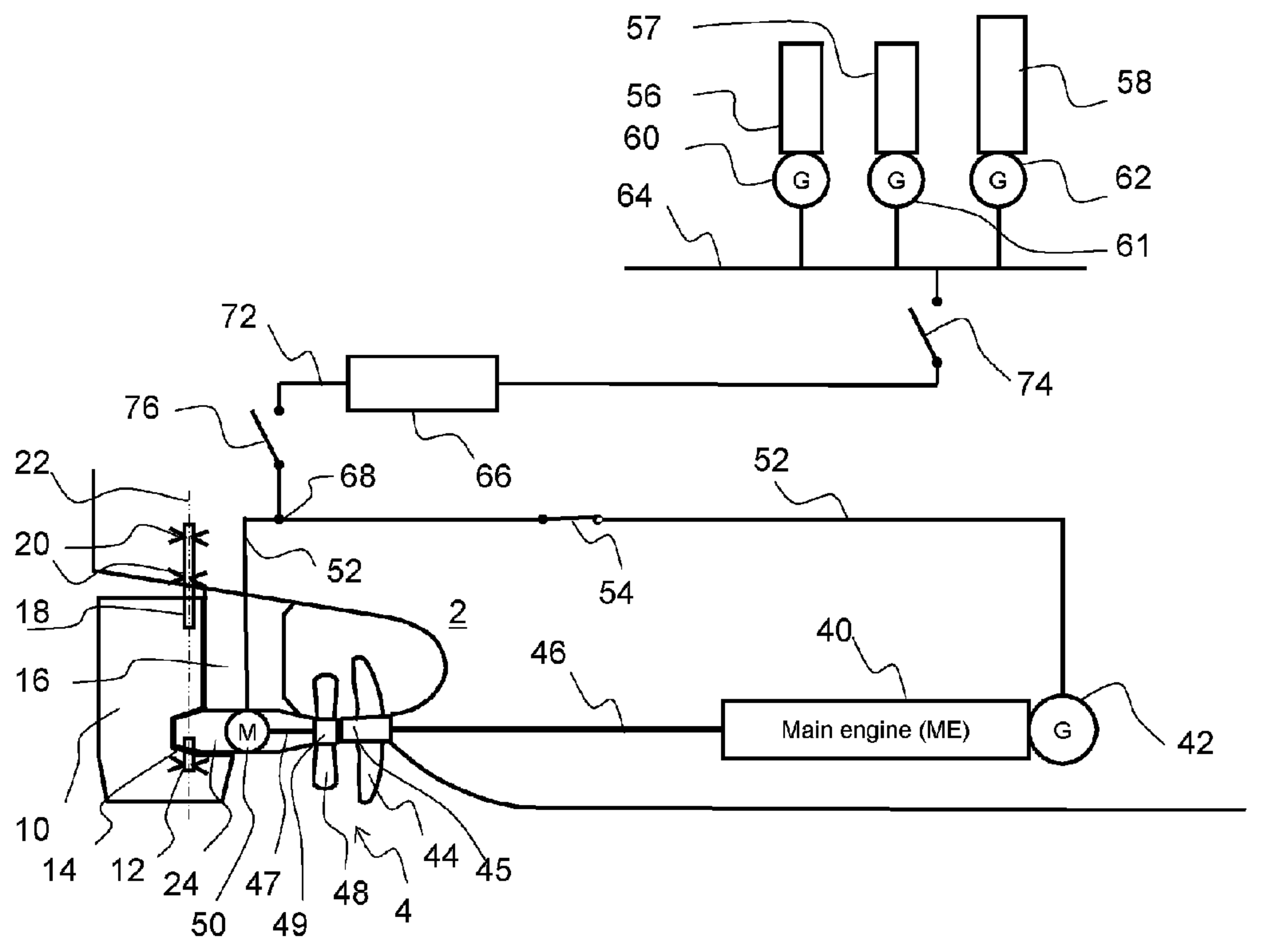
Fig. 1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