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- (71) **Applicant (for all designated States except US):** **ABB OY** [FI/FI]; Strömbergintie 1, FI-00380 Helsinki (FI).
- (72) **Inventor; and**
- (75) **Inventor/Applicant (for US only):** **KOKKILA, Kimmo** [FI/FI]; Kaarlenkatu 12 A 9, FI-00530 Helsinki (FI).
- (74) **Agent:** **KORPELAINEN, Seppo;** ABB Oy, Legal Affairs/Patents, P.O.Box 210, FI-00381 Helsinki (FI).
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(54) **Title:** ARRANGEMENT FOR STEERING A SHIP AND FOR SUPPLYING POWER TO ITS PROPULSION SYSTEM

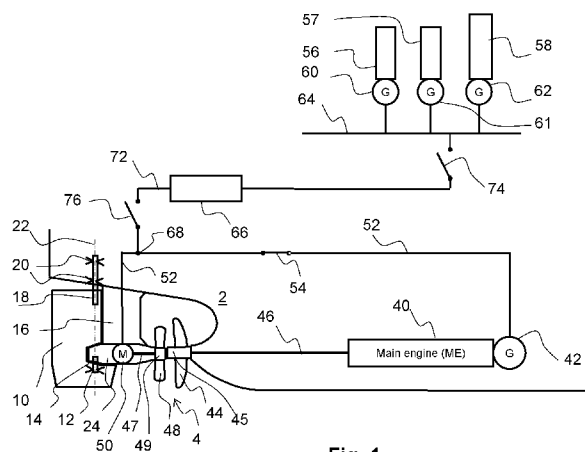


Fig. 1

(57) **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 (44) driven by a rotating power unit (40) and a second propeller (48) driven by an AC motor (50) whereby the second propeller (48) is rotated in the opposite direction as the first propeller (44), and an AC generator (42) coupled to mechanical output shaft of the power unit (40) and driven by a rotating power unit, whereby the AC generator (42) is electrically connected to the AC motor (50). According the arrangement the AC motor (50) and the AC generator (42) have the same electrical frequency, another electrical power source (60,61,62) is electrically connectable to the AC motor (50) parallel to the AC generator (42), the shaft (47) of the second propeller is mounted rotatable in a support structure (16,24) which is attached to a hull of the marine vessel (2), and a rudder (10), which is supported in a manner allowing pivotal movement of the rudder (10) relative to the support structure (16, 24).

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
5 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
10 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
15 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.

20 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
25 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

The object of the invention is to create a new and cost-effective arrangement to supply electric power in a ship or marine vessel. This arrangement according to the invention is characterized by the features of claim 1. Preferred embodiments of the invention are defined in the dependent claims.

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

10 - 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 is supported via a rudder shaft 14 the hull of the vessel 2 and via rudder shaft 18 to the housing 24. The rudder shaft 14 is supported via bearings 20 that allow the pivotal movement of the rudder to the hull. The rudder shaft 18 is on the same vertical axial line 22 as the rudder shaft 14 and the rudder 16 is allowed to have pivotal movement to the housing 24 and to the support strut 16. The rudder shaft is fixed to the housing 24 and rudder is supported thereto via a bearing 12. The rudder 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, 56 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
5 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
10 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
15 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
20 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
25 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
30 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
5 gear arrangements. These modifications allow many varieties that are in scope of the invention.

CLAIMS

1. 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 (44) driven by a rotating power unit (40) and a second propeller (48) driven by an AC motor (50) whereby the second propeller (48) is rotated in the opposite direction as the first propeller(44), and an AC generator (42) coupled to mechanical output shaft of the power unit (40) and driven by a rotating power unit, whereby the AC generator (42) is electrically connected to the AC motor (50), **characterized** in that the arrangement comprises that
- 10 - (i) the AC motor (50) and the AC generator (42) have the same electrical frequency,
- (ii) another electrical power source (60,61,62) is electrically connectable to the AC motor (50) parallel to the AC generator (42),
- (iii) the shaft (47) of the second propeller is mounted rotatable in a support structure (16,24) which is attached to a hull of the marine vessel (2), and
- 15 - (iv) a rudder (10), which is supported in a manner allowing pivotal movement of the rudder (10) relative to the support structure (16,24).
2. Arrangement according to claim 1 **characterized** in that the rudder (10) is supported to the hull of the marine vessel (2).
3. Arrangement according to claim 1 **characterized** in that hubs (45,49) of the first
20 propeller (44) and the second propeller (48) form a continuous streamlined shape.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/051561

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B63H5/10 B63H23/24
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 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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 117 881 A1 (LICENTIA GMBH [DE]) 12 September 1984 (1984-09-12)	1,2
Y	the whole document	3
X	WO 2005/030573 A1 (ABB OY [FI]; PAKASTE RISTO [FI]) 7 April 2005 (2005-04-07) the whole document	1,2
Y	EP 1 466 826 A2 (WAERTSILAE FINLAND OY [FI]) 13 October 2004 (2004-10-13)	3
A	figure 1	1,2

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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- "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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/EP2012/051561

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