(19) DANMARK

(10) DK 177460 B1

(12) PATENTSKRIFT

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *F 02 G 5/02 (2006.01)* *B 63 J 3/00 (2006.01)*

(21) Ansøgningsnummer: **PA 2012 00287**

(22) Indleveringsdato: **2012-04-26**

(24) Løbedag: **2012-04-26**

(41) Alm. tilgængelig: **2013-06-17**

(45) Patentets meddelelse bkg. den: **2013-06-17**

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(54) Benævnelse: **Drivsystem til skibe med en stor turboladet totakts stempelmotor med spildvarmegenvinding og fremgangsmåde til drift af driftsystemet**

(56) Fremdragne publikationer:
JP 02061307
WO A1 2007/124068
WO A2 2006/116479
JP 61258700

(57) Sammendrag:
A marine propulsion system (1) with waste heat recovery, and main large two stoke turbocharged internal combustion engine (2) driving a propeller shaft (3) that is coupled to a ship propeller (4) . The waste heat recovery system (11) includes a turbine (18) and a generator (20) for generating electrical energy from waste heat of the main engine (2) for an electrical network (5) of the ship. A shaft generator/motor (10) is coupled to the propeller shaft (3) and connected electrically to the electrical network (5) of the ship. The shaft generator/motor (10) is configured to convert electrical energy from the electrical network (5) into mechanical energy for driving the propeller shaft (3) in a drive motor operation mode of the shaft generator/motor (10) and the shaft generator/motor (10) is configured to convert mechanical energy from the propeller shaft (3) into electric energy for the electrical network (5) in a generator operation mode of the shaft generator/motor (10). A controller (16) is operably connected to the shaft generator/motor (10) and the controller (12) is configured to control the frequency of the electrical network by adjusting the operation of the shaft generator/motor (10)

Fortsættes ...

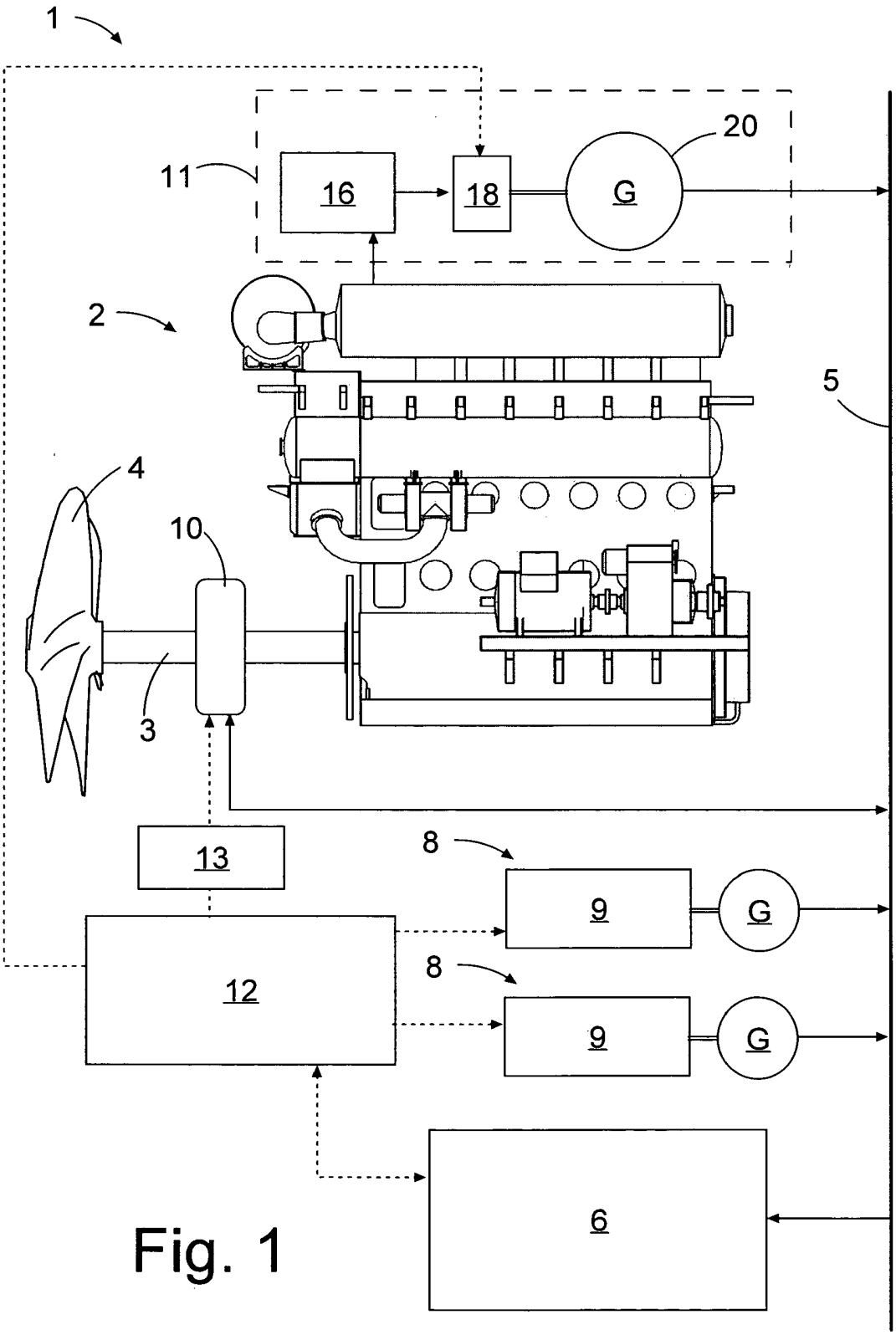


Fig. 1

A MARINE PROPULSION SYSTEM WITH A LARGE TURBOCHARGED TWO-STROKE RECIPROCATING PISTON ENGINE WITH WASTE HEAT RECOVERY AND A METHOD FOR OPERATING THE MARINE PROPULSION SYSTEM

FIELD OF THE INVENTION

The present disclosure relates to a method of operating a marine propulsion system with waste heat recovery as well as to a marine propulsion system with waste heat recovery.

BACKGROUND ART

WO 2007/124968 discloses a marine propulsion system for large cargo ships, e.g. container ships, Typically, such a propulsion system comprises a main engine in the form of a slow-speed two-stroke diesel engine for generating mechanical energy to drive a propeller shaft which is coupled to the ship's propeller. The continuous rating of such engines will begin at approximately 5 MW and ends above 110 MW.

Electrical loads on board a ship are usually supplied by the ship's electrical network, which in turn receives electricity from generators that are running on combustion engines that run faster than the main engine: generator sets. These are normally four-stroke diesel engine driven generator sets. Rising fuel prices, the demand for lower emissions and to lower operating costs have in recent years have increased interest in the use of waste heat from the main engine for enhanced energy utilization. Excess heat is found especially in the exhaust gas and cooling system of the main engine. In the

aforementioned publication the propulsion system includes a waste heat recovery system that generates electricity from waste heat of the main engine and feeds the electricity into the ship's electrical network. A shaft generator/motor is mechanically coupled to the propeller shaft and electrically coupled to the electrical network. The shaft generator/motor is a unit that can operate as a drive motor when it is supplied with electrical current from the electrical network of the ship and can operate as a generator for generating electrical power when it is supplied with rotational mechanical energy from the propeller shaft. The shaft generator/motor can switch between operating as a drive motor on electric power from the ship's electrical and delivering mechanical energy to drive the shaft system and operating as a generator by converting mechanical energy of the shaft system into additional electricity for the ship's network.

Traditionally, the electrical energy for the ship network has been delivered by a plurality of auxiliary engines (gensets) that each drive an electrical generator. In a ship propulsion system with waste energy recovery system, a major part or all of the needed electrical energy can be delivered by the waste energy recovery system. When the waste heat energy recovery system delivers enough power into the ship's electrical network a power management system or controller reduces the power delivered by the auxiliary engines and the auxiliary engines are when possible completely switched off.

In addition, through the shaft generator/motor in generator operation mode, even more electrical energy can be fed into the ship's electrical network and thus the

power consumption of the auxiliary engines can be reduced still further.

These measures allow for a significant reduction of the fuel and operating costs and emissions from the auxiliary engines.

If the waste heat energy recovery system generates more energy than is required for the ship's electrical consumers, then this excess energy is supplied to the shaft generator/motor operating in the drive motor operation mode and thus an additional driving force will be delivered to the propeller shaft. In this case, only the waste heat recovery system feeds electric power network into the ship's electrical network, while the auxiliary engines are shut down.

The known propulsion and power system is constructed and designed in relation to the needs of the ship such that in most operating conditions the waste heat recovery system generates the required electrical power without assistance of other electricity producing units.

In the known propulsion and power system, the frequency of the electrical network is controlled by adjusting, i.e. throttling the electrical power generated by the waste heat recovery system. In order to be able to perform this frequency control there must be sufficient unused capacity to cover changes in the power used by the consumers.

The waste heat recovery system needs to be able to operate in a range of power settings in order to be able to perform the frequency control, i.e. the waste heat

recovery system is not operating at its maximum capacity. Not operating at its maximum capacity means an efficiency decrease, because a portion of the "free" energy from the waste heat system is not exploited.

DISCLOSURE OF THE INVENTION

On this background, it is an object of the present disclosure to provide a marine propulsion system of the aforementioned type with improved fuel efficiency.

This object is achieved by providing a marine propulsion system with waste heat recovery with a main large two stoke turbocharged internal combustion engine driving a propeller shaft that is coupled to a ship propeller, a waste heat recovery system including a turbine and a generator for generating electrical energy from waste heat of the main engine for an electrical network of the ship, a shaft generator/motor coupled to the propeller shaft and connected electrically to the electrical network of the ship, the shaft generator/motor being configured to convert electrical energy from the electrical network into mechanical energy for driving the propeller shaft in a drive motor operation mode of the shaft generator/motor, the shaft generator/motor being configured to convert mechanical energy from the propeller shaft into electric energy for the electrical network in a generator operation mode of the shaft generator/motor, a controller operably connected to the shaft generator/motor and the controller being configured to control the frequency of the electrical network by adjusting the operation of the shaft generator/motor.

By using the power range of the shaft generator/motor for controlling the frequency of the network it becomes possible to exploit all available power from the waste heat recovery system and thereby improve the energy efficiency of the ship propulsion system.

In an embodiment the controller is configured to control the frequency of the electrical network by adjusting the operation of the shaft generator/motor in the drive motor operation mode and in the generator operation mode. This measure extends the power range available for the frequency control.

In an embodiment the controller is configured to control the frequency of the electrical network by adjusting the power to the shaft generator/motor in the drive motor mode and by adjusting the load on the shaft generator/motor in the generator mode.

In an embodiment the controller is configured to control the frequency of the electrical network by adjusting the operation of the shaft generator/motor over a continuous range of operation settings including drive motor operation mode and generator operation mode.

In an embodiment the controller is configured to control the frequency of the network with shaft generator/motor by controlling the excitation current of the motor/generator.

In an embodiment the controller propeller shaft is connected to a controllable pitch propeller, and wherein said controller is configured to operate the propulsion system with constant propeller shaft rotary speed and

thereby maintain the motor/generator rotary speed constant for providing a constant network frequency.

In an embodiment the controller ship propulsion system further comprises a variable ratio transmission coupled between the shaft motor/generator and the propeller shaft, and wherein said controller is coupled to said variable ratio transmission and wherein said controller is configured to maintain the rotational speed of the shaft generator/motor constant despite variations in rotary speed of the proper shaft by controlling the ratio of said variable ratio transmission.

In an embodiment the controller is configured to operate with frequency droop control for controlling the frequency of the electrical network.

In an embodiment the controller is configured to operate with isochronous frequency control for controlling the frequency of the electrical network.

In an embodiment the controller is operably connected to the waste heat recovery system and the controller is configured to control the operation of the waste heat recovery system as a base load.

It is an object of the present invention to provide a method of operating a marine propulsion system of the aforementioned type in order to obtain an improved fuel efficiency.

The above object is also achieved by providing a method of operating a marine propulsion system with a main large two stoke turbocharged internal combustion engine

driving a propeller shaft that is coupled to a ship propeller, a waste heat recovery system including a turbine and a generator for generating electrical energy from waste heat of the main engine for an electrical network of the ship, a shaft generator/motor coupled to the propeller shaft and connected electrically to the electrical network of the ship, the shaft generator/motor being configured to convert electrical energy from the electrical network into mechanical energy for driving the propeller shaft in a drive motor operation mode of the shaft generator/motor, the shaft generator/motor being configured to convert mechanical energy from the propeller shaft into electric energy for the electrical network in a generator operation mode of the shaft generator/motor, and controlling the frequency of the electrical network by adjusting the operation of the shaft generator/motor.

By using the power range of the shaft generator/motor for controlling the frequency of the network it becomes possible to exploit all available power from the waste heat recovery system and thereby improve the energy efficiency of the ship propulsion system.

In an embodiment the method comprises controlling the frequency of the electrical network by adjusting the operation of the shaft generator/motor in the drive motor operation mode and in the generator mode. This measure extends the power range available for the frequency control.

In an embodiment the method comprises controlling the frequency of the electrical network by adjusting the power to the shaft generator/motor in the drive motor

mode and by adjusting the load on the shaft generator/motor in the generator mode.

In an embodiment the method comprises controlling the frequency of the electrical network by adjusting the operation of the shaft generator/motor over a continuous range of operation settings including drive motor operation mode and generator operation mode.

In an embodiment the method comprises operating with droop speed control for controlling the frequency of the electrical network

In an embodiment the method comprises operating with isochronous speed control for controlling the frequency of the electrical network.

In an embodiment the method comprises controlling the operation of the waste heat recovery system (20) as a base load.

In an embodiment the method comprises maintaining the rotational speed of the main engine constant regardless of the operation mode and amount of power used by or delivered to the shaft generator/motor.

In an embodiment the method comprises adjusting the setting of the waste heat recovery system when the desired setting for shaft generator/motor is about to move outside the operating range of the shaft generator/motor.

Further objects, features, advantages and properties of the marine propulsion and method for operating the marine

propulsion system according to the present disclosure will become apparent from the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present description, the invention will be explained in more detail with reference to the exemplary embodiments shown in the drawings, in which:

Fig. 1 is a diagrammatic and schematic representation of an exemplary embodiment of a marine propulsion system, and

Fig. 2 is a diagrammatic and schematic representation of another exemplary embodiment of a marine propulsion system.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following detailed description, the marine propulsion system and method will be described by the exemplary embodiments. Figure 1 shows a highly schematic exemplary embodiment of a marine propulsion system 1 with waste heat recovery for a large ship, such as e.g. a container ship. The core of the propulsion system is a main large low speed turbocharged two-stroke diesel engine 2 with a crankshaft that is connected to the pistons via connecting rods, crossheads and piston rods. Large turbocharged two-stroke diesel engines have typically between five and sixteen cylinders in line. The total output of the engine may, for example, range from 5,000 to 110,000 kW.

The main engine 2 is operably connected via a propeller shaft 3 to a fixed pitch propeller 4 to propel the ship. An electric network 5 is used to supply electrical devices and systems on board the ship with electrical power.

Power consuming devices can e.g. be refrigeration devices for cooling the cargo. For reasons of clarity and simplicity, Fig. 1 shows only a single electrical load 6. However, in practice a larger number of such consumers are powered from the ship's electrical network.

To generate energy for the ship's electrical network 5 several generator sets 8 (gensets) are provided. Each generator set includes an electric generator and an auxiliary engine 9. The auxiliary engines 9 are significantly smaller and faster running than the main engine 2. The auxiliary engines 9 are usually medium-speed four-stroke diesel engines with a capacity of for example up to 5 MW.

A shaft generator/motor 10 is mechanically connected to the propeller shaft 3 and electrically coupled to the ship's electrical network 5.

The shaft motor/generator 10 is designed as a low-speed synchronous machine and preferably acts directly without an intermediate gearbox to the propeller shaft 3.

The shaft motor/generator 10 may be coupled via a gearbox to the propeller shaft 3 or coupled to the crankshaft of the main engine 2, namely at the end of the crankshaft opposite to the propeller shaft 3.

The marine propulsion system is provided with a waste heat recovery system 11. Waste heat from the exhaust gas of the main engine 2 is sent via a heat exchanger 16 to a not shown steam cycle, into which a steam turbine 18 is connected. The steam turbine 18 drives an electric generator 20. The electric energy generated by the generator 20 is fed into the ship's electrical network 5.

In another embodiment the steam turbine 18 is combined with a power turbine powered by waste heat or replaced by a power turbine powered by waste heat.

The primary goal in operating the marine propulsion system 1 is to feed the whole available electric energy from the waste heat recovery system in the ship's electric network 5.

Once the generator 20 feeds electric power into the ship's electrical network 5 a controller 12 will relieve the auxiliary diesel generator sets 8 and, if possible, switch the generator sets 8 off altogether.

These measures can reduce the fuel and operating costs and emissions of diesel generator sets 10 significantly.

If the waste heat recovery system 11 generates more energy than needed for the electric loads 6 this energy surplus is used to operate the shaft generator/motor 10 in the drive motor mode and, thereby creating an additional driving force to the propeller shaft 3.

In in a drive motor operation mode the shaft generator/motor 10 converts electrical energy from the

electrical network 5 into mechanical energy for driving the propeller shaft 3.

Reserve capacity in the ship's electrical network 5 can thus be used for increasing the propulsion power of the vessel, thereby either increasing the speed of the vessel or, when maintaining the speed of the vessel reducing the load on the main engine 2.

In in a generator operation mode the shaft generator/motor 10 converts rotational mechanical energy from the propeller shaft 3 into electrical energy for the electrical network 5.

This allows power reserves of the main engine 2 to be used to generate energy for the ship's electrical network 5.

The control and regulation of the shaft generator/motor is effected by a common, preferably in digital technology, executed, control and regulating system: controller 12.

The operation settings for the shaft generator/motor 10 are controlled and regulated by the controller 12. In particular, the controller 12 can in an embodiment control the exciter current of the shaft generator/motor 10 via an F/V converter 13.

By controlling and regulating the exciter current of the shaft generator/motor 10 the shaft generator/motor 10 is either operated as a drive motor or generator. This is

particularly useful for constant speed generator and controllable pitch propeller

The controller 12 is configured to control the frequency of the electrical network 5 by adjusting the operation of the shaft generator/motor 10 in the drive motor operation mode and in the generator operator mode

The controller is configured to control the frequency of the electrical network 5 by adjusting the power to the shaft generator/motor 10 in the drive motor mode and by adjusting the load on the shaft generator/motor 10 in the generator mode, preferably via the exciter current of the shaft generator/motor 10.

The controller is configured control and adjust the operation of the shaft generator/motor 10 over a continuous range of operation settings including both drive motor operation mode and generator operation mode, with a substantially smooth transition between the two operation modes.

The controller 12 can independently control and adjust the exciter current or the controller 12 can control and adjust an excitation system of the shaft generator/motor 10. For this purpose the controller 12 registers the speed of the shaft generator/motor 10, the motor voltage and the network voltage and frequency and controls the excitation current via a frequency-to-voltage converter 13-.

In a variation of the embodiment shown in Fig. 1 the marine propulsion system 1 is provided with a controlled

pitch propeller 4. The controller 12 controls in this embodiment the pitch of the propeller with the aim to maintain a constant propeller shaft speed, independent of the speed of the ship or vessel. The result is a constant rotary speed of the shaft generator/motor 10 and thereby a constant network frequency generated by the shaft generator/motor 10.

Fig. 2 shows another embodiment of the invention that is essentially identical to the embodiment of Fig. 1, except that a variable transmission 10 is placed between the propeller shaft 3 and the shaft generator/motor 10. The variable transmission is coupled to and controlled by the controller 12. The variable transmission 10 is an embodiment a gearbox with a variable transmission ratio that is operatively coupled between the propeller shaft 3 and the propeller 4. The propeller can is this embodiment be a fixed pitch propeller.

In this embodiment the controller 12 is configured to control the variable transmission 10 such that that the generator/motor 10 operates with constant speed regardless of the rotary speed of the propeller shaft 3 and thus the shaft generator/motor 10 provides constant frequency for the network

The controller is in an embodiment configured to allow the waste heat recovery system to act as a base load and to control the shaft generator/motor 10 to act as a swing machine with extended operation range as it both can produce and consume power.

Traditional load shearing concepts with droop speed control and isochronous speed control can be applied to cover the extended control range for the shaft generator/motor 10.

In an embodiment the controller 16 is configured to maintain the rotational speed of the main engine 2 constant regardless of the operation mode and amount of power used by or delivered to the shaft generator/motor 10.

The controller 12 may also be configured to control the operation of one or more of the consumers 6 connected to the ship's electrical network 5 to control the frequency of the electrical network 5.

The controller 12 may further be configured to adjusting the setting of the waste heat recovery system 11 when the desired setting for shaft generator/motor 10 risks to move outside the operating range of the shaft generator/motor 10.

The term "comprising" as used in the claims does not exclude other elements or steps. The term "a" or "an" as used in the claims does not exclude a plurality. The single processor or other unit may fulfill the functions of several means recited in the claims.

The reference signs used in the claims shall not be construed as limiting the scope.

Although the present invention has been described in detail for purpose of illustration, it is understood that such detail is solely for that purpose, and variations

can be made therein by those skilled in the art without departing from the scope of the invention. For example it can also be practiced on a large two stroke engine that uses exhaust gas recirculation.

DRIVSYSTEM TIL SKIBE MED EN STOR TURBOLADET TOTAKTS STEMPELMOTOR MED SPILDVARMEGENVINDING OG FREMGANGSMÅDE TIL DRIFT AF DRIVSYSTEMET

PATENTKRAV:

1. Drivsystem til skibe (1) med spildvarmegenvinding, der omfatter:

en stor totakts turboladet hovedforbrændingsmotor (2), der driver en propelaksel (3), der er koblet til en skibspropel (4),

et spildvarmegenvindingssystem (11), der indeholder en turbine (18) og en generator (20) til produktion af elektrisk energi fra hovedmotorens (2) spildvarme til et elektrisk net (5) på skibet,

en akselgenerator/-motor (10), der er koblet til propelakslen (3) og er forbundet elektrisk med det elektriske net (5),

idet akselgeneratoren/-motoren (10) er konstrueret til at omforme elektrisk energi fra det elektriske net (5) til mekanisk energi til drift af propelakslen (3) i en drivmotordriftsmodus for akselgeneratoren/-motoren (10),

idet generatoren/motoren (10) er konstrueret til at omforme mekanisk energi fra propelakslen (3) til elektrisk energi til det elektriske net (5) i en generatordriftsmodus for akselgeneratoren/-motoren (10),

en controller (12), der er driftsmæssigt forbundet med akselgeneratoren/-motoren (10), idet denne controller

(12) er konstrueret til at regulere frekvensen i det elektriske net (5) ved justering af driften af akselgeneratoren/-motoren (10).

2. Drivsystem til skibe (1) ifølge krav 1, ved hvilket controlleren (12) er konstrueret til at regulere frekvensen i det elektriske net (4) ved justering af driften af akselgeneratoren/-motoren (10) i drivmotordriftsmodusen og i generatordriftsmodusen.

3. Drivsystem til skibe (1) ifølge krav 1 eller 2, ved hvilket controlleren (12) er konstrueret til at regulere frekvensen i det elektriske net (5) ved justering af effekten til akselgeneratoren/-motoren (10) i drivmotormodusen og ved justering af belastningen af akselgeneratoren/-motoren (10) i generatormodusen.

4. Drivsystem til skibe (1) ifølge et hvilket som helst af kravene 1 til 3, ved hvilket controlleren (12) er konstrueret til at regulere frekvensen i det elektriske net (5) ved justering af driften af akselgeneratoren/-motoren (10) over et kontinuerligt område af driftsindstillinger inklusive drivmotordriftsmodus og generatordriftsmodus.

5. Drivsystem til skibe (1) ifølge et hvilket som helst af kravene 1 til 4, ved hvilket controlleren (12) er konstrueret til drift med statikhastighedsregulering til regulering af frekvensen i det elektriske net (5).

6. Drivsystem til skibe (1) ifølge et hvilket som helst af kravene 1 til 4, ved hvilket controlleren (12) er konstrueret til drift med isokron hastighedsregulering til regulering af frekvensen i det elektriske net (5).

7. Drivsystem til skibe (1) ifølge et hvilket som helst af kravene 1 til 6, ved hvilket controlleren (12) er driftsmæssigt forbundet med spildvarmegenvindingssystemet (11), og ved hvilket controlleren (12) er konstrueret til at drive spildvarmegenvindingssystemet (11) som basisbelastning.

8. Drivsystem til skibe ifølge et hvilket som helst af kravene 1 til 7, ved hvilket controlleren (12) er konstrueret til at regulere frekvensen i nettet med akselgeneratoren/-motoren (10) via regulering af magnetiseringsstrømmen i motoren/generatoren (10).

9. Drivsystem til skibe ifølge et hvilket som helst af kravene 1 til 7, ved hvilket propelakslen (3) er forbundet med en regulerbar pitchpropel (4), og ved hvilket controlleren (12) er konstrueret til at drive drivsystemet med en konstant omdrejningstal på propelakslen og i den forbindelse holde motorens/generatorens omdrejningstal på et konstant niveau for at tilvejebringe en konstant netfrekvens.

10. Drivsystem til skibe ifølge et hvilket som helst af kravene 1 til 7, der desuden omfatter en transmission med variabel udveksling (19), der er tilkoblet mellem akselmotoren/-generatoren (10) og propelakslen (3), og ved hvilket controlleren (12) er koblet sammen med transmissionen med variabel udveksling (19), og ved hvilket controlleren (12) er konstrueret til at holde akselgeneratorens/-motorens omdrejningstal på et konstant niveau (10) på trods af variationer af propelakslens (3) omdrejningstal ved regulering af udvekslingsforholdet på transmissionen med variabel udveksling (19).

11. Fremgangsmåde til drift af et drivsystem til skibe (1), der omfatter:

en stor totakts turboladet hovedforbrændingsmotor (2), der driver en propelaksel (3), der er koblet til en skibspropel (4),

et spildvarmegenvindingssystem (11), der indeholder en turbine (18) og en generator (20) til produktion af elektrisk energi fra hovedmotorens (2) spildvarme til et elektrisk net (5) på skibet,

en akselgenerator/-motor (10), der er koblet til propelakslen (3) og er forbundet elektrisk med det elektriske net (5) på skibet,

idet akselgeneratoren/-motoren (10) er konstrueret til at omforme elektrisk energi fra det elektriske net (5) til mekanisk energi til drift af propelakslen (3) i en drivmotordriftsmodus for akselgeneratoren/-motoren (10),

idet generatoren/motoren (10) er konstrueret til at omforme mekanisk energi fra propelakslen (3) til elektrisk energi til det elektriske net (5) i en generatordriftsmodus for akselgeneratoren/-motoren (10), samt

regulering af frekvensen i det elektriske net ved justering af driften af akselgeneratoren/-motoren (10).

12. Fremgangsmåde ifølge krav 8, der omfatter regulering af frekvensen i det elektriske net (5) ved justering af driften af akselgeneratoren/-motoren (10) i drivmotordriftsmodusen og i generatordriftsmodusen.

13. Fremgangsmåde ifølge krav 11 eller 12, der omfatter regulering af frekvensen i det elektriske net (5) ved justering af effekten til akselgeneratoren/-motoren (10) i drivmotormodusen og ved justering af belastningen af akselgeneratoren/-motoren (10) i generatormodusen.

14. Fremgangsmåde ifølge et hvilket som helst af kravene 11 til 13, der omfatter regulering af frekvensen i det elektriske net (5) ved justering af driften af akselgeneratoren/-motoren (10) over et kontinuerligt område af driftsindstillinger inklusive drivmotordriftsmodus og generatordriftsmodus.

15. Fremgangsmåde ifølge et hvilket som helst af kravene 11 til 14, der omfatter drift med statikhastighedsregulering til regulering af frekvensen i det elektriske net.

16. Fremgangsmåde ifølge et hvilket som helst af kravene 11 til 15, der omfatter drift med isokron hastighedsregulering til regulering af frekvensen i det elektriske net.

17. Fremgangsmåde ifølge et hvilket som helst af kravene 11 til 16, der omfatter regulering af driften af spildvarmegenvindingssystemet (11) som basisbelastning.

18. Fremgangsmåde ifølge et hvilket som helst af kravene 11 til 17, der desuden omfatter fastholdelse af omdrejningstallet på hovedmotoren (2) på et konstant niveau uafhængigt af driftsmodusen og mængden af effekt, der anvendes af eller leveres til akselgeneratoren/-motoren (10).

19. Fremgangsmåde ifølge et hvilket som helst af kravene 11 til 18, der desuden omfatter justering af indstillingen af spildvarmegenvindingssystemet (11), når der er risiko for, at den ønskede indstilling for akselgeneratoren/-motoren bevæger sig væk fra driftsområdet for akselgeneratoren/-motoren (10).

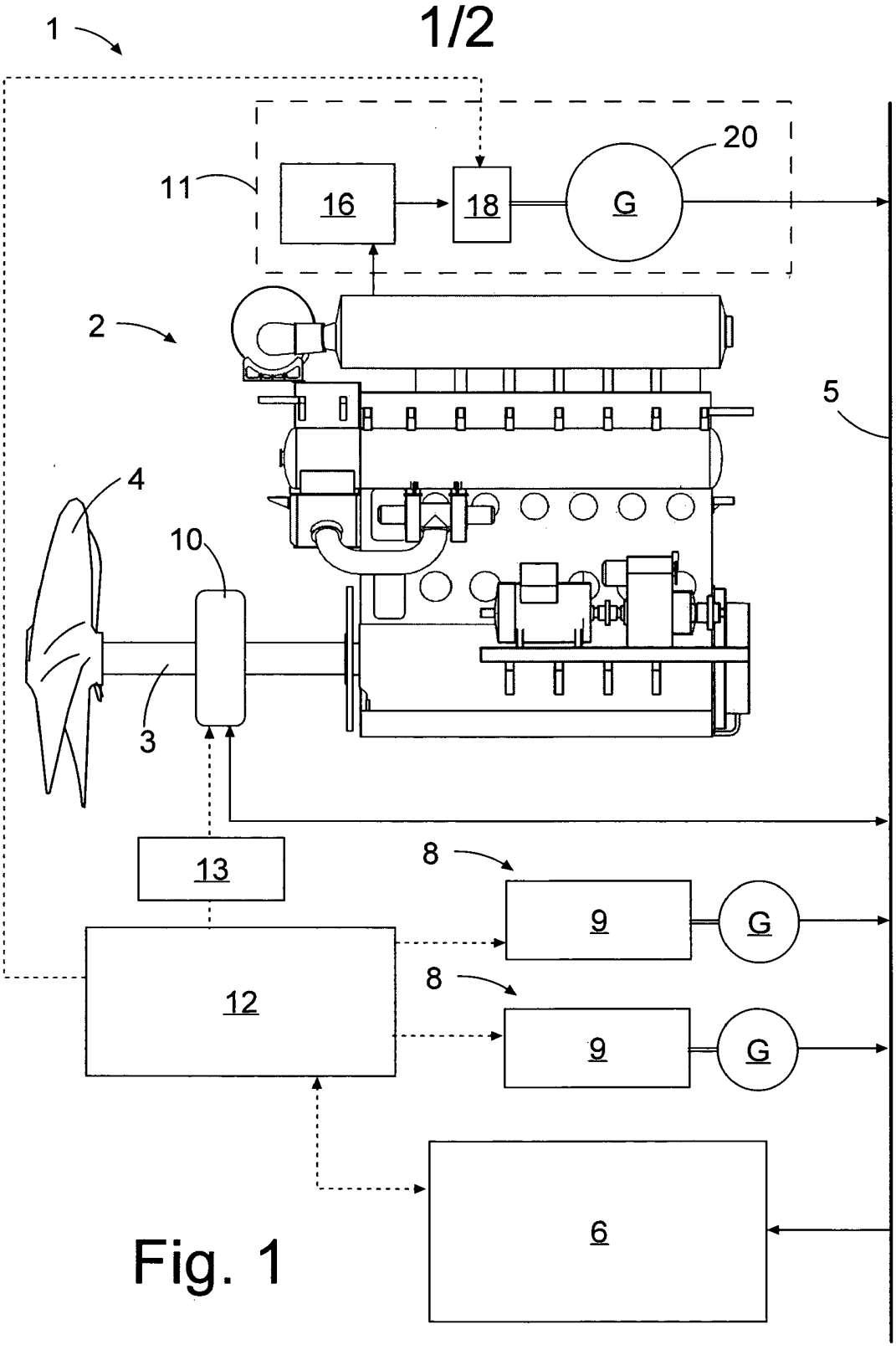


Fig. 1

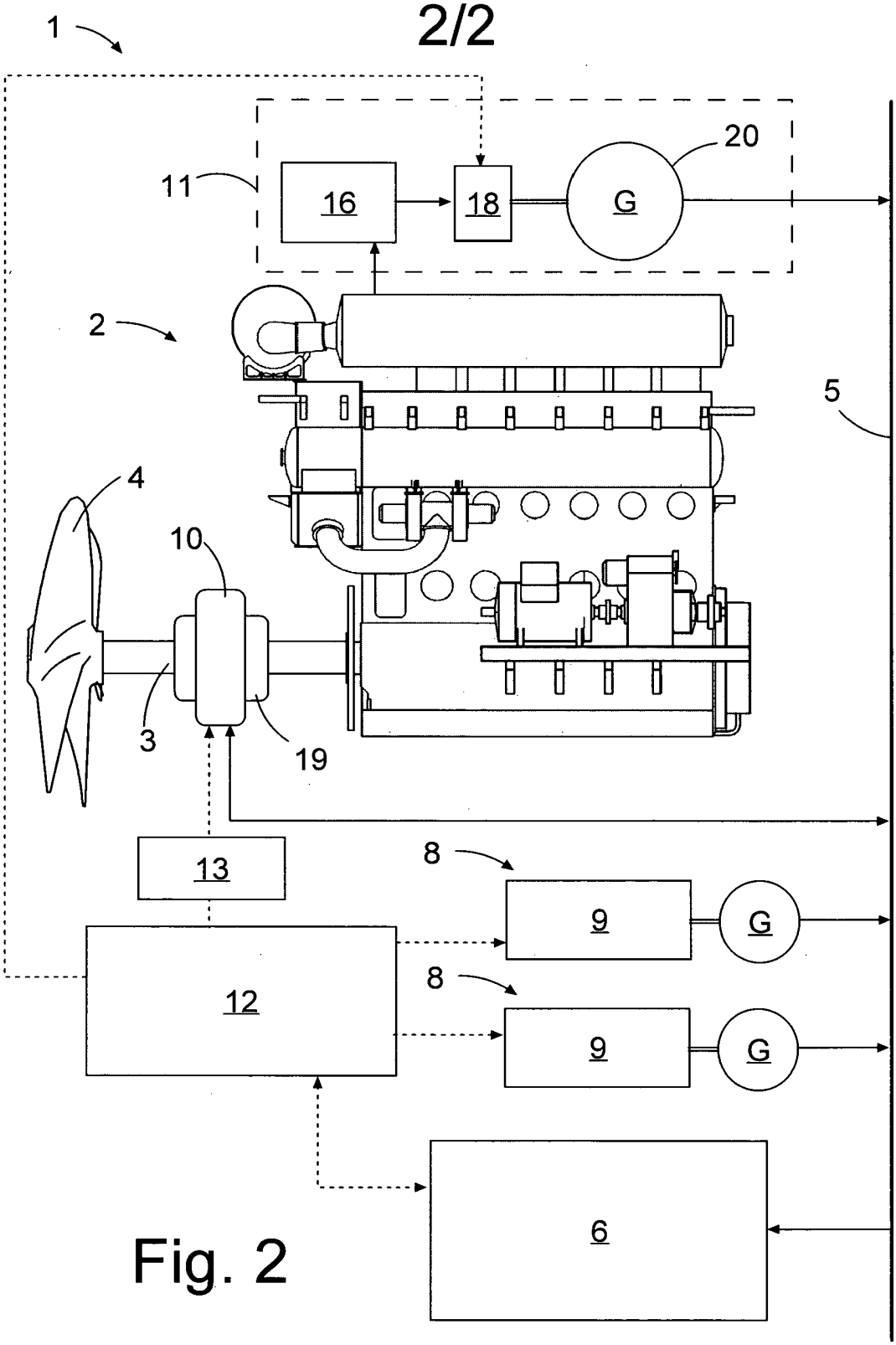


Fig. 2