

【DESCRIPTION】**【Invention Title】**

APPARATUS AND METHOD FOR CONTROLLING AND
MONITORING AUXILIARY APPARATUS OF DRILLING EQUIPMENT IN
DRILL SHIP

【Technical Field】

[1] The present invention relates to a drill ship, and more particularly, to an apparatus and method for controlling and monitoring an auxiliary apparatus of drilling equipment in a drill ship.

【Background Art】

[2] With rapid industrialization and industrial development, usage of resources such as petroleum has gradually increased and thus stable production and supply of oil have become important issues at a global level.

[3] For this reason, development of smaller marginal fields or deep-sea oil fields, which have been ignored due to lack of economic feasibility, is now emerging. Thus, development of offshore plants provided with oil drilling equipment suitable for use in such oil fields is actively carried out along with development of seabed mining technology.

[4] An offshore plant is provided with various types of drilling-related equipment such as a derrick system, a draw-works, a top drive, a mud pump, a cement pump, a riser, and a drill pipe in order to perform drilling for oil or gas present under the sea floor.

[5] The draw-works performs lifting of the drill pipe, insertion of a casing, and the like, and includes a drum and a motor. The drum is powered by the motor so as to wind or unwind a wire rope for controlling lifting of the drill pipe. The rotational speed of the motor can be adjusted so as to adjust the rotational speed of the drum, thereby enabling adjustment of the speed of the drill pipe.

[6] The top drive provides power for drilling and pipe fastening in drilling

operation.

[7] Mud is inserted into the drill pipe in order to prevent a drill bit from being overheated due to heat during drilling operation of the drill bit and to facilitate the drilling operation by providing lubrication. Then, the mud escapes through the drill pipe and is returned to the drill ship through the casing and the riser by the mud pump, which provides pumping force for transferring the mud for drilling operation stored in a mud tank.

[8] Offshore plants are divided into a stationary platform anchored at one point nearshore to perform drilling operations and a floating offshore plant capable of performing drilling operation at ocean depths of 3,000 m or more.

[9] The floating offshore plant is provided with a plurality of thrusters as a main propulsion device or a propulsion device for computer-aided dynamic positioning. The thrusters are located at the bottom of a ship to change an operating direction of a propeller and are commonly used to allow the ship to navigate or sail in a canal or to enter/leave a port under its own power without a tug. The thruster is powered by a thrust motor connected thereto.

[10] First, a typical power supply system will be described with reference to Fig. 1. Fig. 1 is a diagram of a typical power supply system of a drill ship.

[11] Referring to Fig. 1, AC power generated by a generator 110 is supplied to an AC bus, to which a first AC/DC converter 121, a second AC/DC converter 122, and a third AC/DC converter 123 are connected.

[12] The first AC/DC converter 121 converts alternating current supplied from the AC bus into direct current and supplies the direct current to a first DC bus 131, and a DC/AC converter 171 converts direct current supplied from the first DC bus 131 into alternating current and supplies the alternating current to a first thruster motor 181.

[13] The second AC/DC converter 122 converts alternating current supplied from the AC bus into direct current and supplies the direct current to a second DC bus 132, and a DC/AC converter 172 converts direct current supplied from the second DC bus 132 into alternating current and supplies the alternating current to a second thruster motor 182.

[14] The third AC/DC converter 123 converts alternating current supplied from the

AC bus into direct current and supplies the direct current to a third DC bus 133, and a plurality of DC/AC converters 141 to 149 is connected to the third DC bus 133. Each of the DC/AC converters 141 to 149 converts direct current supplied from the third DC bus 133 into alternating current and supplies the alternating current to a corresponding motor among a plurality of draw-works motors 151, 152, 153, 158, 159, a plurality of top drive motors 154, 155, a mud pump motor 156, and a cement pump motor 167.

[15] Next, a typical apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship will be described with reference to Fig. 2. Fig. 2 is a diagram of a typical apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship.

[16] Referring to Fig. 2, a typical apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship includes drilling equipment controller 210 and a motor control center (MCC) 250.

[17] The drilling equipment controller 210 controls drilling-related equipment. The drilling-related equipment may include a draw-works, a top drive, a mud pump, and a cement pump, and the drilling equipment controller 210 may be a draw-works controller, a top drive controller, a mud pump controller, and a cement pump controller. The draw-works controller, the top drive controller, the mud pump controller, and the cement pump controller may constitute a drilling control system (DCS).

[18] The draw-works is driven by a draw-works motor; the top drive is driven by a top drive motor; the mud pump is driven by a mud pump motor; and the cement pump is driven by a cement pump motor. The draw-works controller controls the draw-works motor; the top drive controller drives the top drive motor; the mud pump controller drives the mud pump motor; and the cement pump controller drives the cement pump motor.

[19] However, assuming that the draw-works motor, the top drive motor, the mud pump motor, and the cement pump motor are referred to as a main apparatus 230, an auxiliary apparatus 260 such as a blower motor, a lube oil pump motor, and the like must be operated in order to allow operation of the main apparatus 230. Thus, the

drilling equipment controller 210 sends a control signal for operating the auxiliary apparatus 260 to the MCC 250 in order to operate the auxiliary apparatus 260 before operation of the main apparatus 230, and the MCC 250 operates the auxiliary apparatus 260 in response to the control signal.

[20] In addition, a measurement instrument 270 disposed around the auxiliary apparatus 260 measures conditions related to the auxiliary apparatus 260 and sends control signals to the drilling equipment controller 210. Then, the drilling equipment controller 210 determines whether the auxiliary apparatus 260 is normally operated, and operates the main apparatus 230 upon determining that the auxiliary apparatus 260 is normally operated.

[21] The drilling equipment controller 210 is connected to a DC/AC converter 220 via wired communication or wireless communication and sends a control signal instructing operation of the main apparatus 230 to the DC/AC converter 220, which is connected to the main apparatus 230 to be operated. The DC/AC converter 220 operates the main apparatus 230 in response to the control signal instructing operation of the main apparatus 230.

[22] However, in such a conventional technology, since the DCS monitors and controls the auxiliary apparatus, there is a problem of a complicated procedure in monitoring and controlling the auxiliary apparatus. In addition, when the main apparatus is not normally operated, it is difficult to confirm whether abnormal operation of the main apparatus is related to the DCS or the DC/AC converter. Thus, in order to find the problem related to abnormal operation of the main apparatus, both the DCS and the DC/AC converter must be inconveniently overhauled. Moreover, the DCS and the DC/AC converter are generally manufactured by different manufacturers. Thus, if the main apparatus fails to operate during drilling operation at sea, the DCS manufacturer and the DC/AC converter manufacturers must come to sea to find problems and equipment to repair, thereby causing cost and time consumption to repair the drilling equipment.

【Disclosure】

【Technical Problem】

[23] It is one aspect of the present invention to provide an apparatus and method for controlling and monitoring an auxiliary apparatus of drilling equipment in a drill ship, which can simplify control and monitoring procedures of the auxiliary apparatus and operation procedures of a main apparatus and can reduce costs and time required for repairing drilling equipment.

[23a] In accordance with one aspect of the present invention, there is provided a ship including an apparatus for controlling an auxiliary apparatus of drilling equipment, comprising: a DC/AC converter operating a main apparatus when an auxiliary apparatus related to the main apparatus is normally operated; a drilling equipment controller sending a main apparatus execution command to the DC/AC converter to operate the main apparatus; and a motor control center (MCC) operating the auxiliary apparatus, wherein the DC/AC converter sends an auxiliary apparatus execution command to the MCC to operate the auxiliary apparatus in response to the main apparatus execution command sent from the drilling equipment controller and the auxiliary apparatus is previously operated for operation of the main apparatus.

【Technical Solution】

[24] As disclosed, an apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship includes: a drilling equipment controller sending a main apparatus execution command to a DC/AC converter to operate a main apparatus; and a DC/AC converter sending an auxiliary apparatus execution command to a motor control center (MCC) to operate an auxiliary apparatus related to the main apparatus in response to the main apparatus execution command sent from the drilling equipment controller and operating the main apparatus when the auxiliary apparatus is normally operated, wherein the auxiliary apparatus is previously operated for operation of the main apparatus.

[25] The apparatus for controlling an auxiliary apparatus may further include an MCC operating the auxiliary apparatus in response to the auxiliary apparatus execution command.

[26] The DC/AC converter may determine whether the auxiliary apparatus is

normally operated in response to information regarding a condition of the auxiliary apparatus sent from an auxiliary apparatus-related instrument disposed around the auxiliary apparatus.

[27] The auxiliary apparatus-related instrument may be a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus.

[28] The main apparatus may be a top drive motor and the auxiliary apparatus-related instrument may be a flow meter provided to a pipe through which water flows into the top drive driven by the top drive motor.

[29] The main apparatus may be a draw-works motor.

[30] The auxiliary apparatus may be a blower motor for air cooling of the main apparatus

[31] The auxiliary apparatus may be a lube oil pump motor for oil cooling drilling equipment driven by the main apparatus and for providing lubrication to the drilling equipment.

[32] In accordance with another aspect of the present invention, a method of controlling an auxiliary apparatus of drilling equipment for ship includes: sending, by a drilling equipment controller, a main apparatus execution command to a DC/AC converter to operate a main apparatus; sending, by the DC/AC converter, an auxiliary apparatus execution command to a motor control center (MCC) to operate an auxiliary apparatus related to the main apparatus; operating the auxiliary apparatus by the MMC; and operating the main apparatus by the DC/AC converter when the auxiliary apparatus is normally operated, wherein the auxiliary apparatus is previously operated for operation of the main apparatus.

[33] The method of controlling an auxiliary apparatus may further include measuring a condition of the auxiliary apparatus and sending information regarding the condition of the auxiliary apparatus to the DC/AC converter by an auxiliary apparatus-related instrument disposed around the auxiliary apparatus.

[34] The DC/AC converter may determine whether the auxiliary apparatus is normally operated in response to the information regarding the condition of the auxiliary apparatus sent from the auxiliary apparatus-related instrument.

[35] The auxiliary apparatus-related instrument may be a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus.

[36] The main apparatus may be a top drive motor and the auxiliary apparatus-related instrument may be a flow meter provided to a pipe through which water flows into the top drive driven by the top drive motor.

[37] The main apparatus may be a draw-works motor.

[38] The auxiliary apparatus may be a blower motor for air cooling of the main apparatus.

[39] The auxiliary apparatus may be a lube oil pump motor for oil cooling drilling equipment driven by the main apparatus and for providing lubrication to the drilling equipment.

[40] As disclosed, an apparatus for

monitoring an auxiliary apparatus of drilling equipment in a drill ship includes: a main apparatus-related instrument disposed around a main apparatus and measuring a condition of the main apparatus; an auxiliary apparatus-related instrument disposed around an auxiliary apparatus and measuring a condition of the auxiliary apparatus to be previously operated for operation of the main apparatus; and a DC/AC converter receiving information regarding the condition of the main apparatus sent from the main apparatus-related instrument and information regarding the condition of the auxiliary apparatus sent from the auxiliary apparatus-related instrument.

[41] The DC/AC converter may determine whether the auxiliary apparatus is normally operated based on the information regarding the condition of the auxiliary apparatus, and may operate the main apparatus upon determining that the auxiliary apparatus is normally operated.

[42] The auxiliary apparatus-related instrument may be a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus.

[43] The main apparatus may be a top drive motor and the auxiliary apparatus-related instrument may be a flow meter provided to a pipe through which water flows into the top drive driven by the top drive motor.

[44] The main apparatus-related instrument may be a winding temperature sensor measuring a temperature of a winding of the main apparatus and sending information regarding the temperature of the winding to the DC/AC converter.

[45] The DC/AC converter may generate an alarm when the temperature of the winding is higher than or equal to a first threshold value and may stop operation of the main apparatus when the temperature of the winding is higher than or equal to a second threshold value, and the second threshold value may be greater than the first threshold value.

[46] The main apparatus-related instrument may be a bearing temperature sensor measuring a temperature of a bearing of the main apparatus and sending information regarding the temperature of the bearing to the DC/AC converter.

[47] The DC/AC converter may generate an alarm when the temperature of the bearing is higher than or equal to a first threshold value and may stop operation of the main apparatus when the temperature of the bearing is higher than or equal to a

second threshold value, and the second threshold value may be greater than the first threshold value.

[48] The main apparatus-related instrument may be an encoder sensor sensing a rotation speed and a rotation angle of the main apparatus and sending information regarding the rotation speed and the rotation angle to the DC/AC converter.

[49] The main apparatus-related instrument may be a moisture sensor configured to measure humidity of the main apparatus and to send information regarding the humidity of the main apparatus to the DC/AC converter.

[50] The DC/AC converter may operate a motor space heater to remove inner moisture from the main apparatus when the humidity of the main apparatus is higher than or equal to a threshold value.

[51] In accordance with yet another aspect of the present invention, a method of monitoring an auxiliary apparatus of drilling equipment in a drill ship includes: sending, by a drilling equipment controller, a main apparatus execution command to a DC/AC converter to operate a main apparatus; sending, by the DC/AC converter, an auxiliary apparatus execution command to a motor control center (MCC) to operate an auxiliary apparatus related to the main apparatus; operating the auxiliary apparatus by the MMC; measuring a condition of the auxiliary apparatus and sending information regarding the condition of the auxiliary apparatus to the DC/AC converter by an auxiliary apparatus-related instrument; and measuring a condition of the main apparatus and sending information regarding the condition of the main apparatus to the DC/AC converter by a main apparatus-related instrument.

[52] The method of monitoring an auxiliary apparatus may further include determining, by the DC/AC converter, whether the auxiliary apparatus is normally operated based on the information regarding the condition of the auxiliary apparatus, and operating the main apparatus upon determining that the auxiliary apparatus is normally operated.

[53] The auxiliary apparatus-related instrument may be a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus.

[54] The main apparatus may be a top drive motor and the auxiliary apparatus-related instrument may be a flow meter provided to a pipe through which water flows

into the top drive driven by the top drive motor.

[55] The main apparatus-related instrument may be a winding temperature sensor measuring a temperature of a winding of the main apparatus and sending information regarding the temperature of the winding to the DC/AC converter.

[56] The DC/AC converter may generate an alarm when the temperature of the winding is higher than or equal to a first threshold value and may stop operation of the main apparatus when the temperature of the winding is higher than or equal to a second threshold value, and the second threshold value may be greater than the first threshold value.

[57] The main apparatus-related instrument may be a bearing temperature sensor measuring a temperature of a bearing of the main apparatus and sending information regarding the temperature of the bearing to the DC/AC converter.

[58] The DC/AC converter may generate an alarm when the temperature of the bearing is higher than or equal to a first threshold value and may stop operation of the main apparatus when the temperature of the bearing is higher than or equal to a second threshold value, and the second threshold value may be greater than the first threshold value.

[59] The main apparatus-related instrument may be an encoder sensor sensing a rotation speed and a rotation angle of the main apparatus and sending information regarding the rotation speed and the rotation angle to the DC/AC converter.

[60] The main apparatus-related instrument may be a moisture sensor configured to measure humidity of the main apparatus and to send information regarding the humidity of the main apparatus to the DC/AC converter.

[61] The DC/AC converter may operate a motor space heater to remove inner moisture from the main apparatus when the humidity of the main apparatus is higher than or equal to a threshold value.

[62] In accordance with yet another aspect of the present invention, an apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship includes: a drilling equipment controller sending a main apparatus execution command to a DC/AC converter to operate a main apparatus; a DC/AC converter sending an auxiliary apparatus execution command to a motor control center (MCC) to operate

an auxiliary apparatus related to the main apparatus in response to the main apparatus execution command sent from the drilling equipment controller; an auxiliary apparatus-related instrument disposed around the auxiliary apparatus and measuring a condition of the auxiliary apparatus; and the MCC receiving information regarding the condition of the auxiliary apparatus sent from the auxiliary apparatus-related instrument and controlling the auxiliary apparatus based on the information regarding the condition of the auxiliary apparatus.

[63] The auxiliary apparatus may be a blower motor for air cooling of the main apparatus.

[64] The auxiliary apparatus may be a lube oil pump motor for oil cooling drilling equipment driven by the main apparatus and for providing lubrication to the drilling equipment.

[65] The auxiliary apparatus-related instrument may be a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus and measuring pressure of the pipe to send information regarding the pressure of the pipe to the MCC.

[66] The MMC may increase a speed of the auxiliary apparatus when the pressure received from the pressure gauge is less than or equal to a first threshold value and may decrease the speed of the auxiliary apparatus if the pressure received from the pressure gauge is higher than or equal to a second threshold value, and the second threshold value may be greater than the first threshold value.

[67] The main apparatus may be a top drive motor and the auxiliary apparatus-related instrument may be a flow meter provided to a pipe through which water flows into the top drive driven by the top drive motor.

[68] The DC/AC converter may operate the main apparatus when the auxiliary apparatus is normally operated.

[69] The DC/AC converter may determine whether the auxiliary apparatus is normally operated by receiving information regarding a condition of the auxiliary apparatus from the auxiliary apparatus-related instrument.

[70] The main apparatus may be a draw-works motor.

[71] In accordance with yet another aspect of the present invention, a method for

controlling an auxiliary apparatus of drilling equipment in a drill ship includes: sending, by a drilling equipment controller, a main apparatus execution command to a DC/AC converter to operate a main apparatus; sending, by the DC/AC converter, an auxiliary apparatus execution command to a motor control center (MCC) to operate an auxiliary apparatus related to the main apparatus; operating the auxiliary apparatus by the MMC; measuring a condition of the auxiliary apparatus and sending information regarding the condition of the auxiliary apparatus to the MCC by an auxiliary apparatus-related instrument disposed around the auxiliary apparatus; and controlling, by the MCC, the auxiliary apparatus based on the information regarding the condition of the auxiliary apparatus.

[72] The auxiliary apparatus may be a blower motor for air cooling of the main apparatus.

[73] The auxiliary apparatus may be a lube oil pump motor for oil cooling drilling equipment driven by the main apparatus and for providing lubrication to the drilling equipment.

[74] The auxiliary apparatus-related instrument may be a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus and measuring pressure of the pipe to send information regarding the pressure of the pipe to the MCC.

[75] The MMC may increase a speed of the auxiliary apparatus when the pressure received from the pressure gauge is less than or equal to a first threshold value and may decrease the speed of the auxiliary apparatus if the pressure received from the pressure gauge is higher than or equal to a second threshold value, and the second threshold value may be greater than the first threshold value.

[76] The main apparatus may be a top drive motor and the auxiliary apparatus-related instrument may be a flow meter provided to a pipe through which water flows into the top drive driven by the top drive motor.

[77] The method of controlling an auxiliary apparatus may further include operating, by the DC/AC converter, the main apparatus when the auxiliary apparatus is normally operated.

[78] The DC/AC converter may determine whether the auxiliary apparatus is

normally operated by receiving information regarding a condition of the auxiliary apparatus from the auxiliary apparatus-related instrument.

[79] The main apparatus may be a draw-works motor.

【Advantageous Effects】

[80] According to embodiments of the present invention, a DC/AC converter controls and monitors an auxiliary apparatus of drilling equipment, thereby simplifying a procedure of controlling the auxiliary apparatus and a procedure of operating a main apparatus while reducing costs and time for overhauling the drilling equipment.

【Description of Drawings】

[81] Fig. 1 is a diagram of a typical power supply system of a drill ship.

[82] Fig. 2 is a diagram of a typical apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship.

[83] Fig. 3 is a diagram of a power supply system of a drill ship according to one embodiment of the present invention.

[84] Fig. 4 is a diagram of an apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship according to one embodiment of the present invention.

[85] Fig. 5 is a flowchart of a method of controlling an auxiliary apparatus of drilling equipment in a drill ship according to one embodiment of the present invention.

【Best Mode】

[86] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. It should be noted that like components will be denoted by like reference numerals throughout the specification and the accompanying drawings. In addition, detailed descriptions of known functions and constructions which can unnecessarily obscure the subject matter of the present invention will be omitted.

[87] First, a power supply system according to one embodiment of the present invention will be described with reference to Fig. 3. Fig. 3 is a diagram of a power supply system of a drill ship according to one embodiment of the present invention.

[88] Referring to Fig. 3, a power supply system according to one embodiment of the invention includes a generator 310, an AC/DC converter 320, a DC bus 321, a variable frequency drive (VFD) controller 330, DC/DC converters 351 to 353, DC/AC converters 341 to 349, electric power loads 361 to 369, power storage units 371 to 373, resistance units 381 to 383, and a sensor 391.

[89] The generator 310 is a device generating electric power for an offshore plant and is connected to the AC/DC converter 320 via an AC bus. Electric power generated by the generator 310 may be supplied to the AC/DC converter 320 after being altered to voltage suitable for use in electric power loads. The generator 310 is an AC generator and can generate AC power.

[90] The AC/DC converter 320 converts AC power generated by the generator 310 into direct current and supplies the direct current to the DC bus 321.

[91] The DC bus 321 supplies electric power to electric power loads connected to the DC bus 321. Electric power loads using DC power may be directly connected to the DC bus 321 and electric power loads using AC power may be connected to the DC bus 321 via the DC/AC converters 341 to 349.

[92] The electric power loads 361 to 369 shown in Fig. 3 are electric power loads using AC power and are connected to the DC bus 321 via the DC/AC converters 341 to 349, respectively. The DC/AC converters 341 to 349 convert direct current supplied from the DC bus 321 into alternating current and supply the alternating current to the electric power loads 361 to 369, respectively.

[93] The electric power loads 361 to 363 may be a draw-works motor, a top drive motor, a mud pump motor, and a cement pump motor, respectively.

[94] Although three draw-works motors 361 to 363, two top drive motors 364 to 365, one mud pump motor 366, one cement pump motor 367, and two auxiliary draw-works motors 368, 369 as the electric power loads are shown as being connected to the DC bus 321 in Fig. 3, it should be understood that the present invention is not limited thereto and various numbers of draw-works motors, top drive motors, mud

pump motors and cement pump motors may be connected to the DC bus 321.

[95] Main draw-works motors 361 to 363 are motors for operating main draw-works and auxiliary draw-works motors 368 to 369 are motors for operating auxiliary draw-works. Since the draw-work repeatedly lifts or lowers drilling equipment such as a drill pipe, a brake is frequently put on the draw-works motors to bring the draw-works motors to a sudden stop or to rotate the draw-works motors in the reverse direction during rotation at rated load, thereby causing frequent generation of regenerative power in the draw-works motors.

[96] The top drive motors 364 to 365 are motors for operating a top drive. The top drive is a device for supplying power for drilling and pipe connection in drilling operation, a brake is frequently put on the top drive motors 364 to 365 to bring the top drive motors 364 to 365 to a sudden stop or to rotate the top drive motors 364 to 365 in the reverse direction during rotation at rated load, thereby causing frequent generation of regenerative power in the draw-works motors.

[97] The mud pump motor 366 operates a mud pump and the cement pump motor 367 operates a cement pump.

[98] The power storage units 371 to 373 receive electric power from the DC bus 321 so as to store the electric power when a voltage of the DC bus 321 is maintained at a first threshold value or higher for a first period of time, and supply electric power to the DC bus 321 when the voltage of the DC bus 321 is maintained at a second threshold value or less for a second period of time. For example, assuming that the DC bus 321 is a 720 V DC bus and is tripped at 750 V or higher, the first threshold value may be set to 740 V.

[99] The DC/DC converters 351 to 353 measure the voltage of the DC bus 321 and supply electric power from the DC bus 321 to the power storage units 371 to 373 such that the power storage units 371 to 373 store electric power when the voltage of the DC bus is maintained at the first threshold value or higher for the first period of time. In addition, the DC/DC converters 351 to 353 allow electric power to flow from the power storage units 371 to 373 to the DC bus 321 such that the DC bus 321 can receive electric power from the power storage units 371 to 373 when the voltage of the DC bus is maintained at the second threshold value or less for the second period

of time.

[100] When regenerative power is generated in the electric power loads 361 to 365, 368 to 369, the voltage of the DC bus 321 is increased, and, when power consumption of the electric power loads 361 to 365, 368 to 369 is abruptly increased, the voltage of the DC bus 321 drops.

[101] In other words, when regenerative power is generated in the electric power loads 361 to 365, 368 to 369 causing increase in the voltage of the DC bus 321 and the voltage of the DC bus 321 is maintained at the first threshold value or higher for the first period of time, the DC/DC converters 351 to 353 supply electric power to the power storage units 371 to 373 such that the power storage units 371 to 373 store electric power, thereby allowing regenerative power generated in the electric power loads 361 to 363 to be stored in the power storage units 371 to 373.

[102] In addition, when power consumption of the electric power loads 361 to 365, 368 to 369 is abruptly increased causing drop in the voltage of the DC bus 321 and the voltage of the DC bus 321 is maintained at the second threshold value or less for the second period of time, the DC/DC converters 351 to 353 allow electric power to flow from the power storage units 371 to 373 to the DC bus 321 such that the DC bus 321 receives the electric power from the power storage units 371 to 373. The power storage units 371 to 373 may include at least one of an ultracapacitor, a capacitor, a battery, and a flywheel. Particularly, when the power storage units 371 to 373 are ultracapacitors that have higher responsiveness than the generator 310, the power storage units 371 to 373 can rapidly supply electric power to the electric power loads 361 to 363 upon sudden increase in power consumption of the electric power loads 361 to 365; 368 to 369.

[103] In addition, the power storage units 371 to 373 can supply electric power to the DC bus 321 in a transient state or upon power failure. When a sensor 391 for detecting a transient state or power failure senses the transient state or power failure and sends detection signals to the DC/DC converters 351 to 353, the DC/DC converters 351 to 353 allow electric power to be supplied from the power storage units 371 to 373 to the DC bus 321.

[104] The sensor 391 may be mounted on at least one of a switchboard and the DC

bus 321.

[105] Drilling equipment such as a draw-works and a top drive can cause a dangerous situation upon abrupt interruption of power supply. Thus, the power storage units 371 to 373 supply electric power to the DC bus 321 in a transient state or upon power failure to safely shut down the drilling equipment.

[106] The resistance units 381 to 383 consume electric power when the voltage of the DC bus 321 is maintained at the first threshold value or higher for a third period of time. Here, the third period of time is longer than the first period of time.

[107] When regenerative power is generated in the electric power loads 361 to 365, 368 to 369 causing increase in the voltage of the DC bus 321 and the voltage of the DC bus 321 is maintained at the first threshold value or higher for the first period of time, the power storage units 371 to 373 store the power. If the power storage units 371 to 373 are full, the voltage of the DC bus 321 does not drop and is continuously maintained at the first threshold value or higher. Thus, if the voltage of the DC bus 321 is maintained at the first threshold value or higher for the third period of time, it can be determined that the power storage units 371 to 373 are full. When regenerative power is continuously generated even after the power storage units 371 to 373 are full, the voltage of the DC bus 321 continuously increases, thereby tripping the DC bus 321. Thus, when the voltage of the DC bus 321 is maintained at the first threshold value or higher for the third period of time, the DC/DC converters 351 to 353 allow the resistance units 381 to 383 to consume the power.

[108] Although three power storage units 371 to 373 and three resistance units 381 to 383 are shown in Fig. 3, it should be understood that the present invention is not limited thereto and may include various numbers of power storage units and resistance units.

[109] Next, an apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship according to one embodiment of the present invention will be described with reference to Fig. 4. Fig. 4 is a diagram of an apparatus for controlling an auxiliary apparatus of drilling equipment in a drill ship according to one embodiment of the present invention.

[110] Referring to Fig. 4, an apparatus for controlling an auxiliary apparatus of

drilling equipment in a drill ship according to one embodiment of the present invention includes a drilling equipment controller 410, a DC/AC converter 420, a motor control center (MCC) 450, and an auxiliary apparatus-related instrument 470.

[111] The drilling equipment controller 410 controls drilling equipment. Drilling is an operation of drilling the sea floor in order to obtain resources under the sea floor, and drilling equipment includes a draw-works, a top drive, a mud pump, a cement pump, and the like. The draw-works is driven by a draw-works motor, the top drive is driven by a top drive motor, the mud pump is driven by a mud pump motor, and the cement pump is driven by a cement pump motor.

[112] The draw-works is controlled by a draw-works controller; the top drive is controlled by a top drive controller; the mud pump is controlled by a mud pump controller; and a cement pump is controlled by a cement pump controller. The draw-works controller, the top drive controller, the mud pump controller, and the cement pump controller may constitute a drilling control system (DCS).

[113] In Fig. 4, a main apparatus 430 may be the draw-works motor, the top drive motor, the mud pump motor, or the cement pump motor, and the drilling equipment controller 410 may be the draw-works controller, the top drive controller, the mud pump controller, or the cement pump controller. The draw-works controller controls the draw-works motor; the top drive controller controls the top drive motor; the mud pump controller controls the mud pump motor; and the cement pump controller controls the cement pump motor.

[114] For operation of the main apparatus 430, such as the draw-works motor, the top drive motor, the mud pump motor and the cement pump motor, an auxiliary apparatus 460 related to the main apparatus 430 must be operated.

[115] The auxiliary apparatus 460 includes a blower motor, a lube oil pump motor, a hydraulic pump motor, and the like. The auxiliary apparatus 460 of Fig. 4 may be the blower motor, the lube oil pump motor, or the hydraulic motor. Although one auxiliary apparatus 460 is shown in Fig. 4, it should be understood that a plurality of auxiliary apparatus 460 may be connected to the MCC 450. For example, the blower motor, the lube oil pump motor and the hydraulic motor as the auxiliary apparatus may be connected to the MCC 450.

[116] The blower motor performs air cooling of the main apparatus 430. The lube oil pump motor performs oil cooling of the drilling equipment such as a draw-works, a top drive, a mud pump or a cement pump, and provides lubrication to gears of the drilling equipment in order to reduce mechanical friction while allowing smooth operation thereof.

[117] The hydraulic motor operates the auxiliary apparatus 460 by hydraulic pressure when the auxiliary apparatus 460 is a hydraulic apparatus. The hydraulic motor is an auxiliary apparatus additionally disposed near the auxiliary apparatus 460 when the auxiliary apparatus 460 is a hydraulic apparatus.

[118] The auxiliary apparatus 460 must be operated before operation of the main apparatus 430. Since the main apparatus 430 is stopped, causing significant influence on drilling operation, in an event that the auxiliary apparatus 460 is not operated before operation of the main apparatus 430 or is not operated or has a problem during operation of the main apparatus 430, the main apparatus 430 is set to operate when the precondition that the auxiliary apparatus 460 has no problem is satisfied through operation of the auxiliary apparatus 460 before operation of the main apparatus 430.

[119] The drilling equipment controller 410 sends a main apparatus execution command to the DC/AC converter 420 in order to operate the main apparatus 430.

[120] The DC/AC converter 420 sends an auxiliary apparatus execution command to the MCC 450 in response to the main apparatus execution command.

[121] The MCC 450 operates an auxiliary apparatus in response to the auxiliary apparatus execution command sent from the DC/AC converter 420. The MCC 450 is equipment in which starters for operating motors are collected. Each of the starters has a protection function with respect to overload of the motors, fault current, and the like.

[122] The auxiliary apparatus-related instrument 470 is disposed around the auxiliary apparatus 460 and measures a condition of the auxiliary apparatus 460 to send information regarding the condition of the auxiliary apparatus 460 to the DC/AC converter 420.

[123] The auxiliary apparatus-related instrument 470 may be a pressure gauge or a flow meter. Alternatively, both the pressure gauge and the flow meter may be

provided as the auxiliary apparatus-related instrument.

[124] The pressure gauge measures pressure of a pipe through which a refrigerant is supplied to the main apparatus 430. The refrigerant for cooling the main apparatus 430 may be water, air, or oil. In order to supply the refrigerant to the main apparatus 430, a cooling pump motor is used when the refrigerant is water; a blower motor is used when the refrigerant is air; and a lube oil pump motor is used when the refrigerant is oil. However, during operation of the cooling pump motor, the blower motor or the lube oil pump motor for supply of the lubricant, the pressure of the pipe for supply of the refrigerant is varied. Accordingly, it can be determined based on the pressure of the pipe for supply of the refrigerant whether the cooling pump motor, the blower motor or the lube oil pump motor provided as the auxiliary apparatus is normally operated.

[125] The top drive is cooled by water and a cooling pump is used for cooling the top drive. That is, the flow meter is provided to a pipe through which water flows into the top drive by the cooling pump. The cooling pump is operated by the cooling pump motor. When the cooling pump is operated by the MMC operating the cooling pump motor, the amount of water in the pipe flowing into the top drive changes. Accordingly, it can be determined based on the value of the flow meter whether the cooling pump motor as the auxiliary apparatus is operated.

[126] The DC/AC converter 420 receives information regarding the condition of the auxiliary apparatus 460 from the auxiliary apparatus-related instrument 470 and determines whether the auxiliary apparatus 460 is normally operated. The DC/AC converter 420 operates the main apparatus 430 upon determining that the auxiliary apparatus 460 is normally operated.

[127] The auxiliary apparatus-related instrument 470 may measure the condition of the auxiliary apparatus 460 and send information regarding the condition of the auxiliary apparatus 460 to the MCC 450. Then, the MCC 450 may control the auxiliary apparatus 460 based on the information regarding the condition of the auxiliary apparatus 460.

[128] For example, if the auxiliary apparatus 460 is the blower motor or the lube oil pump motor and the auxiliary apparatus-related instrument 470 is the pressure gauge,

the MCC 450 may increase the speed of the auxiliary apparatus 460 when the pressure of the pressure gauge is less than or equal to a sixth threshold value, and may decrease the speed of the auxiliary apparatus 460 when the pressure of the pressure gauge is higher than or equal to a seventh threshold value. Here, the seventh threshold value is greater than the sixth threshold value.

[129] Alternatively, if the main apparatus 430 is the top drive motor, the auxiliary apparatus 460 is the cooling motor, and the auxiliary apparatus-related instrument 470 is the flow meter, the MCC 450 may increase the speed of the auxiliary apparatus 460 when the flux of the flow meter is less than or equal to an eighth threshold value, and may decrease the speed of the auxiliary apparatus 460 when the flux of the flow meter is higher than or equal to a ninth threshold value. Here, the ninth threshold value is greater than the eighth threshold value.

[130] The main apparatus-related instrument 440 is disposed around the main apparatus 430 and measures a condition of the main apparatus 430 to send information regarding the condition of the main apparatus 430 to the DC/AC converter 420.

[131] At least one of a winding temperature sensor, a bearing temperature sensor, an encoder sensor, and a moisture sensor may be provided as the main apparatus-related instrument 440.

[132] The winding temperature sensor measures the temperature of a winding of the main apparatus 430 and sends information regarding the temperature of the winding to the DC/AC converter 420. The DC/AC converter 420 may generate an alarm when the temperature of the winding is higher than or equal to a first threshold value, and may stop operation of the main apparatus 430 when the temperature of the winding is higher than or equal to a second threshold value. Here, the second threshold value is greater than the first threshold value.

[133] The bearing temperature sensor measures the temperature of a bearing of the main apparatus 430 and sends information regarding the temperature of the bearing to the DC/AC converter 420. The DC/AC converter 420 may generate an alarm when the temperature of the bearing is higher than or equal to a third threshold value, and may stop operation of the main apparatus 430 when the temperature of the bearing is

higher than or equal to a fourth threshold value. Here, the fourth threshold value is greater than the third threshold value.

[134] The encoder sensor senses a rotation speed and a rotation angle of the main apparatus 430 and sends information regarding the rotation speed and the rotation angle to the DC/AC converter 420.

[135] The moisture sensor measures humidity of the main apparatus 430 and sends information regarding the humidity of the main apparatus 430 to the DC/AC converter 420. When the main apparatus 430 has a high moisture content, the DC/AC converter 420 activates a motor space heater to remove moisture from the main apparatus 430. For example, when the humidity of the main apparatus 430 is higher than or equal to a fifth threshold value, the DC/AC converter 420 may activate the motor space heater.

[136] Next, a method of controlling an auxiliary apparatus of drilling equipment in a drill ship according to one embodiment of the present invention will be described with reference to Fig. 5. Fig. 5 is a flowchart of a method of controlling (monitoring) an auxiliary apparatus of drilling equipment in a drill ship according to one embodiment of the present invention.

[137] If the drilling equipment controller 410 sends a main apparatus execution command to the DC/AC converter 420 (S510), the DC/AC converter 420 sends an auxiliary apparatus execution command to the MCC 450 (S520). Then, the MMC 450 operates the auxiliary apparatus 460.

[138] The auxiliary apparatus-related instrument 470 sends information regarding a condition of the auxiliary apparatus 460 to the DC/AC converter 420 (S530) and the DC/AC converter 420 determines whether the auxiliary apparatus 460 is normally operated based on the information regarding the condition of the auxiliary apparatus 460 received from the auxiliary apparatus-related instrument 470.

[139] Upon determining that the auxiliary apparatus 460 is normally operated, the DC/AC converter 420 operates the main apparatus 430 (S540). In addition, the main apparatus-related instrument 440 measures a condition of the main apparatus 430 and sends information regarding the condition of the main apparatus 430 to the DC/AC converter 420 (S550).

[140] Although some embodiments have been described herein, it should be understood by those skilled in the art that these embodiments are given by way of illustration only, and that various modifications, variations and alterations can be made without departing from the spirit and scope of the invention. Therefore, the embodiments disclosed herein should not be construed as limiting the technical scope of the present invention, but should be construed as illustrating the idea of the present invention. The scope of the present invention should be interpreted according to the appended claims as covering all modifications or variations derived from the appended claims and equivalents thereof.

CLAIMS

【Claim 1】

A ship including an apparatus for controlling an auxiliary apparatus of drilling equipment, comprising:

- a DC/AC converter operating a main apparatus when an auxiliary apparatus related to the main apparatus is normally operated;

- a drilling equipment controller sending a main apparatus execution command to the DC/AC converter to operate the main apparatus; and

- a motor control center (MCC) operating the auxiliary apparatus,

wherein the DC/AC converter sends an auxiliary apparatus execution command to the MCC to operate the auxiliary apparatus in response to the main apparatus execution command sent from the drilling equipment controller and the auxiliary apparatus is previously operated for operation of the main apparatus.

【Claim 2】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 1, further comprising:

- an auxiliary apparatus-related instrument disposed around the auxiliary apparatus and measuring a condition of the auxiliary apparatus.

【Claim 3】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 2, wherein the DC/AC converter determines whether the auxiliary apparatus is normally operated in response to information regarding a condition of the auxiliary apparatus sent from the auxiliary apparatus-related instrument.

【Claim 4】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 2, wherein the auxiliary apparatus-related instrument is a pressure gauge provided to a pipe through which a refrigerant is supplied to the main apparatus and the MMC increases a speed of the auxiliary apparatus when the pressure received from the pressure gauge is less than or equal to a first threshold value, and decreases the speed of the auxiliary apparatus when the pressure received from the pressure gauge is higher than or equal to a second threshold value, the second threshold value being greater than the first threshold value.

【Claim 5】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 2, wherein the main apparatus is a top drive motor and the auxiliary apparatus-related instrument is a flow meter provided to a pipe through which water flows into the top drive driven by the top drive motor.

【Claim 6】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 2, wherein the MCC receiving information regarding the condition of the auxiliary apparatus sent from the auxiliary apparatus-related instrument and

controlling the auxiliary apparatus based on the information regarding the condition of the auxiliary apparatus.

【Claim 7】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 1, further comprising:

a main apparatus-related instrument disposed around a main apparatus and measuring a condition of the main apparatus.

【Claim 8】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 7, wherein the main apparatus-related instrument is a winding temperature sensor measuring a temperature of a winding of the main apparatus and sending information regarding the temperature of the winding to the DC/AC converter and the DC/AC converter generates an alarm when the temperature of the winding is higher than or equal to a first threshold value, and stops operation of the main apparatus when the temperature of the winding is higher than or equal to a second threshold value, the second threshold value being greater than the first threshold value.

【Claim 9】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 7, wherein the main apparatus-related instrument is a bearing temperature sensor measuring a temperature of a bearing of the main apparatus and sending information regarding the temperature of the bearing to the DC/AC converter and the DC/AC converter generates an alarm when the temperature of the bearing is higher than or equal to a first threshold value, and stops operation of the main apparatus when the temperature of the bearing is higher than or equal to a second threshold value, the second threshold value being greater than the first threshold value.

【Claim 10】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 7, wherein the main apparatus-related instrument is an encoder sensor sensing a rotation speed and a rotation angle of the main apparatus and sending information regarding the rotation speed and the rotation angle to the DC/AC converter.

【Claim 11】

The ship including an apparatus for controlling an auxiliary apparatus of drilling equipment according to claim 7, wherein the main apparatus-related instrument is a moisture sensor measuring humidity of the main apparatus and sending information regarding the humidity of the main apparatus to the DC/AC converter and the DC/AC converter operates a motor space heater to remove inner moisture from the main apparatus when the humidity of the main apparatus is higher than or equal to a threshold value.

【Claim 12】

A method of controlling an auxiliary apparatus of drilling equipment for ship, comprising:

sending, by a drilling equipment controller, a main apparatus execution command to a DC/AC converter to operate a main apparatus;

sending, by the DC/AC converter, an auxiliary apparatus execution command to a motor control center (MCC) to operate an auxiliary apparatus related to the main apparatus;
operating the auxiliary apparatus by the MMC; and
operating the main apparatus by the DC/AC converter when the auxiliary apparatus is normally operated,
wherein the auxiliary apparatus is previously operated for operation of the main apparatus.

【Claim 13】

The method of controlling an auxiliary apparatus of drilling equipment for ship according to claim 12, further comprising:
measuring a condition of the auxiliary apparatus and sending information regarding the condition of the auxiliary apparatus to the DC/AC converter by an auxiliary apparatus-related instrument.

【Claim 14】

The method of controlling an auxiliary apparatus of drilling equipment for ship according to claim 13, wherein the DC/AC converter determines whether the auxiliary apparatus is normally operated in response to the information regarding the condition of the auxiliary apparatus sent from the auxiliary apparatus-related instrument.

【Claim 15】

The method of controlling an auxiliary apparatus of drilling equipment for ship according to claim 14, further comprising:
measuring a condition of the main apparatus and sending information regarding the condition of the main apparatus to the DC/AC converter by a main apparatus-related instrument.