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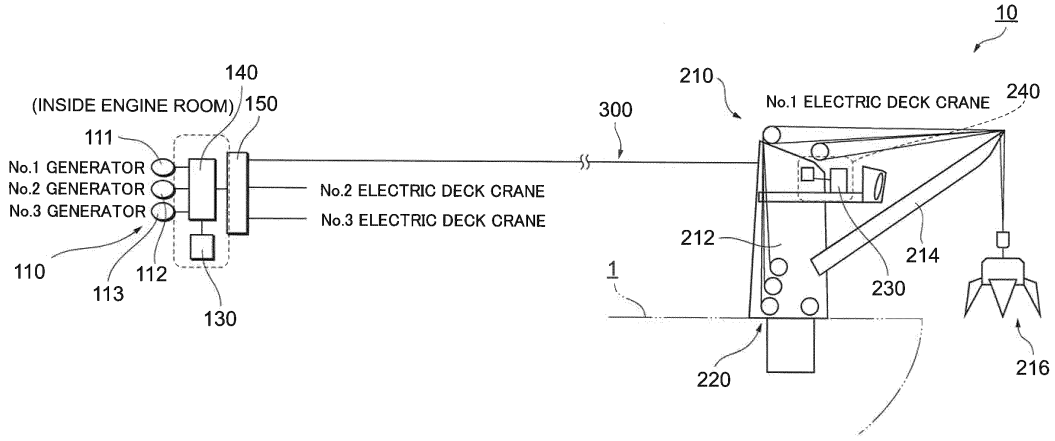
(54) **CRANE DEVICE FOR SHIPS**

(57) Provided is a crane apparatus for a ship, which is configured to optimize the inboard electric power, particularly the electric power for cargo handling, thereby curbing the impact on the environmental burden and improving the efficiency. In order to realize such crane apparatus, one aspect of the present invention is a crane apparatus (10) for a ship (1) equipped with an electric deck crane (210), the crane apparatus (10) including; a motor (220) driving the electric deck crane (210); a crane-side battery (230) attached to the electric deck crane (210); a generator (110) provided on a hull of the ship; a hull-side battery (130) provided on the hull; and wiring (300) connecting the motor (220), the crane-side battery (230), the generator (110), and the hull-side battery (130).

FIG.1



EP 4 053 067 A1

Description

Technical Field

[0001] The present invention relates to a crane apparatus for a ship.

Background Art

[0002] A ship equipped with a deck crane on board is used as a cargo ship (e.g., a chip carrier) (see Patent Publication JP2010-285271A, for example). An electric deck crane used for cargo handling, for example, is configured to perform necessary operations such as hoisting, luffing, and slewing by means of a motor.

Citation List

Patent Document

[0003] Patent Document 1: Patent Publication JP2010-285271A

Summary

Technical Problem

[0004] However, from the viewpoint of optimizing the inboard electric power (particularly the electric power for cargo handling), there is still room for improvement in the conventional electric deck crane or crane apparatus including said conventional electric deck crane.

[0005] Therefore, an object of the present invention is to provide a crane apparatus for a ship, which is configured to optimize the inboard electric power, particularly the electric power for cargo handling, thereby curbing the impact on the environmental burden and improving the efficiency.

Solution to Problem

[0006] One aspect of the present invention is a crane apparatus for a ship equipped with an electric deck crane, the crane apparatus including:

a motor driving the electric deck crane;

a crane-side battery attached to the electric deck crane;

a generator provided on a hull of the ship;

a hull-side battery provided on the hull; and

wiring connecting the motor, the crane-side battery, the generator, and the hull-side battery.

[0007] In the conventional electric crane apparatus, although regenerative electric power is used as the inboard electric power, the excess electric power may be consumed as heat by a resistor provided on the ship, possibly wasting energy. According to the crane apparatus of the foregoing aspect, on the other hand, the inboard electric power, particularly the electric power for cargo handling can be optimized by utilizing the batteries, thereby curbing the impact on the environmental burden and improving the efficiency.

[0008] The hull-side battery of the crane apparatus according to the foregoing aspect may be composed of a battery such as a lithium-ion battery that has a higher energy density than the crane-side battery.

[0009] The crane-side battery of the crane apparatus according to the foregoing aspect may be composed of a battery capable of charging and discharging more rapidly than the hull-side battery, such as a lithium-ion battery or a capacitor with a high capacity rate.

[0010] The motor of the crane apparatus according to the foregoing aspect may be any of a wire hoisting motor, a luffing motor, and a slewing motor.

[0011] In the crane apparatus according to the foregoing aspect, a hull-side system may be provided with a hull-side control unit, and a crane-side system may be provided with a crane-side control unit. In such a case, a switchboard may be provided between the hull-side control unit and the crane-side control unit.

Advantageous Effects of Invention

[0012] The present invention can provide a crane apparatus for a ship, which is configured to optimize the inboard electric power, particularly the electric power for cargo handling, thereby curbing the impact on the environmental burden and improving the efficiency.

Brief Description of Drawings

[0013]

Fig. 1 is a diagram schematically illustrating a configuration of a crane apparatus according to an embodiment of the present invention;

Fig. 2 is a block diagram illustrating a configuration example of a hull-side system and a crane-side system of the crane apparatus;

Fig. 3 is a side view for explaining a hoisting/lowering operation of an electric deck crane;

Fig. 4 is a side view for explaining a luffing [up]/luffing [down] operation of the electric deck crane;

Fig. 5 is a plan view for explaining a slewing operation of the electric deck crane; and

Fig. 6 is a graph for explaining a brief overview of

peak shaving/charging performed in the crane apparatus.

Description of Embodiments

[0014] Preferred embodiments of the present invention are now described hereinafter with reference to the accompanying drawings.

[0015] A crane apparatus 10 is an apparatus for a ship equipped with an electric deck crane 210. The crane apparatus 10 according to the present embodiment includes a hull-side system 100 provided on the hull (ship) 1 side and a crane-side system 200 (see Figs. 1 and 2).

[0016] The hull-side system 100 includes a generator 110, a hull-side battery 130, a hull-side control unit 140, and a switchboard 150. The crane-side system 200 includes an electric deck crane 210, a motor 220, a crane-side battery 230, and a crane-side control unit 240 (see Figs. 1 and 2).

[0017] The generator 110 is a device that generates electricity by utilizing power of an engine 20 in the hull 1 (see Fig. 2). For example, in the crane apparatus 10 of the present embodiment, three generators 111, 112, and 113, generators No. 1 to No. 3, are arranged in the hull 1, constituting the crane apparatus 10 (see Fig. 1).

[0018] Of at least two batteries provided in the crane apparatus 10, the hull-side battery 130 is the one provided in the hull 1. The hull-side battery 130 of the present embodiment is composed of a battery having a higher energy density than the crane-side battery 230. A preferred example of such hull-side battery 130 is a lithium-ion battery. The hull-side battery 130 of the present embodiment is connected to the hull-side control unit 140 via a battery control unit 132 (Fig. 2).

[0019] The hull-side control unit 140 is a control unit provided in the hull-side system 100. Such hull-side control unit 140 of the present embodiment configured by an EMS keeps the amount of electric power of each of the generators 111, 112, and 113 constant at all times and manages the amount of charge/discharge of the hull-side battery 130.

[0020] The electric deck crane 210 of the crane-side system 200 is a crane apparatus configured to perform necessary operations such as a hoisting/lowering operation of hook 216 (or sometimes a bucket shown in Fig. 1) (see Fig. 3), an luffing [up]/luffing [down] operation of a jib (arm) 214 (see Fig. 4), and a slewing operation of a crane body 212 (see Fig. 5). For example, three electric deck cranes 210, electric deck cranes No. 1 to No. 3, are installed in the hull 1 of the present embodiment (see Fig. 1), but Figs. 2 to 5 illustrate only one of these electric deck cranes as a representative example.

[0021] The motor 220 provides driving force for causing the electric deck cranes 210 to perform necessary operations. In the crane-side system 200 of the present embodiment, the electric deck cranes 210 are provided with a hoisting motor 220A, a luffing motor 220B, and a slewing motor 220C, respectively (see Fig. 2). These motors 220 (hoisting motor 220A, luffing motor 220B, and slewing motor 220C) are connected to the crane-side control unit 240 via respective inverters 222 (a hoisting motor inverter 222A, a luffing motor inverter 222B, and a slewing motor inverter 222C) (see Fig. 2).

[0022] The the crane-side battery 230 is a battery attached to each electric deck crane 210. The crane-side battery 230 of the present embodiment is composed of a battery capable of charging and discharging more rapidly than the hull-side battery 130, and is provided for each electric deck crane. A favorable example of such crane-side battery 230 is a battery composed of a lithium-ion battery or a capacitor with a high capacity rate. The crane-side battery 230 of the present embodiment is connected to the crane-side control unit 240 via a battery control unit 232 (see Fig. 2).

[0023] The crane-side control unit 240 is a control unit provided in the crane-side system 200. The crane-side control unit 240 of the present embodiment performs various types of control on the electric deck crane 210, such as managing the amount of charge/discharge of the crane-side battery 230.

[0024] As described above, the components constituting the crane apparatus 10, that is, the motor 220, the crane-side battery 230, the generators 110, the hull-side battery 130 and the like, are connected by wiring 300.

[0025] A switchboard is provided between the hull-side control unit 140 and the crane-side control unit 240. For example, in the present embodiment, the switchboard 150 is provided on the wiring 300 on the hull-side system 100 side (see Fig. 2).

[0026] Next, operations for carrying out a cargo handling operation by the crane apparatus 10 of the present embodiment, electric power fluctuations, and the like will be described step by step (see Fig. 6).

(1) Prior to hoisting

[0027] In the stage prior to the hoisting operation (the stage prior to starting the cargo handling operation), the hull-side battery 130 is being charged from the generator 110.

(2) Hoist

[0028] The hoisting motor 220A is driven to perform the hoisting operation. At the start of hoisting, the crane-side battery 230 discharges to supply electric power to the hoisting motor 220A, and thereafter the hull-side battery 130 discharges to supply electric power to the hoisting motor 220A.

(3) Luffing [down]

[0029] The both batteries (the hull-side battery 130 and the crane-side battery 230) are charged with regenerative electric power that is generated in the luffing motor 220B to perform the luffing [down] operation.

(4) Luffing [down] and slewing

[0030] The both batteries (the hull-side battery 130 and the crane-side battery 230) are charged with the regenerative electric power that is generated in the luffing motor 220B to perform the luffing [down] operation.

(5) Lower

[0031] The both batteries (the hull-side battery 130 and the crane-side battery 230) are charged with regenerative electric power that is generated in the hoisting motor 220A to perform the lowering operation.

(6) Grab a cargo

[0032] A grabbing operation for grabbing a cargo by the bucket (or an operation for hooking a cargo by the hook 216) is performed.

(7) Hoist

[0033] The hoisting motor 220A is driven to perform the hoisting operation. In so doing, the crane-side battery 230 discharges to supply electric power to the hoisting motor 220A.

(8) Luffing [up]

[0034] The luffing motor 220B is driven to perform the luffing [up] operation. At the start of luffing [up], the crane-side battery 230 discharges to supply electric power to the luffing motor 220B, and thereafter the hull-side battery 130 discharges to supply electric power to the luffing motor 220B.

(9) Slewing

[0035] The slewing operation is performed during or after the luffing operation. In this slewing operation, the hull-side battery 130 discharges to supply electric power to the luffing motor 220B and/or the slewing motor 220C.

(10) Luffing [down]

[0036] The both batteries (the hull-side battery 130 and the crane-side battery 230) are charged with the regenerative electric power that is generated in the luffing motor 220B to perform the luffing [down] operation.

(11) Lower

[0037] The both batteries (the hull-side battery 130 and the crane-side battery 230) are charged with the regenerative electric power that is generated in the hoisting motor 220A to perform the lowering operation.

[0038] In the cargo handling operation that has been described step by step from (1) to (11) above, the crane apparatus 10 of the present embodiment is operated in accordance with the fluctuating electric power demand of the electric deck crane 210. Specifically, the electric power is supplied (discharged) from the hull-side battery 130 to the electric deck crane 210 when the electric power demand thereof exceeds the amount of electric power supply, and the electric power is stored (charged) in the hull-side battery 130 when the electric power demand of the electric deck crane 210 is below the amount of electric power supply. During a single cargo handling cycle (typically for approximately 200 seconds), discharge and charge are switched once or twice. When the hoisting/luffing motors 220A and 220B start to move, each of the motors instantaneously (for 1 to 2 seconds) requires several to ten times as much electric power as the electric power required during steady rotation. This instantaneous electric power demand occurs once or twice during a single cargo handling cycle. This instantaneous electric power demand is supplied (discharged) from the crane-side battery 230. In addition, the regenerative electric power that is generated by the reverse rotation (lowering, etc.) of the hoisting/luffing motors 220A and 220B during a cargo handling cycle is charged to the crane-side battery 230.

[0039] In the crane apparatus 10 of the present embodiment, the crane-side system 200 is characterized in responding to an instantaneous electric power demand, and the hull-side system 100 is characterized in balancing the electric power demand relatively gently. Therefore, it is preferred that a rapid charge/discharge compatible battery be used for the crane-side battery 230, that a capacity storage battery be used for the hull-side battery 130, and that the charge/discharge timing be employed in accordance with the characteristics of said batteries.

[0040] Moreover, in the crane apparatus 10 of the present embodiment, balancing of all the electric power supply/demand is controlled by the hull-side control unit 140 and the crane-side control unit 240, and the crane apparatus 10 can be operated at a constant generator output, improving the fuel efficiency. Thus, a highly efficient system can be realized. As a result, the generators 110 make no load fluctuations, thereby achieving fuel saving. Another advantage is that, even when performing cargo handling with the electric power received from the outside, the amount of the electric power received can be reduced.

[0041] Also, according to the crane apparatus 10 of the present embodiment, cost reduction, energy saving, reduction of the environmental burden and the like can be accomplished by utilizing the batteries. Specifically, the following are achieved:

1) Optimization of the capacities of the generators (the sizes of the generators can be reduced by utilizing the batteries).
2) Optimization of the efficiency of the generation engine with the assistance of the batteries.

3) Power peak shaving in cargo handling by means of the batteries (see Fig. 6).
4) At the time of cargo handling, charging the batteries with the regenerative electric power generated when lowering the crane.

[0042] Now, the above 3) will be explained supplementarily. Let it be assumed that the curve of the electric power used in cargo handling using a crane apparatus for a typical ship is as shown in Fig. 6. By utilizing the batteries of the crane apparatus 10 of the present embodiment, the amount of electric power that exceeds a predetermined output value X [kW] obtained when a constant output operation is performed by the generator 110 can be reduced (power peak shaving), and the electric power that is generated by the generator 110 when the required electric power is less than 0 [kW] can be stored in the batteries (see Fig. 6).

[0043] Although the foregoing embodiment is an example of a preferred embodiment of the present invention, the present invention is not limited thereto; the present invention can be modified and implemented in various ways without departing from the gist of the present invention.

Industrial Applicability

[0044] The present invention can favorably be applied to a crane apparatus for a ship equipped with an electric deck crane.

Reference Signs List

[0045]

1	Hull (ship)
10	Crane apparatus
20	Engine
100	Hull-side system
110	Generator
130	Hull-side battery
132	Battery control unit
140	Hull-side control unit
150	Switchboard
200	Crane-side system
210	Electric deck crane
212	Crane body
214	Jib
216	Hook
220	(Hoisting/luffing/slewing) motor
222	Inverter
230	Crane-side battery
232	Battery control unit
240	Crane-side control unit
300	Wiring

Claims

1. A crane apparatus for a ship equipped with an electric deck crane, the crane apparatus comprising:

a motor driving the electric deck crane;
a crane-side battery attached to the electric deck crane;
a generator provided on a hull of the ship;
a hull-side battery provided on the hull; and
wiring connecting the motor, the crane-side battery, the generator, and the hull-side battery.

2. The crane apparatus for a ship according to claim 1, wherein the hull-side battery is composed of a battery having a higher energy density than the crane-side battery.

3. The crane apparatus for a ship according to claim 1 or 2, wherein the crane-side battery is composed of a battery capable of charging and discharging more rapidly than the hull-side battery.

4. The crane apparatus for a ship according to any one of claims 1 to 3, wherein the motor is any of a wire hoisting motor, a luffing motor, and a slewing motor.

5. The crane apparatus for a ship according to any one of claims 1 to 4, wherein the hull-side system is provided with a hull-side control unit, and the crane-side system is provided with a crane-side control unit.

6. The crane apparatus for a ship according to claim 5, wherein a switchboard is provided between the hull-side control unit and the crane-side control unit.

Amended claims under Art. 19.1 PCT

1. (Amended) A crane apparatus for a ship equipped with an electric deck crane, the crane apparatus comprising:

a motor driving the electric deck crane;
a crane-side battery attached to the electric deck crane;
a generator provided on a hull of the ship;
a hull-side battery that is composed of a battery having a higher energy density than the crane-side battery and is provided on the hull; and
wiring connecting the motor, the crane-side battery, the generator, and the hull-side battery.

2. (Deleted)

3. (Amended) The crane apparatus for a ship according to claim 1, wherein the crane-side battery is composed of a battery capable of charging and discharg-

ing more rapidly than the hull-side battery.

4. (Amended) The crane apparatus for a ship according to any one of claim 1 or 3, wherein the motor is any of a wire hoisting motor, a luffing motor, and a slewing motor.

5. (Amended) The crane apparatus for a ship according to any one of claims 1, 3, and 4, wherein the hull-side system is provided with a hull-side control unit, and the crane-side system is provided with a crane-side control unit.

6. The crane apparatus for a ship according to claim 5, wherein a switchboard is provided between the hull-side control unit and the crane-side control unit.

FIG. 1

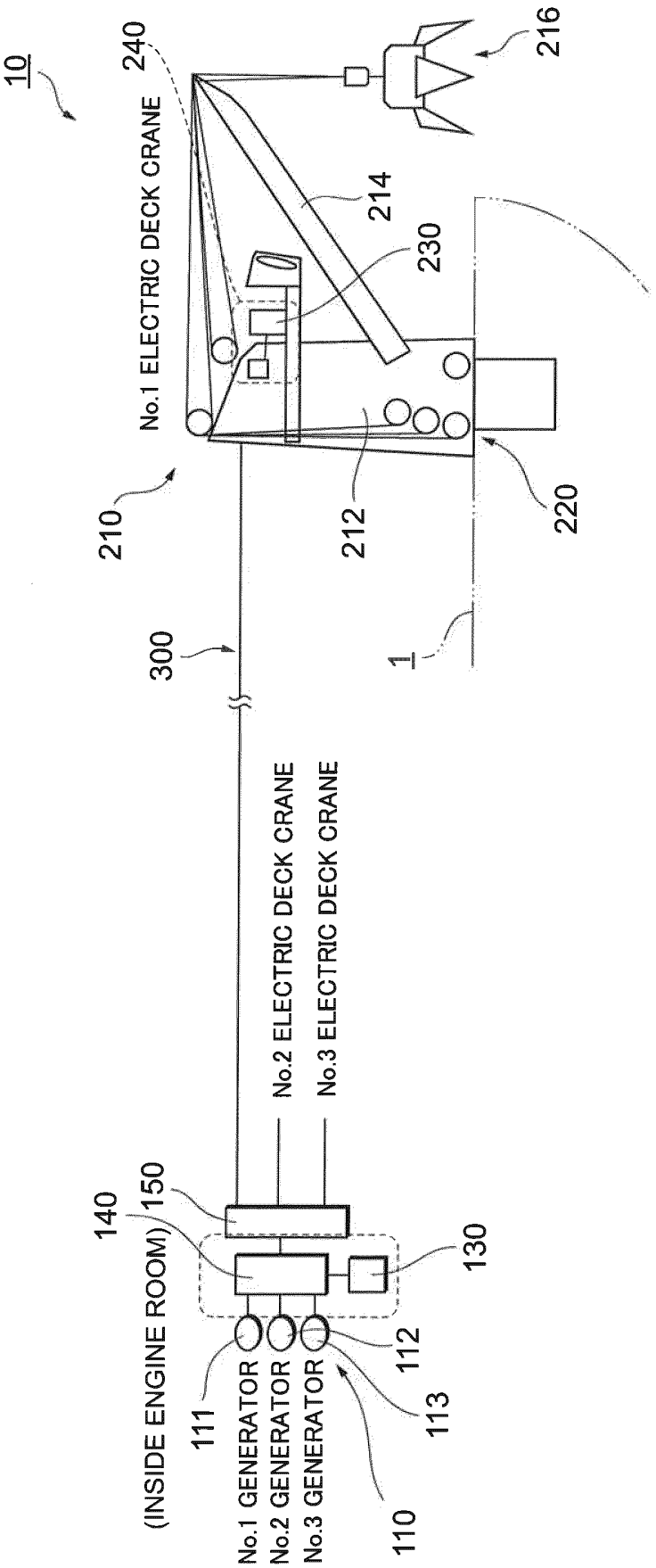

10
240
No.1 ELECTRIC DECK CRANE
216
214
230
210
212
220
1
300
No.2 ELECTRIC DECK CRANE
No.3 ELECTRIC DECK CRANE
140
150
130
(INSIDE ENGINE ROOM)
111
112
113
No.1 GENERATOR
No.2 GENERATOR
No.3 GENERATOR
110

FIG. 2

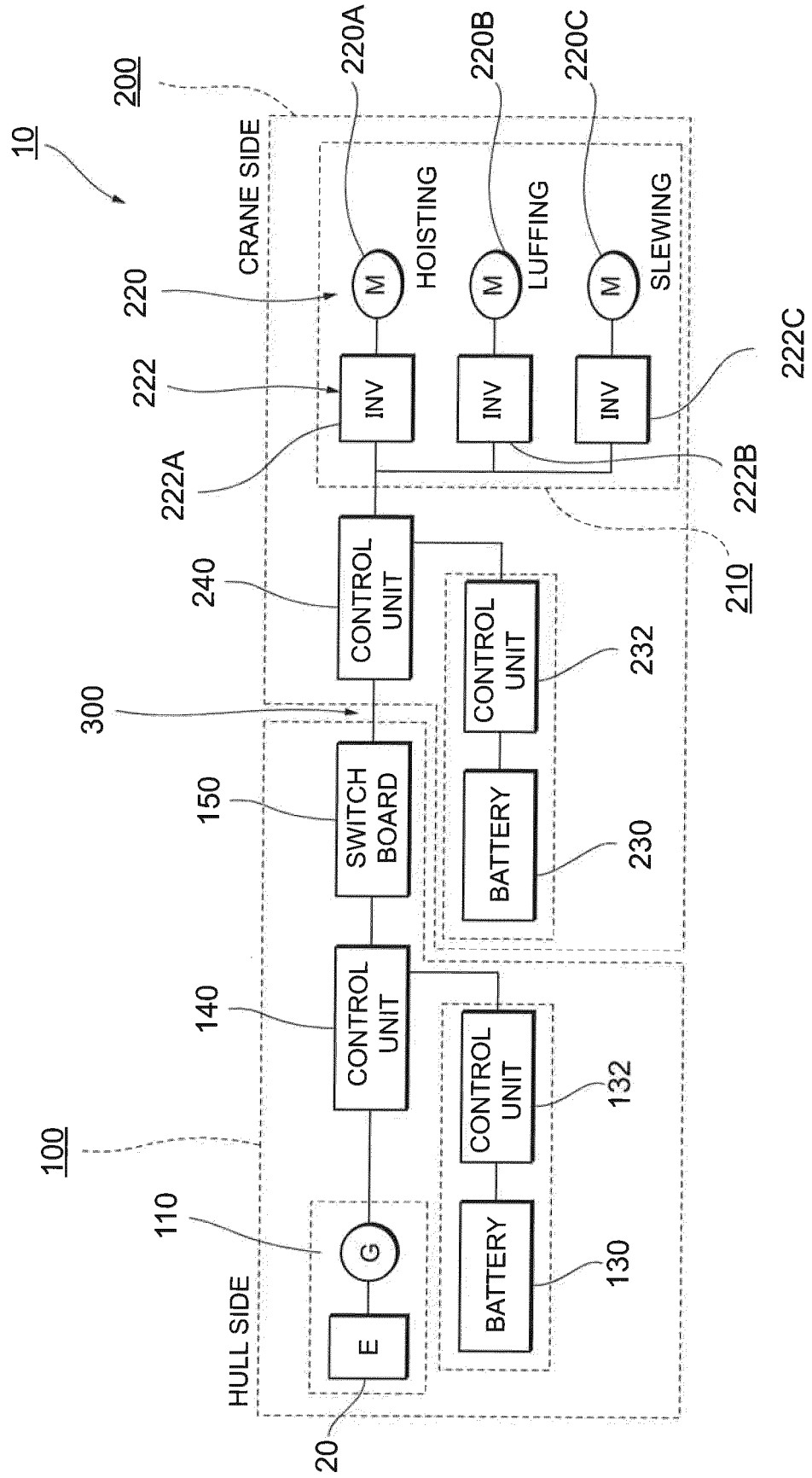

10
200
CRANE SIDE
220A
220B
220C
HOISTING
LUFFING
SLEWING
220
M
222
INV
222A
222B
222C
210
240
CONTROL UNIT
232
CONTROL UNIT
300
150
SWITCH BOARD
BATTERY
230
140
CONTROL UNIT
132
CONTROL UNIT
100
110
G
BATTERY
130
HULL SIDE
E
20

FIG.3

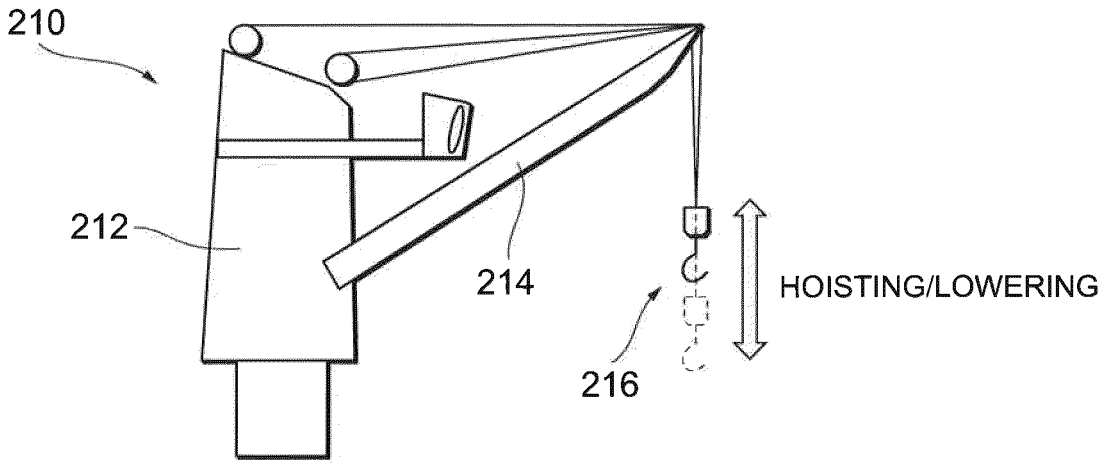


FIG.4

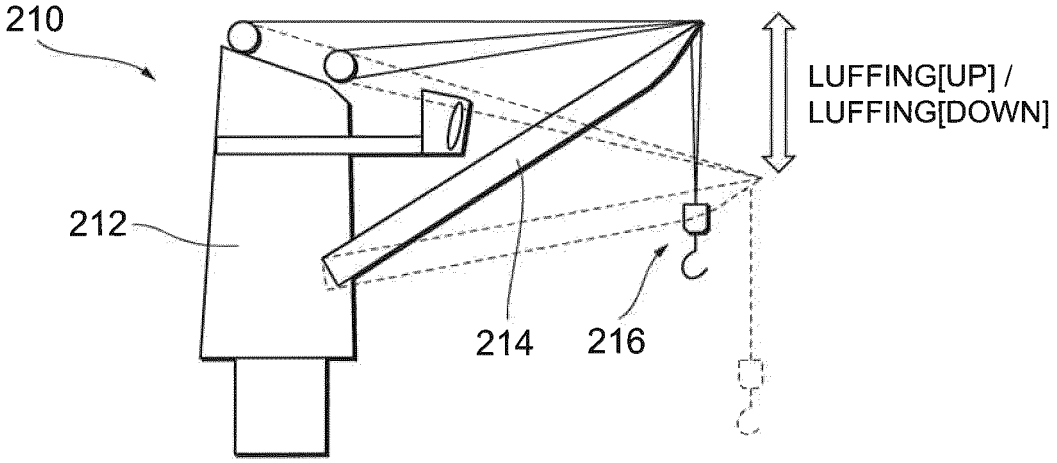


FIG.5

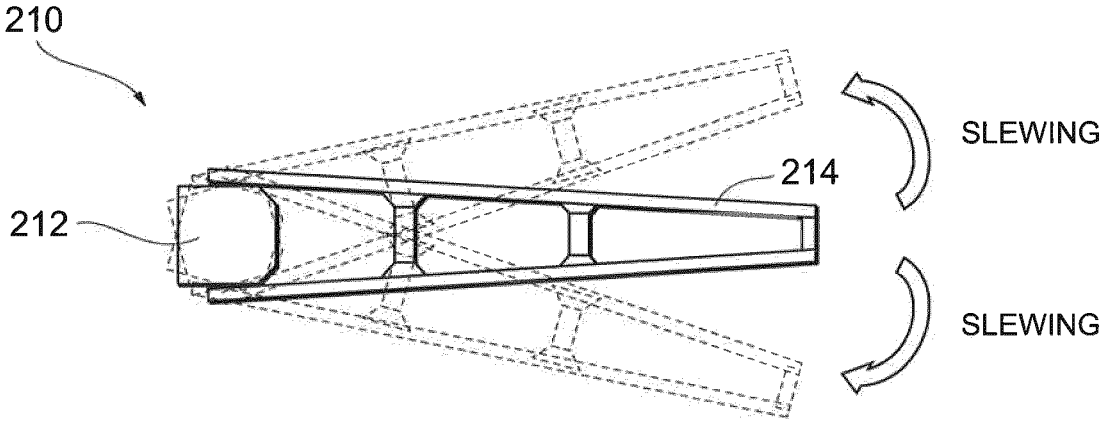
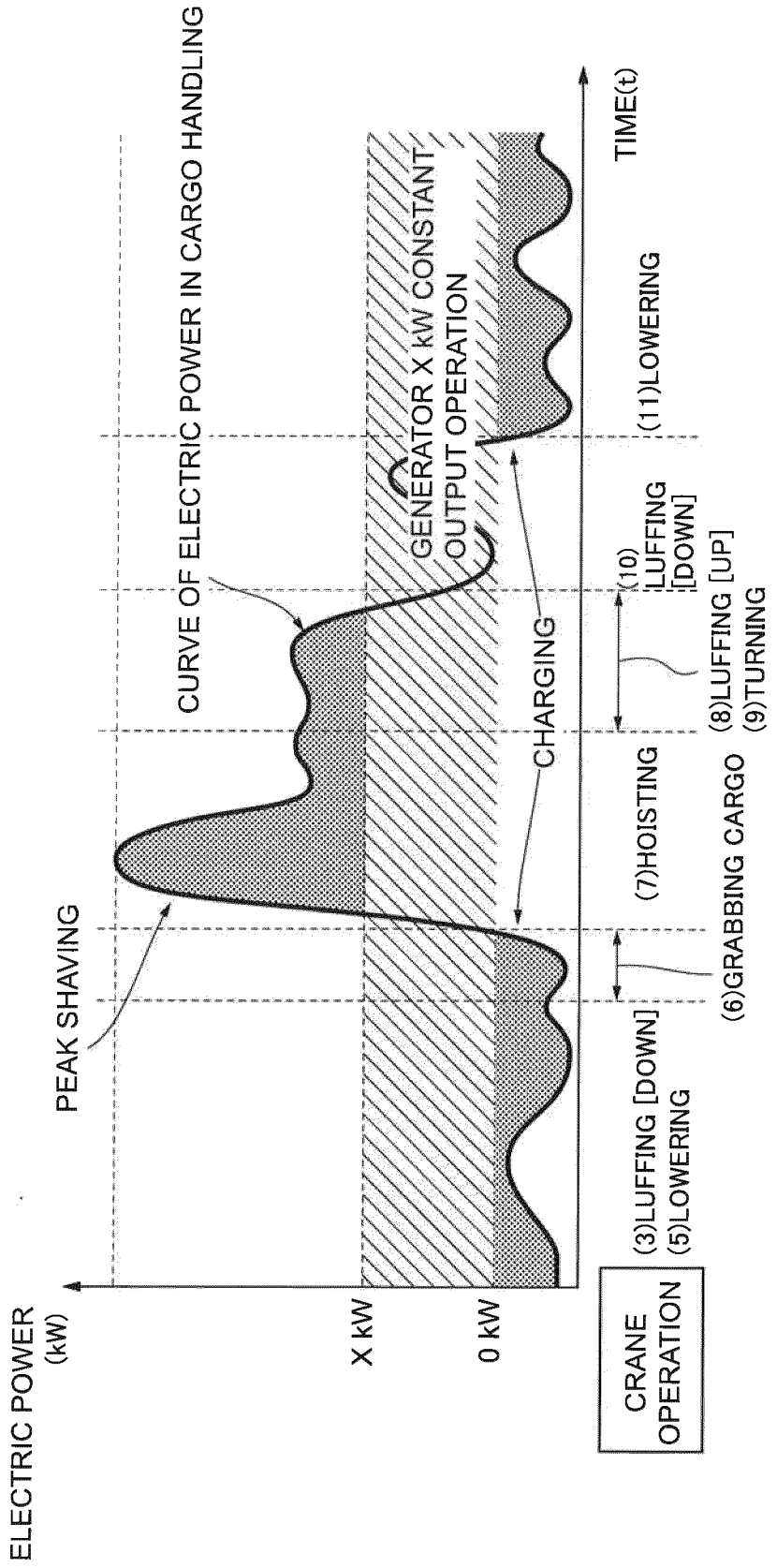


FIG. 6


ELECTRIC POWER (kW)
X kW
0 kW
PEAK SHAVING
CURVE OF ELECTRIC POWER IN CARGO HANDLING
GENERATOR X kW CONSTANT OUTPUT OPERATION
CHARGING
TIME(t)
CRANE OPERATION
(3)LUFFING [DOWN]
(5)LOWERING
(6)GRABBING CARGO
(7)HOISTING
(8)LUFFING [UP]
(9)TURNING
(10) LUFFING [DOWN]
(11)LOWERING

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/042956

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B66C23/52(2006.01)i
FI: B66C23/52

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)
Int.Cl. B66C23/00-B66C23/94

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2008/041498 A1 (TSUJI HEAVY INDUSTRIES CO., LTD.) 10.04.2008 (2008-04-10), paragraphs [0010]-[0036], fig. 2-5	1, 3-6 2
X A	WO 2008/059884 A1 (TSUJI HEAVY INDUSTRIES CO., LTD.) 22.05.2008 (2008-05-22), paragraphs [0014]-[0060], fig. 2-8	1, 3-6 2
A	WO 2014/181460 A1 (MITSUBISHI HEAVY INDUSTRIES, LTD.) 13.11.2014 (2014-11-13), paragraphs [0025]-[0096], fig. 1-9	1-6
A	JP 2010-6591 A (SEKIGAHARA SEISAKUSHO KK) 14.01.2010 (2010-01-14), paragraphs [0013]-[0030], fig. 1, 4	1-6

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15.01.2020	28.01.2020

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/042956

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 9-278366 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 28.10.1997 (1997-10-28), paragraphs [0008]-[0026], fig. 8	1-6
A	JP 2013-107721 A (TOA HARBOR WORKS CO., LTD.) 06.06.2013 (2013-06-06), paragraphs [0015]-[0037], fig. 1, 2	1-6
A	JP 2012-62024 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 29.03.2012 (2012-03-29), paragraphs [0015]-[0053], fig. 1-6	1-6
A	WO 2018/088900 A1 (ITREC B.V.) 17.05.2018 (2018-05-17), page 7, line 30 to page 13, line 2, fig. 1a	1-6

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2019/042956

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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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