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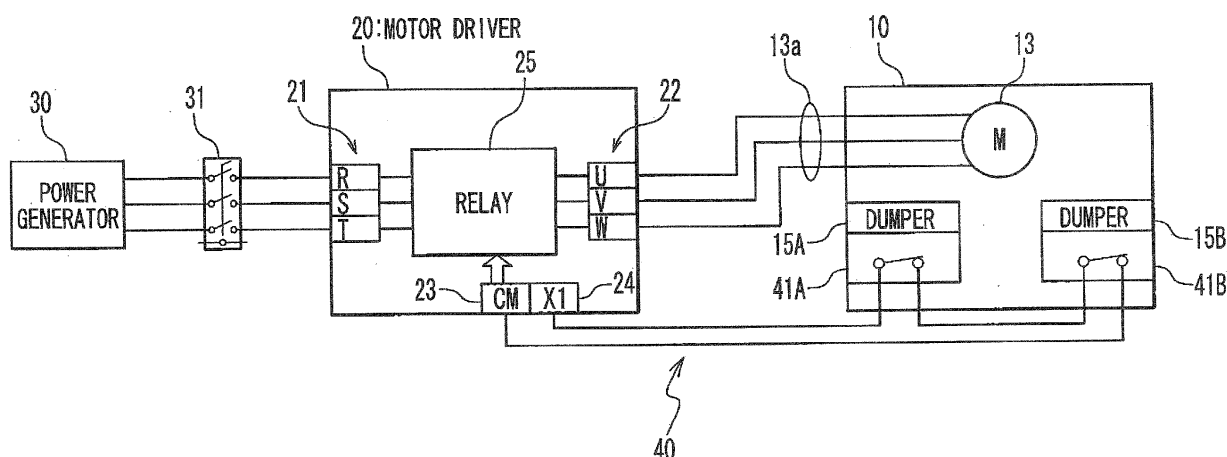
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(54) **Swing motion reducing apparatus for ship**

(57) In a swing motion reducing apparatus for a ship includes a flywheel, a gimbal mechanism configured to rotatably support the flywheel, a motor configured to rotate the flywheel based on a drive power to be supplied; and a motor driver configured to supply the drive power

to the motor. A damper section is configured to brake a swing motion of the gimbal mechanism. A safety unit controls the motor driver to stop the supply of the drive power to the motor when a temperature of the damper section is equal to or higher than a predetermined temperature.

Fig. 1



Description

Background of the Invention

1. Field of the Invention

[0001] The present invention relates to an apparatus for reducing a swinging motion of a ship such as a rolling motion, a pitching motion and a yawing motion.

2. Description of Related Art

[0002] Japanese Patent No. 3,556,857 discloses a swinging motion reducing apparatus for reducing rolling, pitching and yawing motions of a ship. The swinging motion reducing apparatus includes a motor, a flywheel that is driven by the motor, a gimbal mechanism that contains the flywheel, a support section for movably supporting the gimbal mechanism, a frictional damper for controlling a motion of the gimbal mechanism, a power supply for supplying electric power to the motor, and a control section. When the gimbal mechanism rolls at a predetermined angle or more, the control section controls such that the power supply to the motor is stopped to prevent the swinging motion reducing apparatus from being damaged because of the motion of the gimbal mechanism exceeding a limitation of the specification.

Summary of the Invention

[0003] An object of the present invention is to prevent a swinging motion reducing apparatus for a ship from being damaged.

[0004] In an aspect of the present invention, a swing motion reducing apparatus for a ship includes a flywheel, a gimbal mechanism configured to rotatably support the flywheel, a motor configured to rotate the flywheel based on a drive power to be supplied; and a motor driver configured to supply the drive power to the motor. A damper section is configured to brake a swing motion of the gimbal mechanism. A safety unit controls the motor driver to stop the supply of the drive power to the motor when a temperature of the damper section is equal to or higher than a predetermined temperature.

[0005] According to the present invention, damage of a swinging motion reducing apparatus for a ship is prevented.

Brief Description of the Drawings

[0006]

FIG. 1 is a diagram schematically showing a swinging motion reducing apparatus for a ship according to a first embodiment of the present invention; FIG. 2 is a cross-section view of the swinging motion reducing apparatus body; and FIG. 3 is a diagram schematically showing the swing-

ing motion reducing apparatus according to a second embodiment of the present invention.

Description of the Embodiments

[0007] Hereinafter, a swinging motion reducing apparatus for a ship according to the present invention will be described with reference to the attached drawings.

10 [First Embodiment]

[0008] As shown in FIG. 1, a swinging motion reducing apparatus according to a first embodiment of the present invention includes a swinging motion reducing apparatus body 10, a motor driver 20, a generator 30, and a safety unit 40. The swinging motion reducing apparatus body 10 includes a motor 13, a damper 15A, and a damper 15B. The generator 30 and the motor 13 are a 3-phase generator and a 3-phase motor, respectively. The motor driver 20 includes an input terminal 21, an output terminal 22, a CM terminal 23, an X1 terminal 24, and a relay 25. The input terminal 21 includes an R terminal, an S terminal, and a T terminal. The output terminal 22 includes a U terminal, a V terminal, and a W terminal. The relay 25 is provided between the input terminal 21 and the output terminal 22. The relay 25 opens and closes a connection between the R terminal and the U terminal, a connection between the S terminal and the V terminal, and a connection between the T terminal and the W terminal. The input terminal 21 is connected to the generator 30 via a breaker switch 31. The output terminal 22 is connected to a power cable 13a of the motor 13.

[0009] The safety unit 40 includes a bimetal switch 41A provided for the damper 15A and a bimetal switch 41B provided for the damper 15B. The bimetal switches 41A and 41B are in a close state initially, and monitor temperatures of the dampers 15A and 15B, respectively. The bimetal switch 41A opens to set an OFF state when a temperature of the damper 15A increase to a temperature equal to or higher than a predetermined temperature. The bimetal switch 41B opens to set an OFF state when the temperature of the damper 15B increase to a temperature equal to or higher than a predetermined temperature. The CM terminal 23 is connected to the X1 terminal 24 via the bimetal switches 41A and 41B. Since the bimetal switches 41A and 41B are connected to each other in series, the connection between the CM terminal 23 and the X1 terminal 24 is in an ON state (a conduction state) when both of the bimetal switches 41A and 41B close, and the connection between the CM terminal 23 and the X1 terminal 24 is in an OFF state (a non-conduction state) when at least one of the bimetal switches 41A and 41B opens.

[0010] The relay 25 turns the connection between the input terminal 21 and the output terminal 22 to be in the ON state (closes the connection between the input terminal 21 and the output terminal 22) when the connection between the CM terminal 23 and the X1 terminal 24 is in

the ON state. Also, the relay 25 turns the connection between the input terminal 21 and the output terminal 22 to be in the OFF state (opens the connection between the input terminal 21 and the output terminal 22) when the connection between the CM terminal 23 and the X1 terminal 24 is in the OFF state.

[0011] The motor driver 20 supplies a drive power to the motor 13 when the relay 25 keeps the connection between the input terminal 21 and the output terminal 22 in the ON state, and stops the supply of the drive power when the relay 25 turns the connection between the input terminal 21 and the output terminal 22 to be in the OFF state.

[0012] As shown in FIG. 2, the swinging motion reducing apparatus body 10 includes the flywheel 11, the gimbal mechanism 12, the motor 13, a gimbal mechanism support section 14, and the dampers 15A and 15B. The gimbal mechanism 12 supports the flywheel 11 so that the flywheel 11 can rotate around a rotation axis S1. The motor 13 drives the flywheel 11. The gimbal mechanism support section 14 supports the gimbal mechanism 12 so that the gimbal mechanism 12 can swing around a swing axis S2. Each of the dampers 15A and 15B brakes the swinging motion of the gimbal mechanism 12 with a fluid resistance of a hydraulic oil. For example, the dampers 15A and 15B are rotary dampers. The swing axis S2 is orthogonal to the rotation axis S1. The gimbal mechanism support section 14 is fixed to a hull. The bimetal switches 41A and 41B are attached to the outer sides of the dampers 15A and 15B, respectively.

[0013] A principle that the swinging motion reducing apparatus according to the present embodiment reduces the swinging motion of a ship will be described by exemplifying a case that a left or right direction axis (Pitch axis) of the hull is parallel to the swing axis S2. The flywheel 11 is driven by the motor 13 at a high speed so as to have angular momentum H. When the hull receives a wave in a direction of a roll axis to roll at an angular velocity Q, a gyrotorque T1 represented by an exterior product of the angular momentum H and the angular velocity Ω acts to the gimbal mechanism 12, and the gimbal mechanism 12 rolls around the swing axis S2. At this time, since the flywheel 11 works to maintain the angular momentum H, a counter torque T2 acts to the hull via the gimbal mechanism support section 14. When an angular velocity of the swinging motion of the gimbal mechanism 12 is ω , the counter torque T2 is represented by an exterior product of the angular momentum H and the angular velocity ω . Because the counter torque T2 acts to a direction opposite to the roll direction of the hull, the rolling motion in the roll direction of the hull is reduced.

[0014] For example, when the swinging motion reducing apparatus is used under an overload circumstance such as a case where a ship having the swinging motion reducing apparatus according to the present embodiment sails a high wave area, the gimbal mechanism 12 heavily swings so that the temperatures of the dampers 15A and 15B become high, and thus a seal member for

sealing the hydraulic oil may be damaged. Since the gimbal mechanism 12 cannot be broken when the hydraulic oil leaks, the swinging motion reducing apparatus may be damaged.

[0015] Referring to FIG. 1, when the temperature of the damper 15A increases the predetermined temperature or more, the bimetal switch 41A opens to turn the connection between the CM terminal 23 and the X1 terminal 24 to be in the OFF state. Then, since the relay 25 turns the connection between the input terminal 21 and the output terminal 22 to be in the OFF state, the motor driver 20 automatically stops the supply of the drive power. Also, when the temperature of the damper 15B increases the predetermined temperature or more, the motor driver 20 automatically stops the supply of the drive power in the same manner as that of the damper 15A. That is, the safety unit 40 stops the supply of the drive power to the motor driver 20 when at least one of the dampers 15A and 15B exceeds the predetermined temperature. In this manner, the swinging motion reducing apparatus body 10 safely stops and the dampers 15A and 15B can be prevented from being damaged.

[0016] Additionally, in case of occurrence of a failure of the damper 15A or 15B, the temperatures of the damper 15A or 15B becomes high. The present embodiment prevents the swinging motion reducing apparatus from continuing to operate under the condition of occurrence of the failure of the damper 15A or 15B. Accordingly, the damage of the damper 15A or 15B can be prevented and the damage of the swinging motion reducing apparatus body 10 is prevented.

[0017] Moreover, when an atmosphere temperature around the swinging motion reducing apparatus body 10 is high, the damper 15A or 15B cannot release the heat to circumference, and accordingly a braking performance of the damper 15A or 15B deteriorates. When the swinging motion reducing apparatus continues to operate in a state that the braking performance of the damper 15A or 15B deteriorates, the swinging motion reducing apparatus body 10 may be damaged. According to the present embodiment, since the swinging motion reducing apparatus is stopped in the case of a high atmosphere temperature, the damage of the swinging motion reducing apparatus body 10 can be prevented.

[0018] Since the bimetal switches 41A and 41B are respectively arranged on the outer sides of the dampers 15A and 15B, the swinging motion reducing apparatus can be easily assembled. Meanwhile, the bimetal switches 41A and 41B may be arranged in the dampers 15A and 15B, respectively.

[Second Embodiment]

[0019] Referring to FIG. 3, the swinging motion reducing apparatus for a ship according to a second embodiment of the present invention will be described. The swinging motion reducing apparatus according to the second embodiment of the present invention is config-

ured by replacing the safety unit 40 in the first embodiment with a safety unit 50. The safety unit 50 includes temperature sensors 51A and 51B such as a thermocouple or a thermistor, and a determining section 52. The temperature sensors 51A and 51B are provided for the dampers 15A and 15B, respectively. The temperature sensor 51A monitors a temperature of the damper 15A and outputs a signal indicating the temperature of the damper 15A to the determining section 52. The temperature sensor 51B monitors a temperature of the damper 15B and outputs a signal indicating the temperature of the damper 15B to the determining section 52. The determining section 52 is connected to the CM terminal 23 and the X1 terminal 24, respectively. The determining section 52 determines whether or not the temperatures indicated by the signals sent from the temperature sensors 51A and 51B are higher than a predetermined temperature. When both of the signal sent from the temperature sensor 51A and the signal sent from the temperature sensor 51B indicate a temperature lower than the predetermined temperature, the determining section 52 turns the connection between the CM terminal 23 and the X1 terminal 24 to be in the ON state. When the temperature indicated by at least one of the signal sent from the temperature sensor 51A and the signal sent from the temperature sensor 51B exceeds the predetermined temperature, the determining section 52 turns the connection between the CM terminal 23 and the X1 terminal 24 to be in the OFF state. Accordingly, when at least one of the dampers 15A and 15B exceeds the predetermined temperature, the safety unit 50 stops the supply of the drive power to the motor 13.

[0020] When the temperature sensors 51A and 51B are arranged on the outer sides of the dampers 15A and 15B, the swinging motion reducing apparatus can be easily assembled. Meanwhile, the temperature sensors 51A and 51B may be arranged in the dampers 15A and 15B, respectively.

[0021] In the above-mentioned respective embodiments, the generator 30 and the motor 13 may be a single-phase generator and a single-phase motor, respectively. In addition, the dampers 15A and 15B may be a frictional damper, a linear damper, or a hydraulic pump.

Claims

1. A swing motion reducing apparatus for a ship comprising:

- a flywheel;
- a gimbal mechanism configured to rotatably support said flywheel;
- a motor configured to rotate said flywheel based on a drive power to be supplied;
- a motor driver configured to supply the drive power to said motor;
- a damper section configured to brake a swing

motion of said gimbal mechanism; and
a safety unit configured to control said motor driver to stop the supply of the drive power to said motor when a temperature of said damper section is equal to or higher than a predetermined temperature.

2. The swing motion reducing apparatus according to claim 1, wherein said motor driver comprises first and second terminals, wherein said safety unit comprises a path from said first terminal to said second terminal, and said motor driver supplies the drive power to said motor when said path is in an ON state, and stops the supply of the drive power to said motor when said path is in an OFF state.
3. The swing motion reducing apparatus according to claim 2, wherein said damper section comprises a first damper configured to brake the swing motion of said gimbal mechanism, said safety unit comprises a first bimetal switch provided for said first damper in said path, and said first bimetal switch sets said path to the ON state when the temperature of said first damper lower than the predetermined temperature and sets said path to the OFF state when the temperature of said first damper equal to or higher than the predetermined temperature.
4. The swing motion reducing apparatus according to claim 3, wherein said damper section comprises a second damper configured to brake the swing motion of said gimbal mechanism, wherein said safety unit further comprises a second bimetal switch provided for said second damper in said path and connected with said first bimetal switch in series, and said second bimetal switch sets said path to the ON state when the temperature of said second damper lower than the predetermined temperature and sets said path to the OFF state when the temperature of said second damper equal to or higher than the predetermined temperature.
5. The swing motion reducing apparatus according to claim 2, wherein said damper section comprises first and second dampers, each of which brakes the swing motion of said gimbal mechanism; said safety unit further comprises:

- first and second temperature sensors provided for said first and second dampers to detect temperatures of said first and second dampers, respectively; and
- a determining section sets said path to the ON state, when both of temperatures detected by said first and second temperature sensors are

lower than the predetermined temperature, and sets said path to the OFF state, when at least one of temperatures detected by said first and second temperature sensors is equal to or higher than the predetermined temperature.

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Fig. 1

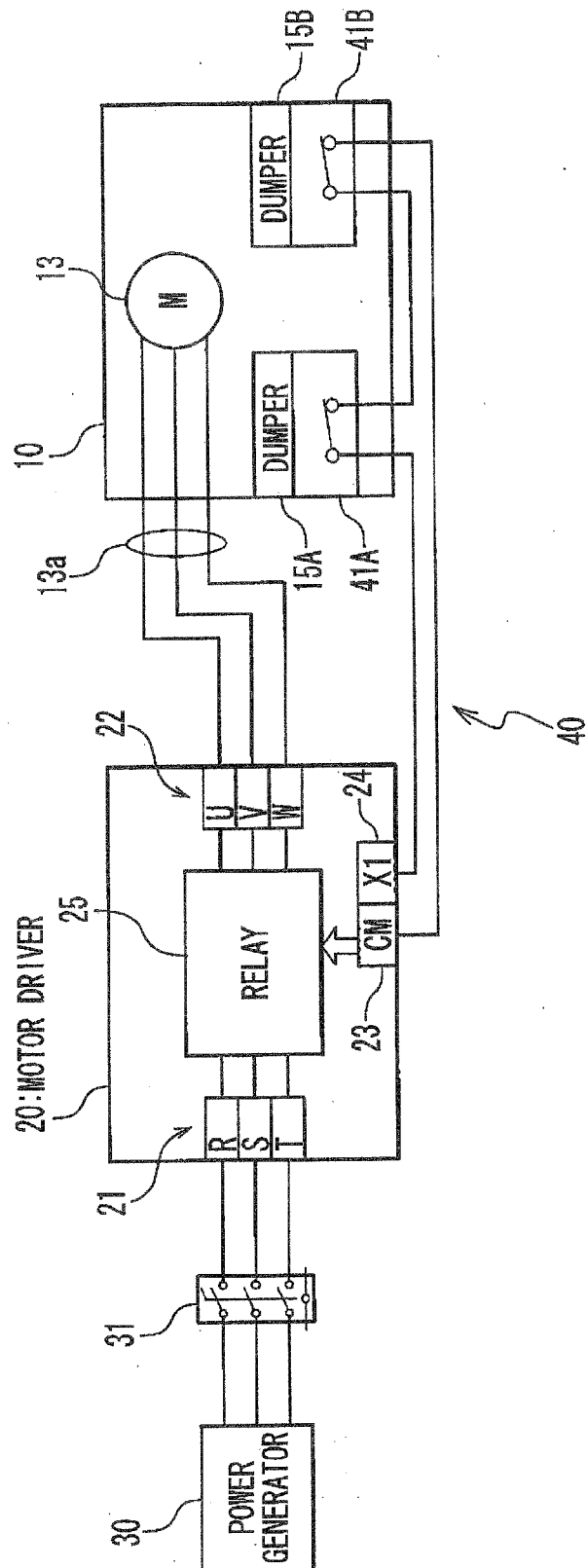


Fig. 2

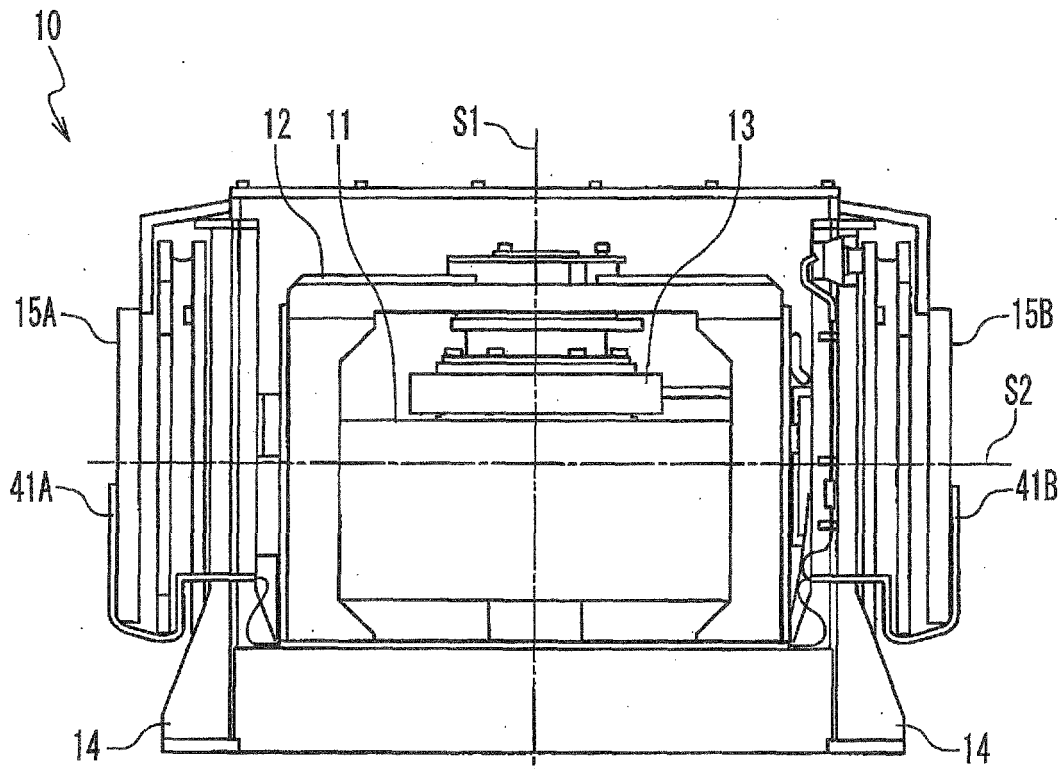
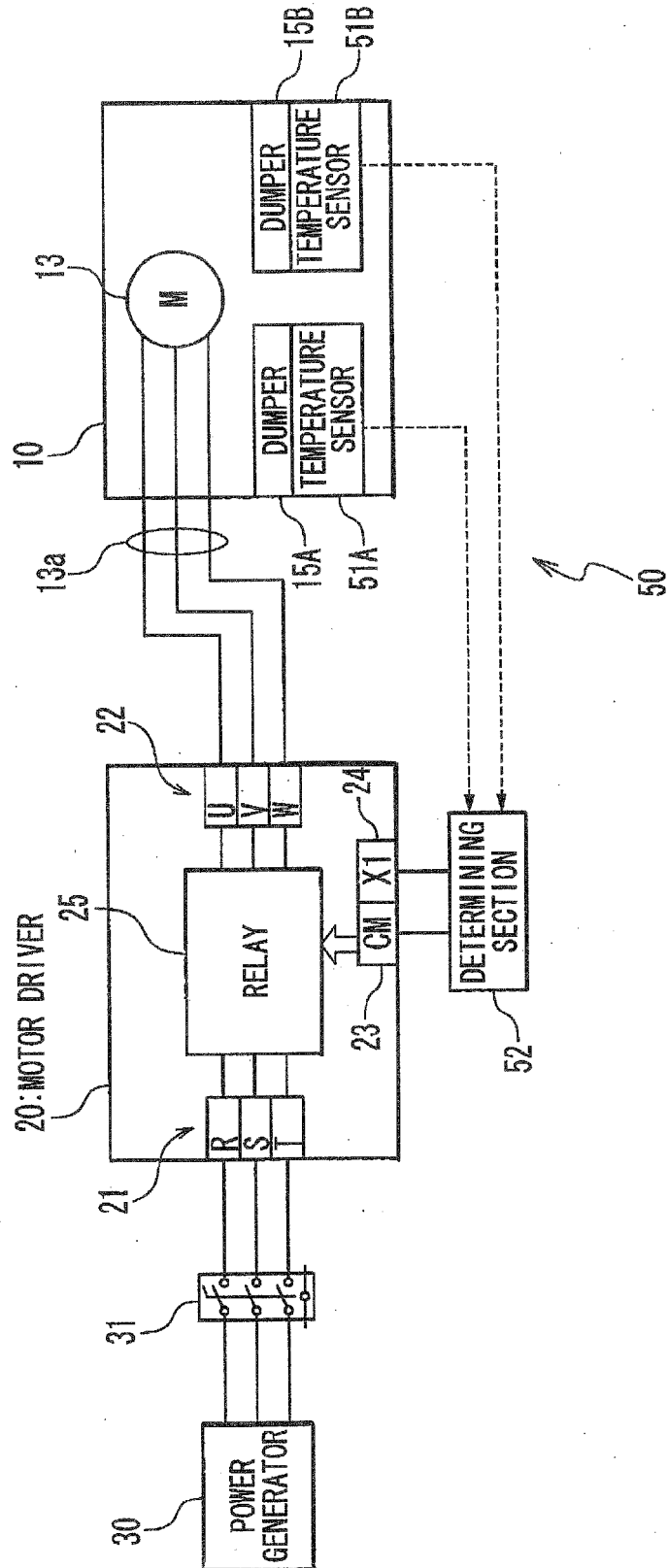


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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