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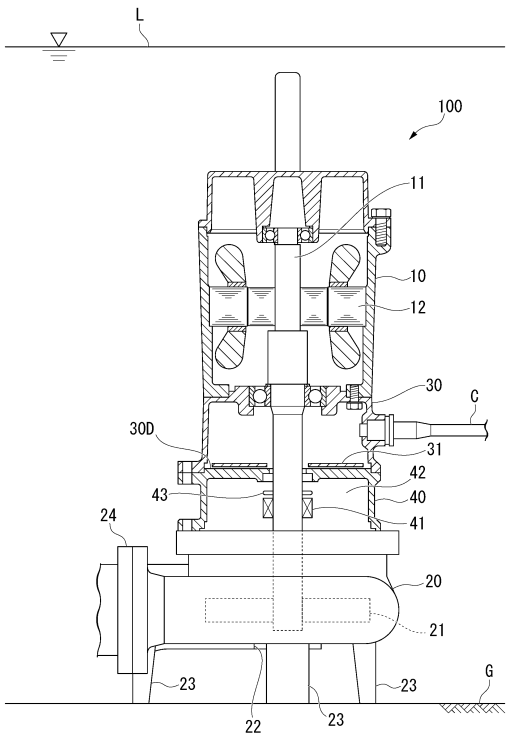
(54) UNDERWATER MOTOR PUMP

(57) An underwater motor pump includes a motor case that accommodates an electric motor which supplies a rotational force to an output shaft, a pump case that has a discharge pipe and that accommodates a first impeller provided on the output shaft, and an inverter case that accommodates an inverter device which controls the electric motor. The inverter case is disposed between the pump case and the motor case.

FIG. 1



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Description

[Technical Field]

[0001] The present invention relates to an underwater motor pump.

[0002] Priority is claimed on Japanese Patent Application No. 2021-094395, filed Jun 4, 2021, the content of which is incorporated herein by reference.

[Background Art]

[0003] Conventionally, there has been an underwater motor pump that is installed in a water tank and used in a submerged state in water in order to discharge water such as wastewater, drainage, or river water stored in the water tank (Patent Document 1).

[Citation List]

[Patent Document]

[0004] [Patent Document 1]
Japanese Unexamined Patent Application, First Publication No. 2019-15204

[Summary of Invention]

[Technical Problem]

[0005] However, there is room for improvement in cooling of a control unit in the conventional underwater motor pumps.

[0006] The present invention provides an underwater motor pump capable of effectively cooling a built-in inverter device.

[Solution to Problem]

[0007] The present invention has the following aspects.

(1) According to an aspect of the present invention, there is provided an underwater motor pump is provided including: a motor case configured to accommodate an electric motor that applies a rotational force to an output shaft; a pump case including a discharge pipe and configured to accommodate a first impeller provided on the output shaft; and an inverter case configured to accommodate an inverter device that controls the electric motor, in which the inverter case is disposed between the pump case and the motor case.

(2) In the aspect (1), the inverter device may be disposed in contact with a lower partition wall of the inverter case.

(3) In the aspect (1), the inverter device may be disposed apart from an upper partition wall and a lower partition wall of the inverter case.

(4) In any one of the aspects (1) to (3), a mechanical seal case configured to accommodate a mechanical sealing portion that rotatably seals the output shaft and a lubricating liquid that lubricates the mechanical sealing portion may be further provided, and the inverter case may be disposed between the mechanical seal case and the motor case.

(5) In any one of the aspects (1) to (3), a mechanical seal case configured to accommodate a mechanical sealing portion that rotatably seals the output shaft and a lubricating liquid that lubricates the mechanical sealing portion may be further provided, and the inverter case may be disposed between the mechanical seal case and the pump case.

(6) In the aspect (4) or (5), the output shaft may include a second impeller that is disposed inside the mechanical seal case and that causes the lubricating liquid to flow toward the inverter case.

(7) In any one of the aspects (1) to (3), the inverter case may accommodate a mechanical sealing portion that rotatably seals the output shaft and a lubricating liquid that lubricates the mechanical sealing portion, and the inverter device may be disposed inside the inverter case.

(8) In the aspect (7), the output shaft may include a second impeller that is disposed inside the inverter case and that causes the lubricating liquid to flow toward the inverter case.

[Advantageous Effects of Invention]

[0008] According to the present invention, it is possible to provide an underwater motor pump capable of effectively cooling a built-in inverter device.

[Brief Description of Drawings]

[0009]

FIG. 1 is a side view of an underwater motor pump according to a first embodiment.

FIG. 2 is a side view of an underwater motor pump according to a second embodiment.

FIG. 3 is a side view of an underwater motor pump according to a third embodiment.

FIG. 4 is a side view of an underwater motor pump according to a fourth embodiment.

[Description of Embodiments]

(First Embodiment)

[0010] Hereinafter, an underwater motor pump 100 according to a first embodiment will be described. FIG. 1 is

a side view of the underwater motor pump 100 according to the first embodiment. In FIGS. 1 to 4, a vertical direction is indicated by an arrow Z, and a horizontal direction is indicated by an arrow X and an arrow Y.

[0011] As shown in FIG. 1, the underwater motor pump 100 according to the first embodiment can be applied to, for example, a pump that pumps up water such as wastewater, drainage, or river water. The underwater motor pump 100 is typically placed on a bottom surface G of a water tank in which water is stored up to a water level L, and is used in a submerged state in the water.

[0012] The underwater motor pump 100 includes a motor case 10 that accommodates an electric motor 12 which supplies a rotational force to an output shaft 11, a pump case 20 that includes a discharge pipe 24 and that accommodates a first impeller 21 provided on the output shaft 11, and an inverter case 30 that accommodates an inverter device 31 which controls the electric motor 12. The electric motor 12 and the inverter device 31 of the underwater motor pump 100 are appropriately connected to a power source (not shown) via a power cable C that penetrates the inverter case 30 while maintaining water tightness.

[0013] The motor case 10 is provided above the pump case 20. As a result, even in a case where the water level L decreases and the motor case 10 is exposed above the water surface of the water stored in the water tank, the operation of the underwater motor pump 100 can continue. In addition, the planar dimension of the underwater motor pump 100 can be made compact.

[0014] The motor case 10 and the pump case 20 are sealed in a state in which the output shaft 11 is pivotally supported to be freely rotatable.

[0015] The motor case 10 accommodates the electric motor 12 including a rotor and a stator in a watertight manner. The electric motor 12 is connected to the power source located outside the underwater motor pump 100. Further, the electric motor 12 is connected to the inverter device 31. The stator supplies a rotational force to the rotor through an electromagnetic action. The rotor is mechanically coupled to the output shaft 11 on which the first impeller 21 is provided, and the rotational force of the rotor is transmitted to the output shaft 11.

[0016] The motor case 10 and the pump case 20 are sealed in a state in which the output shaft 11 is pivotally supported to be freely rotatable.

[0017] The pump case 20 is placed on the bottom surface G of the water tank such that the underwater motor pump 100 can function by acting on the water stored in the water tank, even when the water level L of the water stored in the water tank decreases.

[0018] The pump case 20 includes the discharge pipe 24 and a suction port 22. An internal space of the pump case 20 accommodates the first impeller 21 provided on the output shaft 11. The pump case 20 is submerged in water stored in the water tank and is supported via leg portions 23 that are in contact with the bottom surface G of the water tank. The pump case 20 suctions water into the internal space of the pump case 20 through the suction port 22 using the energy supplied by the first impeller 21 and discharges the suctioned water in the internal space to the discharge pipe 24.

[0019] The discharge pipe 24 is a pipe for discharging water in the internal space of the pump case 20. One end of the discharge pipe 24 is open to the pump case 20, and the other end is connected to a main pipe (not shown) through which the suctioned water passes.

[0020] The suction port 22 is an opening for suctioning water stored in the water tank. The suction port 22 is directed downward.

[0021] The inverter case 30 accommodates the inverter device 31 inside.

[0022] The inverter device 31 includes, for example, a substrate, an inverter circuit mounted on the substrate, a power supply circuit mounted on the substrate, a capacitor or the like mounted on the substrate.

[0023] Here, the inverter case 30 is disposed between the pump case 20 and the motor case 10. That is, the pump case 20 is placed on the bottom surface G of the water tank, the inverter case 30 is disposed above the pump case 20, and the motor case 10 is disposed above the inverter case 30. As a result, heat exchange with a partition wall of the upper part of the pump case 20 can be performed using the flow of water inside the pump case 20 generated by the first impeller 21, so that the inverter case 30 disposed above the pump case 20 can be cooled. Therefore, the built-in inverter device 31 in the underwater motor pump 100 can be effectively cooled. Further, since the distance between the inverter device 31 and the electric motor 12 can be shortened, the electrical wiring between the two can be shortened. Therefore, the structure of the underwater motor pump 100 can be made compact.

[0024] Further, the underwater motor pump 100 may include a mechanical seal case 40 that accommodates a mechanical sealing portion 41 that rotatably seals the output shaft 11 and a lubricating liquid 42 that lubricates the mechanical sealing portion 41. The mechanical sealing portion 41 may be a sliding bearing. The mechanical sealing portion 41 may be, for example, a bushing made of a synthetic resin. The lubricating liquid 42 lubricates a gap between the mechanical sealing portion 41 and the output shaft 11. As a result, wear and overheating of the mechanical sealing portion 41 can be suppressed while maintaining the sealing between the motor case 10 and the pump case 20. It is preferable that the inside of the mechanical seal case 40 is filled with the lubricating liquid 42. The lubricating liquid 42 may be, for example, turbine oil or may be a liquid resin having insulating properties.

[0025] The inverter case 30 may be disposed between the mechanical seal case 40 and the motor case 10. As a result, it is possible to seal a space between the electric motor 12 and the pump case 20 in a state in which the output shaft 11 is pivotally supported to be freely rotatable, and it is possible to perform heat exchange between the water flowing inside the pump case 20 and the in-

verter device 31 accommodated in the inverter case 30 via the lubricating liquid 42 accommodated in the inverter case 30. Therefore, the inverter device 31 can be effectively cooled.

[0026] In addition, the output shaft 11 may include a second impeller 43 that is disposed inside the mechanical seal case 40 and cause the lubricating liquid 42 to flow toward the inverter case 30. As a result, the lubricating liquid 42 that has flowed toward the inverter device 31 by the second impeller 43 undergoes heat exchange with a lower partition wall 30D of the inverter case 30. Therefore, the rotation of the output shaft 11 can be used to effectively cool the inverter device 31 accommodated in the inverter case 30.

(Second Embodiment)

[0027] Next, an underwater motor pump 200 according to a second embodiment will be described. FIG. 2 is a side view of the underwater motor pump 200 according to the second embodiment. Description of matters common to the underwater motor pump 100 according to the first embodiment may not be repeated.

[0028] The underwater motor pump 200 according to the second embodiment may include the mechanical seal case 40 that accommodates the mechanical sealing portion 41 which rotatably seals the output shaft 11 and the lubricating liquid 42 which lubricates the mechanical sealing portion 41, as in the underwater motor pump 100 according to the first embodiment.

[0029] Here, the inverter case 30 may be disposed between the mechanical seal case 40 and the pump case 20. As a result, it is possible to seal the space between the electric motor 12 and the pump case 20 in a state in which the output shaft 11 is pivotally supported to be freely rotatable, and it is possible to perform heat exchange between the water flowing inside the pump case 20 and the inverter device 31 accommodated in the inverter case 30 via the lower partition wall 30D of the inverter case 30 and to perform heat exchange between the lubricating liquid 42 accommodated in the mechanical seal case 40 and the inverter device 31 accommodated in the inverter case 30 via a partition wall of the upper part of the inverter case 30. In other words, the inverter case 30 can be cooled from both upper and lower sides by the lubricating liquid 42 and the water flowing inside the pump case 20. Therefore, the inverter device 31 can be effectively cooled.

(Third Embodiment)

[0030] Next, an underwater motor pump 300 according to a third embodiment will be described. FIG. 3 is a side view of the underwater motor pump 300 according to the third embodiment. Description of matters common to the underwater motor pump 100 according to the first embodiment or the underwater motor pump 200 according to the second embodiment may not be repeated.

[0031] Unlike the underwater motor pump 100 according to the first embodiment or the underwater motor pump 200 according to the second embodiment, the underwater motor pump 300 according to the third embodiment includes the inverter case 30 that also functions as the mechanical seal case 40.

[0032] That is, the inverter case 30 of the underwater motor pump 300 according to the third embodiment accommodates the mechanical sealing portion 41 that rotatably seals the output shaft 11 and the lubricating liquid 42 that lubricates the mechanical sealing portion 41. The inverter device 31 is disposed inside the inverter case 30. As a result, the inverter device 31 can undergo heat exchange by coming into direct contact with the lubricating liquid 42, so that the inverter device 31 can be effectively cooled.

[0033] Here, the inverter device 31 may be disposed in contact with the lower partition wall 30D of the inverter case 30. This can facilitate heat exchange between the inverter device 31 and the water inside the pump case 20. The inverter device 31 can be effectively cooled.

(Fourth Embodiment)

[0034] Next, an underwater motor pump 400 according to a fourth embodiment will be described. FIG. 4 is a side view of the underwater motor pump 400 according to the fourth embodiment. Description of matters common to the underwater motor pump 100 according to the first embodiment to the underwater motor pump 300 according to the third embodiment may not be repeated.

[0035] The underwater motor pump 400 according to the fourth embodiment includes the inverter case 30 that also functions as the mechanical seal case 40, as in the underwater motor pump 300 according to the third embodiment.

[0036] Here, the inverter device 31 may be disposed apart from an upper partition wall 30U and the lower partition wall 30D of the inverter case 30. As a result, the lubricating liquid 42 can circulate above and below the inverter device 31, which can facilitate heat exchange between the inverter device 31 and the lubricating liquid 42. Therefore, the inverter device 31 can be effectively cooled.

[0037] Further, by rotating and driving the output shaft 11 and a stirring blade (second impeller 43) in synchronization with each other, the lubricating liquid 42 can be stirred to promote heat dissipation of the inverter device 31, which can contribute to the cooling of the inverter device 31.

[0038] The underwater motor pump 400 according to each embodiment may not include the second impeller 43.

[0039] Further, with the underwater motor pump 300 according to the third embodiment shown in FIG. 3 or the underwater motor pump 400 according to the fourth embodiment shown in FIG. 4 in which the functions of the inverter case 30 and of the mechanical seal case 40 are

combined into the inverter case 30 having a single chamber, the dimension in the vertical direction (height) can be reduced by the absence of the partition wall partitioning the inverter case 30 and the mechanical seal case 40, as compared with the underwater motor pump 100 according to the first embodiment shown in FIG. 1 or the underwater motor pump 200 according to the second embodiment shown in FIG. 2 in which the inverter case 30 and the mechanical seal case 40 are separately provided. Therefore, the structures of the underwater motor pumps 300 and 400 can be made compact.

[0040] Although the embodiments have been described above with reference to the drawings, the present invention is not limited to the above description. A plurality of features described as the embodiments may be freely combined.

[0041] The underwater motor pump 100 according to the present embodiment includes the motor case 10 that accommodates the electric motor 12 which supplies a rotational force to the output shaft 11, the pump case 20 that includes the discharge pipe 24 and that accommodates the first impeller 21 provided on the output shaft 11, and the inverter case 30 that accommodates the inverter device 31 which controls the electric motor 12. The inverter case 30 is disposed between the pump case 20 and the motor case 10. As a result, heat exchange with the partition wall of the upper part of the pump case 20 can be performed using the flow of water inside the pump case 20 generated by the first impeller 21, so that the inverter case 30 disposed above the pump case 20 can be cooled. Therefore, the built-in inverter device 31 in the underwater motor pump 100 can be effectively cooled. Further, since the distance between the inverter device 31 and the electric motor 12 can be shortened, the electrical wiring between the two can be shortened. Therefore, the structure of the underwater motor pump 100 can be made compact.

[Reference Signs List]

[0042]

10: Motor case
11: Output shaft
12: Electric motor
20: Pump case
21: First impeller
22: Suction port
23: Leg portion
24: Discharge pipe
30: Inverter case
30D: Lower partition wall
30U: Upper partition wall
31: Inverter device
40: Mechanical seal case
41: Mechanical sealing portion
42: Lubricating liquid
43: Second impeller
100, 200, 300, 400: Underwater motor pump
C: Power cable
G: Bottom surface
L: Water level

Claims

1. An underwater motor pump comprising:

a motor case configured to accommodate an electric motor that supplies a rotational force to an output shaft;
a pump case including a discharge pipe and configured to accommodate a first impeller provided on the output shaft; and
an inverter case configured to accommodate an inverter device that controls the electric motor,
wherein the inverter case is disposed between the pump case and the motor case.

2. The underwater motor pump according to Claim 1, wherein the inverter device is disposed in contact with a lower partition wall of the inverter case.

3. The underwater motor pump according to Claim 1, wherein the inverter device is disposed apart from an upper partition wall and a lower partition wall of the inverter case.

4. The underwater motor pump according to any one of Claims 1 to 3, further comprising:

a mechanical seal case configured to accommodate a mechanical sealing portion that rotatably seals the output shaft and a lubricating liquid that lubricates the mechanical sealing portion,
wherein the inverter case is disposed between the mechanical seal case and the motor case.

5. The underwater motor pump according to any one of Claims 1 to 3, further comprising:

a mechanical seal case configured to accommodate a mechanical sealing portion that rotatably seals the output shaft and a lubricating liquid that lubricates the mechanical sealing portion,
wherein the inverter case is disposed between the mechanical seal case and the pump case.

6. The underwater motor pump according to Claim 4 or 5,
wherein the output shaft includes a second impeller that is disposed inside the mechanical seal case and that causes the lubricating liquid to flow toward the inverter case.

7. The underwater motor pump according to any one of Claims 1 to 3,

wherein the inverter case accommodates a mechanical sealing portion that rotatably seals the output shaft and a lubricating liquid that lubricates the mechanical sealing portion, and
the inverter device is disposed inside the inverter case.

8. The underwater motor pump according to Claim 7, wherein the output shaft includes a second impeller that is disposed inside the inverter case and that causes the lubricating liquid to flow toward the inverter case.

FIG. 1

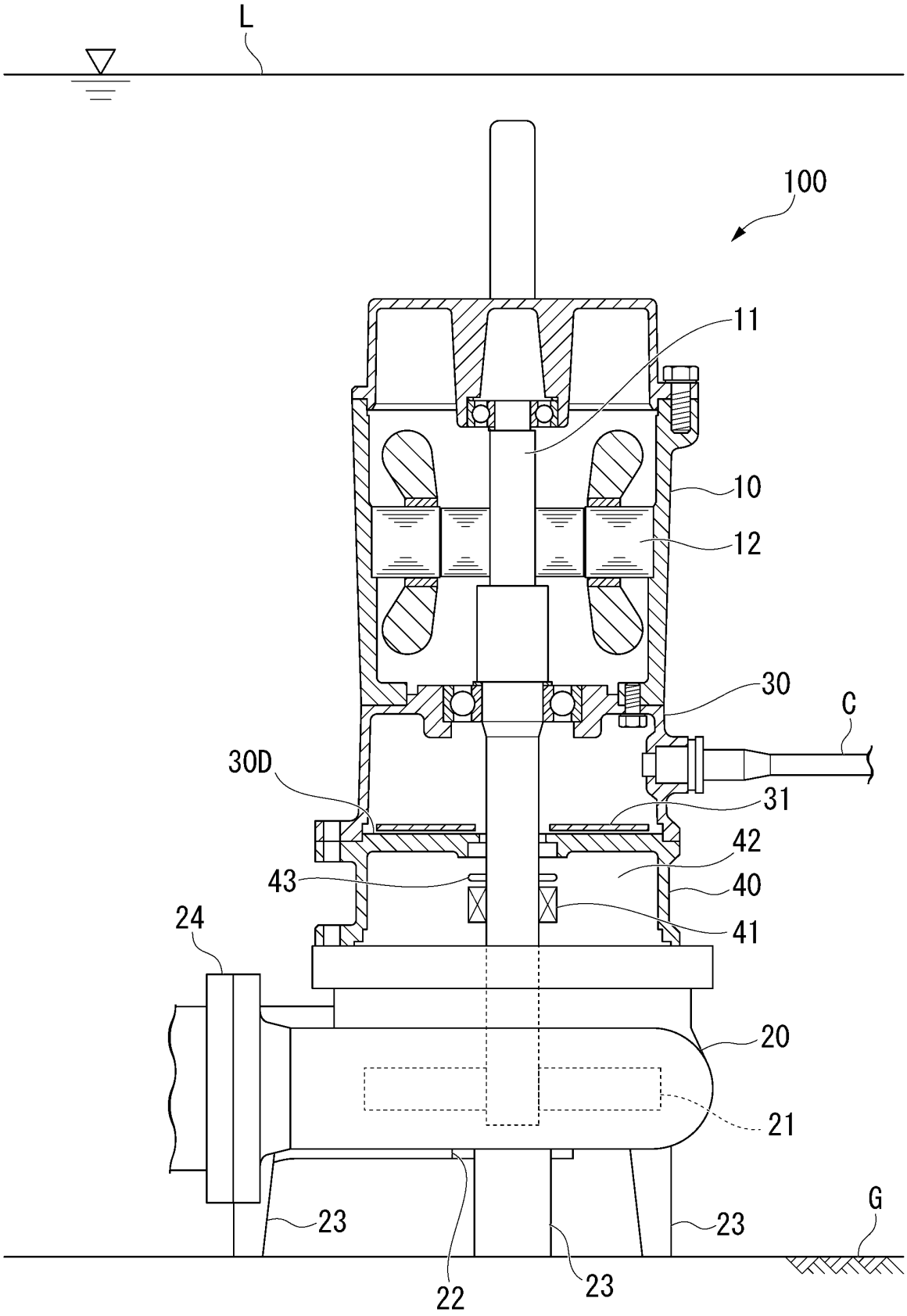


FIG. 2

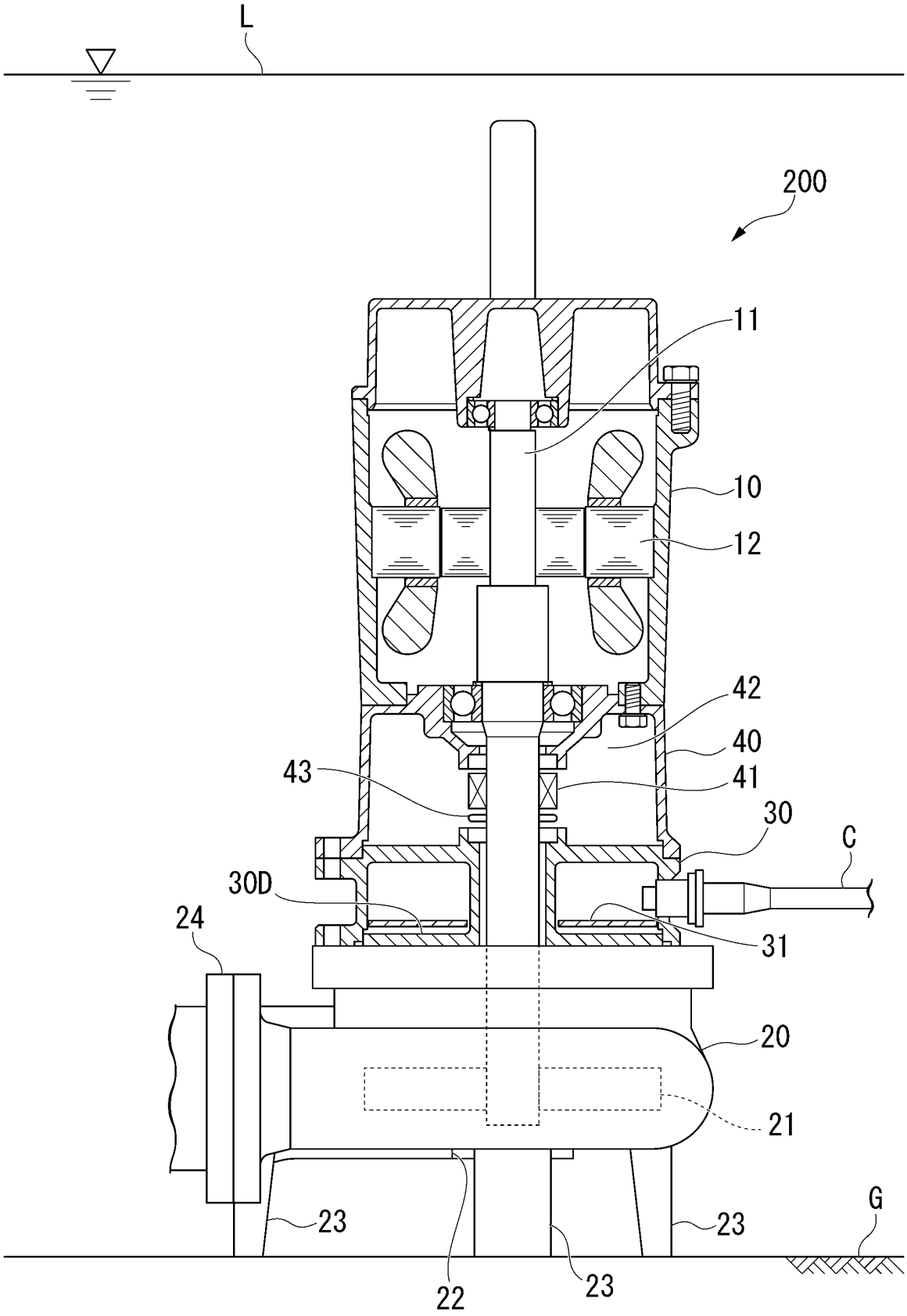


FIG. 3

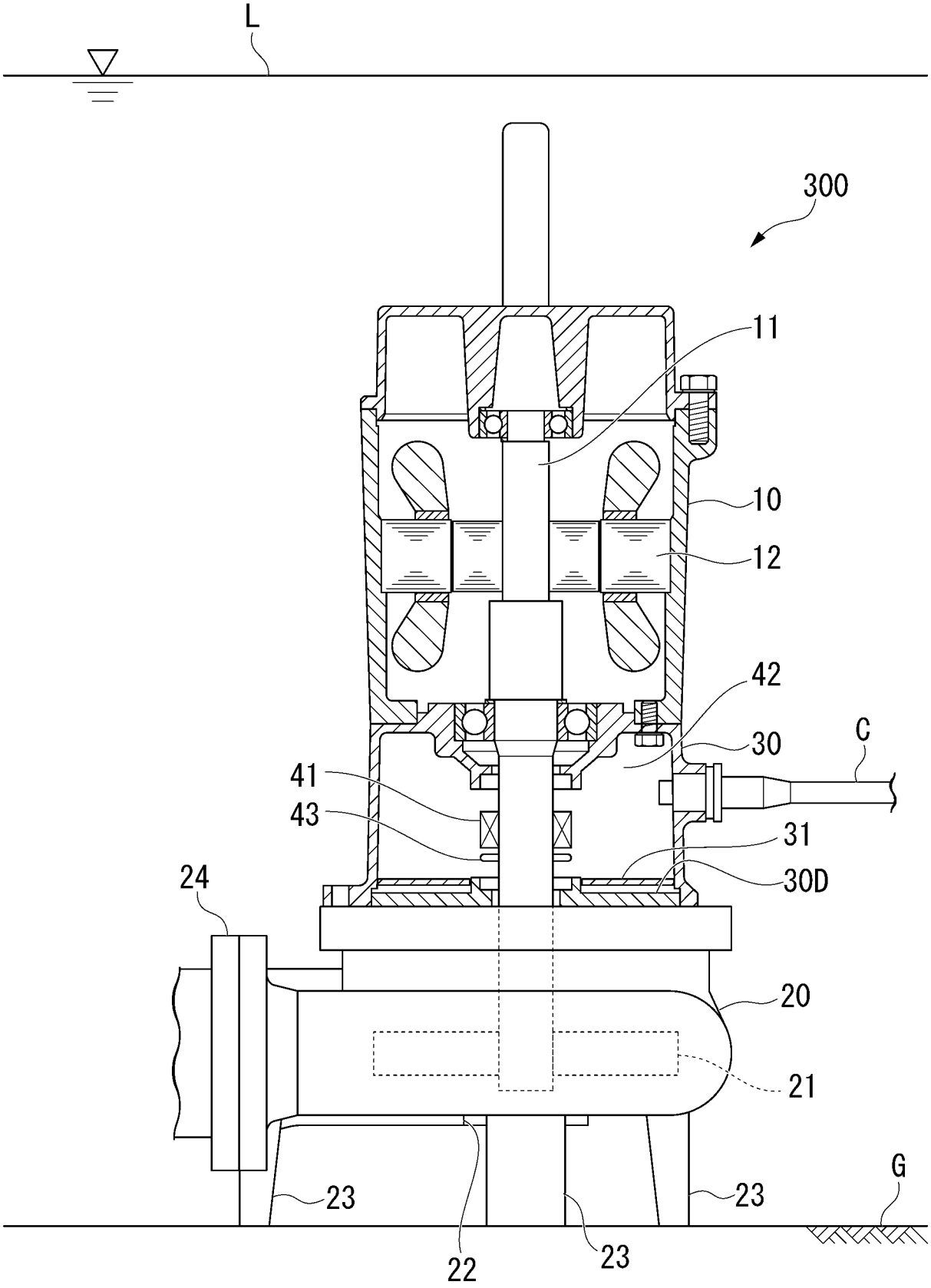
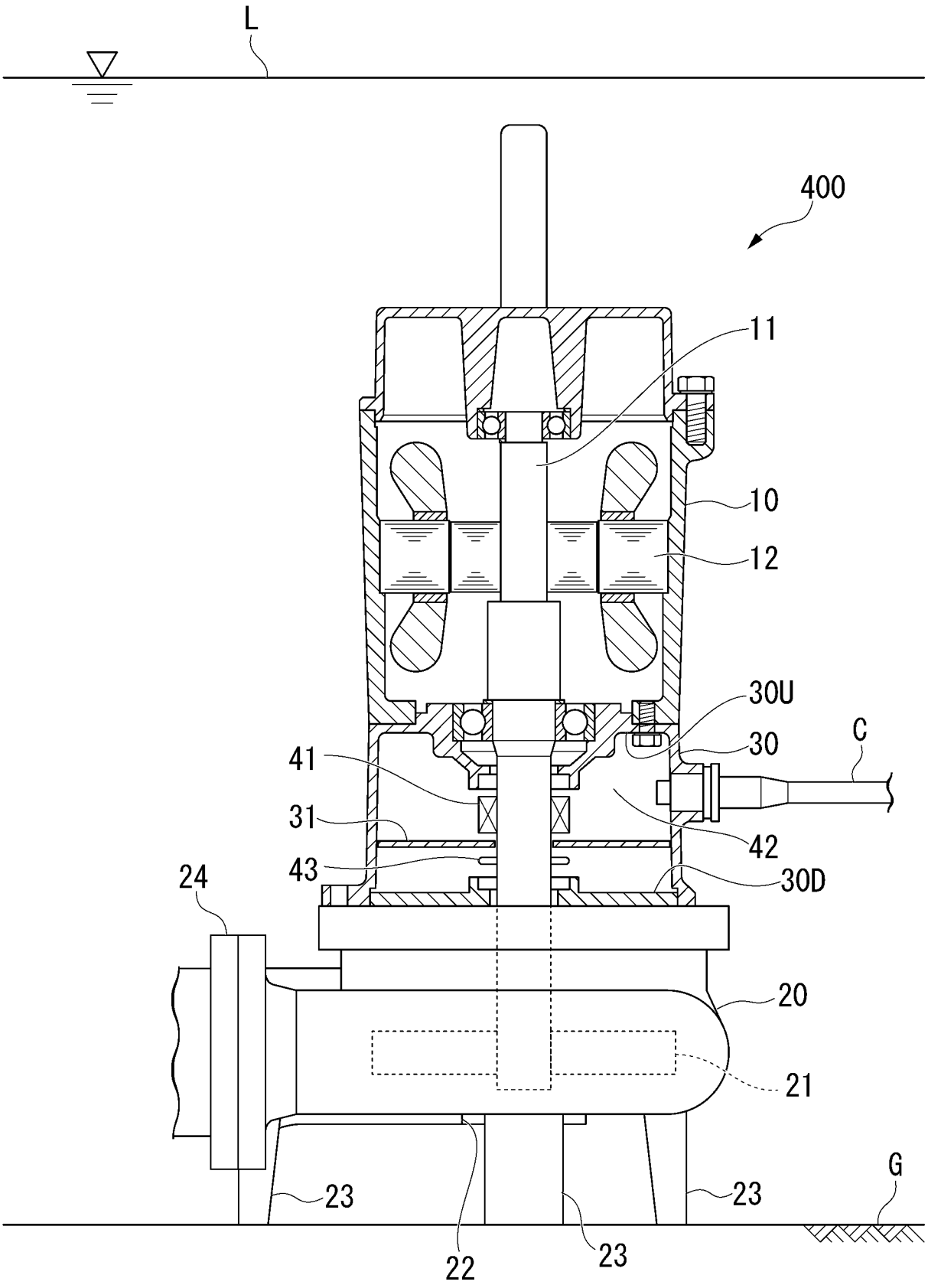


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/003444

A. CLASSIFICATION OF SUBJECT MATTER

F04D 13/08(2006.01)i; ***F04D 29/58***(2006.01)i
FI: F04D13/08 F; F04D29/58 E; F04D29/58 D

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)

F04D13/08; F04D29/58

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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	JP 2000-73962 A (ASMO CO LTD) 07 March 2000 (2000-03-07) paragraphs [0024]-[0032], [0046], fig. 1	1-3
Y		4-6
A		7-8
Y	JP 2015-25429 A (SHIN MEIWA IND CO LTD) 05 February 2015 (2015-02-05) paragraph [0025], fig. 1	4-6
Y	JP 2012-207550 A (TERADA PUMP SEISAKUSHO KK) 25 October 2012 (2012-10-25) paragraph [0006], fig. 5	6
A	JP 6-500614 A (ALFRED TEVES GMBH) 20 January 1994 (1994-01-20) fig. 2	1

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
18 February 2022	**08 March 2022**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/003444

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2000-73962 A	07 March 2000	DE 19927741 A1	
JP 2015-25429 A	05 February 2015	(Family: none)	
JP 2012-207550 A	25 October 2012	(Family: none)	
JP 6-500614 A	20 January 1994	US 5360322 A fig. 2 WO 1993/000513 A1 EP 593913 A2 DE 4231784 A1 DE 4120665 A1	

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 2021094395 A **[0002]**
- JP 2019015204 A **[0004]**