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(54) **ELECTRIC PUMP DEVICE FOR CONSTRUCTION MACHINE, AND HYDRAULIC DRIVE SYSTEM INCLUDING SAME**

(57) An electric pump device for construction machines is installed in a construction machine and includes: a hydraulic pump that includes a drive shaft and when the drive shaft rotates, discharges working fluid; an electric motor that is coupled to the drive shaft and rotatably drives the drive shaft; and a support mem-

ber that supports the hydraulic pump and the electric motor. The support member stands in a first direction perpendicular to an installation surface of the construction machine and supports the hydraulic pump and the electric motor such that the drive shaft extends in the first direction.

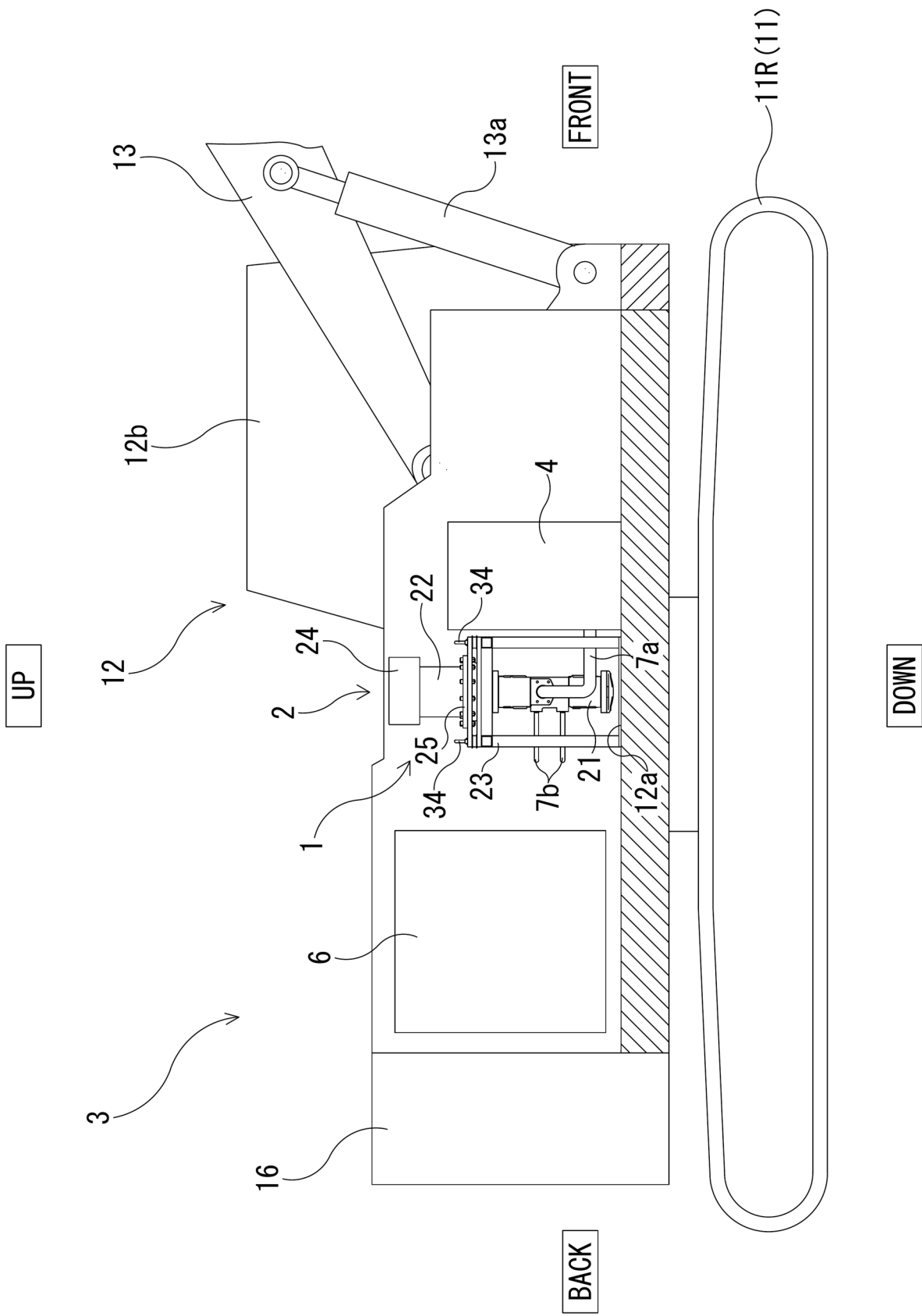


Fig. 6

Description

Technical Field

[0001] The present disclosure relates to electric pump devices for construction machines and hydraulic drive systems for construction machines that are installed in construction machines.

Background Art

[0002] The electrification of construction machines, such as excavators, has been advancing, with electric motors replacing internal combustion engines as the drive sources for hydraulic pumps. Known examples of such construction machines include the electric excavator disclosed in Patent Literature (PTL) 1.

Citation List

Patent Literature

[0003] PTL 1: Japanese Laid-Open Patent Application Publication No. 2022-163964

Summary of Invention

Technical Problem

[0004] There is a demand for electric excavators to be manufactured with substantially the same profile as conventional excavators that use an internal combustion engine as a drive source. On the other hand, electric excavators are required to be equipped with a larger battery to achieve a longer operational duration. Consequently, adopting the same layout of elements as that of conventional excavators renders it difficult to secure sufficient space for a larger battery. Accordingly, to secure the sufficient space, it is desirable for an electric pump device for construction machines, which includes a hydraulic pump and an electric motor, to be configured to minimize the installation footprint thereof.

[0005] Thus, an object of the present disclosure is to provide an electric pump device for construction machines with a smaller installation footprint, and a hydraulic drive system including the electric pump device for construction machines.

Solution to Problem

[0006] An electric pump device for construction machines according to the present disclosure is installed in a construction machine and includes: a hydraulic pump that includes a drive shaft and when the drive shaft rotates, discharges working fluid; an electric motor that is coupled to the drive shaft and rotatably drives the drive shaft; and a support member that supports the hydraulic pump and the electric motor. The support member stands

in a first direction perpendicular to an installation surface of the construction machine and supports the hydraulic pump and the electric motor such that the drive shaft extends in the first direction.

[0007] According to the present disclosure, the support member stands in the first direction and supports the hydraulic pump and the electric motor such that the drive shaft extends in the first direction. This allows for a reduction in the area of the installation footprint of the electric pump device viewed in the first direction. As a result, the electric pump device for construction machines can be installed within a more compact space.

[0008] A hydraulic drive system according to the present disclosure drives a hydraulic actuator of a construction machine by supplying working fluid thereto and includes: the electric pump device for construction machines described above; and a tank that stores the working fluid and is connected via a suction pipe to a suction port of the hydraulic pump of the electric pump device for construction machines. The tank is disposed adjacent to the electric pump device for construction machines in a second direction perpendicular to the first direction. The suction port is formed in a side surface of the hydraulic pump.

[0009] According to the present disclosure, the tank is disposed adjacent to the electric pump device for construction machines in the second direction. The suction port connected to the tank via the suction pipe is formed in the side surface of the hydraulic pump. Therefore, the length of the suction pipe can be reduced.

Advantageous Effects of Invention

[0010] According to the present disclosure, the electric pump device for construction machines can be installed within a more compact space.

[0011] The above object, other objects, features, and advantages of the present disclosure will be made clear by the following detailed explanation of preferred embodiments with reference to the attached drawings.

Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a perspective view of an excavator in which a hydraulic drive system according to an embodiment of the present disclosure is installed.

[Fig. 2] Fig. 2 is a schematic plan view of a hydraulic drive system installed in the excavator of Fig. 1.

[Fig. 3] Fig. 3 is an enlarged perspective view of an electric pump device included in the hydraulic drive system of Fig. 2.

[Fig. 4] Fig. 4 is an enlarged front view of the electric pump device of Fig. 3.

[Fig. 5] Fig. 5 is an enlarged cross-sectional view of the partially cut electric pump device of Fig. 3.

[Fig. 6] Fig. 6 is a schematic side view of the hydraulic

drive system of Fig. 2.

[Fig. 7] Fig. 7 is an enlarged perspective view of an electric pump device according to another embodiment.

Description of Embodiments

[0013] Hereinafter, a hydraulic drive system 1 and an electric pump device 2 included therein according to an embodiment of the present disclosure will be described with reference to the aforementioned drawings. Note that the concept of directions mentioned in the following description is used for the sake of explanation; the orientations, etc., of elements according to the present disclosure are not limited to these directions. The hydraulic drive system 1 and the electric pump device 2 described below are merely an embodiment of the present disclosure. Thus, the present disclosure is not limited to the embodiments and may be subject to addition, deletion, and alteration within the scope of the essence of the present disclosure.

[Construction Machine]

[0014] A construction machine 3 illustrated in Figs. 1 and 2 performs various tasks by moving a bucket 15 and attachments, etc., of a crane not illustrated in the drawings. In the present embodiment, the construction machine 3 is an electric excavator (hereinafter referred to simply as "the excavator") 3. Note that the construction machine 3 is not limited to the excavator 3 and may alternatively be a crane, a wheel loader, or the like or may alternatively be an industrial vehicle such as a forklift. In other words, it is sufficient that the construction machine 3 be a machine that performs various tasks by moving the attachments. The excavator 3 includes a traveling device 11, a slewing body 12, a boom 13, an arm 14, and a bucket 15. The traveling device 11 includes, for example, a pair of crawlers 11L, 11R. Each of the crawlers 11L, 11R can be driven to move in various directions. The slewing body 12 is disposed on the traveling device 11 so as to be rotatable about a pivot axis L1 extending in the vertical direction. The boom 13 is disposed on the slewing body 12 so as to be vertically pivotable. The arm 14 is disposed on a leading end portion of the boom 13 so as to be pivotable in the longitudinal direction. Furthermore, the bucket 15 is disposed on a leading end portion of the arm 14 so as to be pivotable in the longitudinal direction or the vertical direction. Note that the longitudinal direction is, for example, the direction in which the boom 13 extends.

[0015] Furthermore, hydraulic actuators such as a hydraulic motor and a cylinder are disposed in each of the traveling device 11, the slewing body 12, the boom 13, the arm 14, and the bucket 15. Specifically, a traveling hydraulic motor (not illustrated in the drawings) is disposed in each of the crawlers 11L, 11R of the traveling device 11. The traveling motor is supplied with working fluid to drive

the crawlers 11L, 11R. This allows the traveling device 11 to move in various directions. Note that the working fluid is, for example, a liquid such as oil. A slewing hydraulic motor not illustrated in the drawings is disposed in the slewing body 12. When supplied with the working fluid, the slewing hydraulic motor causes the slewing body 12 to slew. A boom cylinder 13a is disposed on the boom 13. An arm cylinder and a bucket cylinder not illustrated in the drawings are disposed on the arm 14 and the bucket 15, respectively. When supplied with the working fluid, the boom cylinder 13a, the arm cylinder, and the bucket cylinder pivot the boom 13, the arm 14, and the bucket 15, respectively.

15 [Hydraulic Drive System]

[0016] Furthermore, a hydraulic drive system 1 is installed in the excavator 3, as illustrated in Fig. 2. More specifically, the hydraulic drive system 1 is disposed within the slewing body 12. The hydraulic drive system 1 supplies the working fluid to each of the aforementioned hydraulic actuators. Moreover, the hydraulic drive system 1 controls the flow (the flow rate and the flow direction) of the working fluid supplied to each of the hydraulic actuators. The hydraulic drive system 1 configured as just described includes a tank 4 and an electric pump device 2, as illustrated in Fig. 2. More specifically, the hydraulic drive system 1 further includes a multi-control valve 5 and a battery 6.

30 [Tank]

[0017] The working fluid is stored in the tank 4. The working fluid in the tank 4 is supplied from the electric pump device 2, which will be described in detail later, to each of the hydraulic actuators via the multi-control valve 5. Furthermore, the working fluid is brought back from each of the hydraulic actuators to the tank 4 via the multi-control valve 5. The tank 4 is positioned within the slewing body 12 as follows, for example. Specifically, the slewing body 12 includes a cabin 12b in which a driver (or an operator) can be seated. The boom 13 is disposed on the front portion of the slewing body 12 that is located in the middle in the lateral direction, and the cabin 12b is disposed in the front area of the slewing body 12 that is on one side in the lateral direction (for example, on the left side) so as to adjoin the boom 13. The tank 4 is disposed within the slewing body 12 on the side opposite the cabin 12b, with the boom 13 interposed therebetween. In other words, the tank 4 is disposed in the front area of the slewing body 12 that is located on the side opposite the cabin 12b in the lateral direction (on the right side in the present embodiment) so as to adjoin the boom 13.

55 [Electric Pump Device]

[0018] The electric pump device 2, which is an example of the electric pump device for construction machines, is

an electric hydraulic pump device installed in the excavator 3. The electric pump device 2 includes a hydraulic pump 21 and an electric motor 22. In the electric pump device 2, the hydraulic pump 21 and the electric motor 22 are arranged in the first direction (which is the vertical direction in the present embodiment) (i.e., placed up-right). The electric pump device 2 configured as just described is disposed on an installation surface 12a of the slewing body 12 in the excavator 3. In the present embodiment, the installation surface 12a is as follows. Specifically, the installation surface 12a is located within the slewing body 12 on the side opposite the cabin 12b, with the boom 13 interposed therebetween. More specifically, the installation surface 12a is located rearward of the tank 4 in a plan view. The electric pump device 2 stands on the installation surface 12a in the first direction (which is the vertical direction in the present embodiment) perpendicular to the installation surface 12a. Therefore, the electric pump device 2 is positioned so that when installed on the installation surface 12a, the electric pump device 2 is adjacent to the tank 4. Furthermore, the electric pump device 2 is electrically connected to the battery 6. Moreover, the electric pump device 2 is connected to the tank 4 via a suction pipe 7a, and is connected to the multi-control valve 5 via a discharge pipe 7b.

[0019] The electric pump device 2 configured as described above is driven by the electric current supplied from the battery 6 to be described later. The electric pump device 2 is driven to draw the working fluid from the tank 4 through the suction pipe 7a. Furthermore, the electric pump device 2 is driven to discharge the working fluid to the multi-control valve 5 through the discharge pipe 7b. As illustrated in Figs. 3 and 4, the electric pump device 2 includes a support frame 23 in addition to the hydraulic pump 21 and the electric motor 22 mentioned above. More specifically, the electric pump device 2 further includes an inverter 24 and a coupling member 25.

[0020] The hydraulic pump 21 includes a drive shaft 21a, as illustrated in Fig. 5. When the drive shaft 21a is driven to rotate, the hydraulic pump 21 discharges the working fluid. The hydraulic pump 21 is, for example, a tandem pump including two pump parts 21c, 21d of the variable capacity type (which are swash plate pumps of the variable capacity type in the present embodiment) (refer also to Fig. 4). The pump parts 21c, 21d of the variable capacity type (hereinafter referred to simply as "the pump parts") share the aforementioned drive shaft 21a. The pump parts 21c, 21d are arranged in the vertical direction which is the first direction in which the drive shaft 21a extends. Furthermore, a housing 21e is disposed between the pump parts 21c, 21d. Therefore, the hydraulic pump 21 is elongated in the first direction in the present embodiment.

[0021] A suction port 21f and discharge ports 21g, 21h are formed in the side surfaces of the hydraulic pump 21. More specifically, one suction port 21f and two discharge ports 21g, 21h are formed in the side surfaces of the

housing 21e. The suction port 21f and the discharge ports 21g, 21h are open on the side surfaces of the housing 21e in the directions perpendicular to the first direction (for example, the second direction and the third direction to be described in detail later). In the present embodiments, the discharge ports 21g, 21h are open in the same direction. The discharge ports 21g, 21h and the suction port 21f are open in the directions perpendicular to each other. The pump parts 21c, 21d share the one suction port 21f and include the discharge ports 21g, 21h, respectively. Therefore, the hydraulic pump 21 draws the working fluid through the suction port 21f and discharges the working fluid through the two ports 21g, 21h. Regulators 21i, 21j are disposed on the pump parts 21c, 21d, respectively. The regulators 21i, 21j change the respective discharge capacities of the pump parts 21c, 21d.

[0022] The electric motor 22 is coupled to the drive shaft 21a. Furthermore, the electric motor 22 rotatably drives the drive shaft 21a. More specifically, when an electric current flows through the electric motor 22, the electric motor 22 drives the drive shaft 21a. As a result, the electric motor 22 causes the hydraulic pump 21 to discharge the working fluid. The electric motor 22 is, for example, a three-phase alternating current motor. More specifically, the electric motor 22 is formed in the shape of a circular column and disposed coaxially with the drive shaft 21a. In other words, the electric motor 22 is aligned in a straight line coaxially with the hydraulic pump 21. Specifically, the electric motor 22 is aligned in a straight line with the hydraulic pump 21 in the first direction. Note that the electric motor 22 does not necessarily need to be aligned in a straight line with the hydraulic pump 21; for example, the electric motor 22 and the hydraulic pump 21 may be positioned parallel to each other with offset axes or may be positioned so that the axis of the electric motor 22 intersects the drive shaft 21a diagonally or at a right angle.

[0023] The inverter 24 converts a direct current into an alternating current. The inverter 24 is electrically connected to the electric motor 22 and the battery 6 to be described later. The inverter 24 converts the direct current supplied from the battery 6 into an alternating current and provides the alternating current to the electric motor 22. With this, the electric motor 22 rotatably drives the drive shaft 21a. The inverter 24 is disposed, for example, on the electric motor 22. In the present embodiment, the inverter 24 is formed integrally on the electric motor 22 so as to be positioned on the side opposite the hydraulic pump 21 in the first direction.

[0024] The coupling member 25 couples the hydraulic pump 21 and the electric motor 22. The coupling member 25 is, for example, a bellhousing. The coupling member 25 includes a cylindrical part 25a and a flange 25b. The cylindrical part 25a couples the hydraulic pump 21 and the electric motor 22. More specifically, the cylindrical part 25a is formed, for example, in the shape of a circular cylinder. In the present embodiment, the cylindrical part 25a is formed into a tapered shape such that the axis

thereof extends in the first direction and the cylindrical part 25a expands in diameter from one side (which is a lower area in the present embodiment) to the other side (which is an upper area in the present embodiment) in the first direction. The hydraulic pump 21 is attached to one end portion of the cylindrical part 25a that is an end located on the one side in the first direction, and the electric motor 22 is attached to the other end portion of the cylindrical part 25a that is an end located on the other side in the first direction. Thus, the hydraulic pump 21 and the electric motor 22 are coupled using the coupling member 25. The drive shaft 21a extends within the cylindrical part 25a along the axis of the cylindrical part 25a (in other words, to the other side in the first direction) and is coupled to the electric motor 22. The flange 25b is formed along the entire circumference of the other end portion of the cylindrical part 25a. The flange 25b projects radially outward from the other end portion of the cylindrical part 25a.

[0025] The support frame 23, which is an example of the support member, stands on the installation surface 12a of the excavator 3 in the first direction (which is the vertical direction in the present embodiment), as illustrated in Fig. 6. The support frame 23 supports the hydraulic pump 21 and the electric motor 22 such that when the support frame 23 stands, the drive shaft 21a extends in the vertical direction. In other words, the support frame 23 supports the hydraulic pump 21 and the electric motor 22 such that the hydraulic pump 21 and the electric motor 22 are placed upright (in other words, arranged in the vertical direction). In the present embodiment, the support frame 23 is a frame body in the approximate shape of a rectangular parallelepiped, as illustrated in Figs. 3 to 5. The support frame 23 supports the hydraulic pump 21 and the electric motor 22 such that the hydraulic pump 21 is located under the electric motor 22. More specifically, the support frame 23 includes a support part 31, an attachment part 32, and a vibration-isolation member 33. The support frame 23 further includes a lifting link 34.

[0026] The support part 31 is a vertically extending member. The support part 31 includes an installation portion 31a at a lower level and, when standing on the installation surface 12a, rests the installation portion 31 on the installation surface 12a. The support part 31 is formed, for example, as a frame in the approximate shape of a rectangular parallelepiped. More specifically, the support part 31 includes the aforementioned installation portion 31a, four leg portions 31b, and a ceiling portion 31c.

[0027] The installation portion 31a is a portion installed on the installation surface 12a. In the present embodiment, the installation portion 31a is a rectangular plate in a plan view. Note that the installation portion 31a may alternatively be a lower end portion 31f of a leg portion 31b as described in detail later (refer to Fig. 7 to be described in detail later). The leg portion 31b is a vertically extending bar-shaped member. The leg portion 31b

is, for example, a hollow prism. Note that the leg portion 31b may alternatively be a hollow column or may alternatively be a solid prism or column, channel-shaped steel, L-shaped steel, or the like. The leg portions 31b are disposed at the respective four corners of the installation portion 31a and extend upward from the installation portion 31a. The ceiling portion 31c is mounted and secured onto the four leg portions 31b. In the present embodiment, the ceiling portion 31c is, for example, a rectangular plate, and the leg portions 31b are secured to the respective four corners of the ceiling portion 31c. Furthermore, a communication hole 31d is formed in the ceiling portion 31c, as illustrated in Fig. 5. The coupling member 25 is inserted through the communication hole 31d of the ceiling portion 31c.

[0028] The hydraulic pump 21 and the electric motor 22 are attached to the attachment part 32. More specifically, the attachment part 32 has an attachment surface 32a. The hydraulic pump 21 and the electric motor 22 are attached to the attachment surface 32a via the coupling member 25. The attachment part 32 is mounted and secured onto the support part 31 (more specifically, the ceiling portion 31c) via the vibration-isolation member 33 to be described in detail later. More specifically, the attachment part 32 is formed as a substantially rectangular plate. The attachment part 32 has a through hole 32b. The through-hole 32b passes vertically through the attachment part 32. The drive shaft 21a is inserted through the through-hole 32b. In the present embodiment, the through-hole 32b also receives the cylindrical part 25a of the coupling member 25. Meanwhile, the through-hole 32b is formed with a diameter less than that of the flange 25b. Therefore, the flange 25b is positioned along the peripheral edge of the through-hole 32b of the attachment part 32. Specifically, the flange 25b is disposed on the attachment surface 32a which is the upper surface of the attachment part 32. The flange 25b disposed on the attachment surface 32a is then secured, for example, using a plurality of fastening members 32c such as bolts. As a result, the hydraulic pump 21 and the electric motor 22 are attached to the attachment part 32 via the coupling member 25.

[0029] The attachment part 32 is attached to the support part 31 as follows. Specifically, the attachment part 32 is attached to the support part 31 via the vibration-isolation member 33 as mentioned above. At this time, with the attachment surface 32a facing upward on the other side in the first direction, the attachment part 32 is attached to the support part 31. In other words, the attachment part 32 is attached to the support part 31 such that the flange 25b is positioned above the attachment part 32. As a result, the hydraulic pump 21 is located under the electric motor 22 on the one side in the first direction. Furthermore, when the attachment part 32 is attached to the support part 31, the hydraulic pump 21 attached to the attachment surface 32a is located above the installation portion 31a. Thus, the hydraulic pump 21 can be held in an elevated position above the installation

portion 31a.

[0030] The vibration-isolation member 33 is disposed between the attachment part 32 and the support part 31. The vibration-isolation member 33 suppresses the transmission of vibration from the attachment part 32 to the support part 31. In other words, the vibration-isolation member 33 reduces the transmission of vibration from the hydraulic pump 21 and the electric motor 22 to the support part 31. The vibration-isolation member 33 is, for example, vibration-isolation rubber. Note that the vibration-isolation member 33 is not limited to vibration-isolation rubber and may alternatively be a vibration-isolation mechanism such as a damper or a liquid-filled mount. In the present embodiment, the vibration-isolation member 33 is, for example, disc-shaped. However, the vibration-isolation member 33 is not necessarily limited to a disc shape and may alternatively be polygonal in shape or the like. The vibration-isolation members 33 are disposed at the respective four corners of the ceiling portion 31c. The attachment part 32 is mounted on the four vibration-isolation members 33. The attachment part 32 and the ceiling portion 31c are fastened together using a fastening member such as a bolt inserted through each of the four vibration-isolation members 33, with the four vibration-isolation members 33 interposed between the attachment part 32 and the ceiling portion 31c. The vibration-isolation member 33 positioned as just described is located between the attachment part 32 and the ceiling portion 31c, resulting in being closer to the center of gravity of a pump unit 8 composed of the hydraulic pump 21 and the electric motor 22 than if the vibration-isolation member 33 were located between the installation portion 31a and the installation surface 12a.

[0031] The lifting link 34 is for hoisting the support frame 23. More specifically, the lifting link 34 is for hoisting the electric pump device 2 itself. The lifting link 34 can be attached, for example, to a lifting device (not illustrated in the drawings) such as a crane. Specifically, the lifting link 34 can engage with a suspension element, such as a hook, of a lifting device. When the suspension element is lifted, the electric pump device 2 is lifted. In the present embodiment, four lifting links 34 are disposed on the attachment part 32, and the lifting links 34 are disposed at the respective four corners of the attachment part 32. It is sufficient that the lifting links 34 be arranged such that when the electric pump device 2 is lifted by the suspension element, the drive shaft 21a extends substantially perpendicularly, in other words, the center of gravity of the plurality of lifting links 34 is positioned on the drive shaft 21a in a plan view.

[Multi-control Valve]

[0032] The multi-control valve 5 supplies the working fluid discharged from the electric pump device 2 to each of the hydraulic actuators, and controls the flow of the working fluid supplied. More specifically, the multi-control valve 5 is connected to the hydraulic pump 21 (more

specifically, the discharge ports 21g, 21h) of the electric pump device 2 via the discharge pipe 7b as mentioned above. The multi-control valve 5 configured as just described is located rearward of the boom 13 in the slewing body 12. In the present embodiment, the multi-control valve 5 is located adjacent to the electric pump device 2 in the slewing body 12.

[Battery]

[0033] The battery 6 is electrically connected to the electric pump device 2 (more specifically, the inverter 24). The battery 6 supplies a direct current to the inverter 24. The battery 6 is disposed within the slewing body 12. More specifically, the battery 6 is positioned rearward of the electric pump device 2 in the slewing body 12. In the present embodiment, a counterweight 16 is disposed at the internal tail end of the slewing body 12. The battery 6 is disposed between the counterweight 16 and the electric pump device 2.

[Positioning of Electric Pump Device]

[0034] The electric pump device 2 stands upward on the installation surface 12a within the slewing body 12, as illustrated in Fig. 6. The tank 4 is disposed on one side of the electric pump device 2 in the second direction. The second direction is a direction perpendicular to the first direction; in the present embodiment, the second direction is the longitudinal direction. The one side in the second direction is the front area in the present embodiment. The electric pump device 2 is disposed with the suction port 21f of the hydraulic pump 21 directed toward one side in the third direction. The third direction, which is a direction perpendicular to the first and second directions, is the lateral direction in the present embodiment; the one side in the third direction is the direction opposite to the direction in which the multi-control valve 5 is located relative to the electric pump device 2, that is, the right side, in the present embodiment. As illustrated in Fig. 2, an openable door 12c is formed on the slewing body 12 on the right side of the electric pump device 2, and the suction port 21f faces the openable door 12c. The suction pipe 7a is connected to the suction port 21f as mentioned above. Therefore, the suction pipe 7a can be exposed by opening the openable door 12c. This facilitates maintenance of the suction pipe 7a.

[0035] The electric pump device 2 is disposed with the discharge ports 21g, 21h of the hydraulic pump 21 facing backward. The discharge pipe 7b is connected to the discharge ports 21g, 21h as mentioned above. Therefore, the discharge pipe 7b is disposed between the electric pump device 2 and the battery 6. This facilitates maintenance of the discharge pipe 7b.

[Installation of Electric Pump Device]

[0036] The electric pump device 2 is installed within the

slewing body 12 of the excavator 3 as follows. Specifically, a suspension element of a lifting device not illustrated in the drawings is attached to the lifting links 34 in the electric pump device 2. After the attachment, the electric pump device 2 is lifted by the lifting device and transferred to a position above the installation surface 12a. Thereafter, the electric pump device 2 is lowered until the installation portion 31a is seated on the installation surface 12a. As a result, the electric pump device 2 stands on the installation surface 12a. Therefore, the electric pump device 2 can be easily installed on the installation surface 12a within the slewing body 12.

[Operation of Hydraulic Drive System]

[0037] When a direct current flows from the battery 6 to the electric pump device 2, the electric pump device 2 operates as follows. Specifically, the inverter 24 converts the direct current into an alternating current and provides the alternating current to the electric motor 22. Accordingly, the electric motor 22 rotatably drives the drive shaft 21a. As a result, the hydraulic pump 21 draws the working fluid stored in the tank 4 from the suction port 21f through the suction pipe 7a and discharges the working fluid to the discharge ports 21g, 21h. The working fluid flows from the discharge ports 21g, 21h to the multi-control valve 5 through the discharge pipe 7b and then is supplied to each of the hydraulic actuators via the multi-control valve 5. Thus, each of the hydraulic actuators can be operated.

[0038] In the electric pump device 2 according to the present embodiment, the support frame 23 stands in an upper area and supports the hydraulic pump 21 and the electric motor 22 such that the drive shaft 21a extends upward. This allows for a reduction in the area of the installation footprint of the electric pump device 2 viewed from above. As a result, the electric pump device 2 can be installed within a more compact space.

[0039] Furthermore, in the electric pump device 2 according to the present embodiment, the hydraulic pump 21 is supported by the support frame 23 so as to be positioned under the electric motor 22. Therefore, the electric motor 22 can be protected from working fluid spatter that has leaked from the hydraulic pump 21.

[0040] Furthermore, in the electric pump device 2 according to the present embodiment, the support frame 23 supports the hydraulic pump 21 such that the hydraulic pump 21 is located above the installation portion 31a. Therefore, when the electric pump device 2 is installed, the hydraulic pump 21 is positioned above the installation surface 12a with spacing therebetween. This reduces damage to the hydraulic pump 21 caused by rubbing against the installation surface 12a due to the vibration of the hydraulic pump 21.

[0041] Furthermore, in the electric pump device 2 according to the present embodiment, the coupling member 25 includes the flange 25b and is secured with the flange 25b mounted on the attachment surface 32a of the support frame 23. Therefore, the coupling member 25 bears

the load of the hydraulic pump 21, allowing the electric motor 22 to be shielded from that load.

[0042] Furthermore, in the electric pump device 2 according to the present embodiment, the vibration-isolation member 33 is disposed between the attachment part 32 and the support part 31. Therefore, the vibration-isolation member 33 can be disposed at a vertical position close to the center of gravity of the pump unit 8 composed of the hydraulic pump 21 and the electric motor 22. This allows for a reduction in the vibration transmitted to the vibration-isolation member 33, leading to improved vibration-isolation performance.

[0043] Furthermore, in the electric pump device 2 according to the present embodiment, the four lifting links 34 are attached to the attachment surface 32a of the attachment part 32. Therefore, the electric pump device 2 can be easily hoisted.

[0044] In the hydraulic drive system 1 according to the present embodiment, the tank 4 is disposed adjacent to the electric pump device 2 in the longitudinal direction. The suction port 21f connected to the tank 4 via the suction pipe 7a is formed in the side surface of the hydraulic pump 21. Therefore, the length of the suction pipe 7a can be reduced.

<Other Embodiments>

[0045] In the electric pump device 2 according to the present embodiment, the hydraulic pump 21 and the electric motor 22 are coaxially aligned; however, the hydraulic pump 21 and the electric motor 22 may alternatively be disposed such that the axis of the electric motor 22 intersects (for example, is perpendicular to) the axis of the hydraulic pump 21. In other words, it is sufficient that in the electric pump device 2, the hydraulic pump 21 and the electric motor 22 be placed upright such that the drive shaft 21a of the hydraulic pump 21 extends in the first direction. The hydraulic pump 21 is not limited to a tandem pump and may alternatively be a single pump. Furthermore, the hydraulic pump 21 is not limited to a swash plate pump and may alternatively be an axial piston pump or a gear pump. Moreover, the hydraulic pump 21 may be disposed on the other side of the electric motor 22 in the first direction (that is, above the electric motor 22). Furthermore, the hydraulic pump 21 may be located at the same position as the installation portion 31a or at a position lower than the installation portion 31a. Moreover, the electric motor 22 is not limited to a three-phase alternating current motor and may alternatively be another motor such as a servo motor.

[0046] In the electric pump device 2 according to the present embodiment, the hydraulic pump 21 and the electric motor 22 are coupled using the coupling member 25; however, the hydraulic pump 21 and the electric motor 22 may be directly attached to the support frame 23 (more specifically, the attachment part 32). The lifting link 34 does not necessarily need to be disposed on the attachment part 32 and may be disposed on the support

part 31. The flange 25b does not necessarily need to be formed along the entire circumference of the cylindrical part 25a. The flange may be configured as follows. Specifically, the flange may be composed of a plurality of projections projecting radially outward from the cylindrical part 25a and spaced apart from each other in the circumferential direction; the shape of the flange is not limited.

[0047] In the electric pump device 2 according to the present embodiment, a reinforcing member 31e may be provided so as to extend between two adjacent leg portions 31b of the support frame 23 (refer to Fig. 7). Furthermore, as illustrated in Fig. 7, a lower end portion 31f of each of the leg portions 31b may form the installation portion or another member may form the installation portion. The support frame 23 is formed in the shape of a frame composed of the plurality of leg portions 31b, but may alternatively be formed in the shape of a hollow cylinder. Furthermore, in the support frame 23, the vibration-isolation member 33 is disposed between the ceiling portion 31c and the attachment part 32; however, the vibration-isolation member 33 may alternatively be disposed between the attachment part 32 and the flange 25b. In this case, the vibration-isolation member 33 is formed in the shape of a circular ring, for example, to be provided on the exterior of the cylindrical part 25a. Furthermore, the vibration-isolation member 33 may be disposed between the installation portion 31a and the installation surface 12a and between the leg portion 31b and the installation portion 31a. Moreover, when the installation surface 12a can be cut away, for example, to position the hydraulic pump 21 with spacing from the installation surface 12a, a portion of the hydraulic pump 21 may project downward below the installation surface 12a.

[0048] In the hydraulic drive system 1 according to the present embodiment, the electric pump device 2 is disposed adjacent to the tank 4; however, the electric pump device 2 may be disposed with spacing from the tank 4. Furthermore, the suction port 21f of the electric pump device 2 does not necessarily need to be open on the one side in the third direction and may be open on the one side and the other side in the second direction and on the other side in the third direction. Similarly, the direction in which the discharge ports 21g, 21h are open is not limited to the other side in the second direction.

<Exemplary Embodiments>

[0049] An electric pump device according to the first aspect is installed in a construction machine and includes: a hydraulic pump that includes a drive shaft and when the drive shaft rotates, discharges working fluid; an electric motor that is coupled to the drive shaft and rotatably drives the drive shaft; and a support member that supports the hydraulic pump and the electric motor. The support member stands in a first direction perpendicular to an installation surface of the construc-

tion machine and supports the hydraulic pump and the electric motor such that the drive shaft extends in the first direction.

[0050] According to this aspect, the support member stands in the first direction and supports the hydraulic pump and the electric motor such that the drive shaft extends in the first direction. This allows for a reduction in the area of the installation footprint of the electric pump device viewed in the first direction. As a result, the electric pump device for construction machines can be installed within a more compact space.

[0051] An electric pump device according to the second aspect is the electric pump device according to the first aspect in which the support member includes, on one side in the first direction, an installation portion to be installed on the installation surface, and the hydraulic pump is supported by the support member so as to be positioned on the one side of the electric motor in the first direction.

[0052] According to this aspect, the hydraulic pump is supported by the support member so as to be positioned on the one side of the electric motor in the first direction. Therefore, the electric motor can be protected from working fluid spatter that has leaked from the hydraulic pump.

[0053] An electric pump device according to the third aspect is the electric pump device according to the second aspect in which the support member supports the hydraulic pump such that the hydraulic pump is disposed on the other side of the installation portion in the first direction.

[0054] According to this aspect, the support member supports the hydraulic pump such that the hydraulic pump is disposed on the other side of the installation portion in the first direction. Therefore, when the electric pump device for construction machines is installed, the hydraulic pump is positioned on the other side of the installation surface in the first direction with spacing therebetween. This reduces damage to the hydraulic pump caused by rubbing against the installation surface due to the vibration of the hydraulic pump.

[0055] An electric pump device according to the fourth aspect is the electric pump device according to any one of the first to third aspects that further includes a coupling member that couples the hydraulic pump and the electric motor. The support member includes an attachment surface. The coupling member includes a flange and is secured with the flange mounted on the attachment surface.

[0056] According to this aspect, the coupling member includes a flange and is secured with the flange mounted on the attachment surface of the support member. Therefore, the coupling member bears the load of the hydraulic pump, allowing the electric motor to be shielded from that load.

[0057] An electric pump device according to the fifth aspect is the electric pump device according to the fourth aspect in which the support member includes: a support part including, on one side in the first direction, an in-

stallation portion to be installed on the installation surface; an attachment part mounted on the support part and including the attachment surface; and a vibration-isolation member that suppresses transmission of vibration from the hydraulic pump and the electric motor to the support part. The vibration-isolation member is disposed between the attachment part and the support part or between the attachment part and the coupling member.

[0058] According to this aspect, the vibration-isolation member is disposed between the attachment part and the support part or between the attachment part and the coupling member. Therefore, the vibration-isolation member can be disposed at a vertical position close to the center of gravity of the pump unit composed of the hydraulic pump and the electric motor. This allows for a reduction in the vibration transmitted to the vibration-isolation member, leading to improved vibration-isolation performance.

[0059] An electric pump device according to the sixth aspect is the electric pump device according to the fourth aspect in which the support member includes a plurality of lifting links that hoist the support member, and the plurality of lifting links are attached to the attachment surface.

[0060] According to this aspect, the plurality of lifting links are attached to the ceiling. Therefore, the electric pump device for construction machines can be easily hoisted.

[0061] A hydraulic drive system according to the seventh aspect drives a hydraulic actuator of a construction machine by supplying working fluid thereto and includes: the electric pump device for construction machines according to any one of the first to sixth aspects; and a tank that stores the working fluid and is connected via a suction pipe to a suction port of the hydraulic pump of the electric pump device for construction machines. The tank is disposed adjacent to the electric pump device for construction machines in a second direction perpendicular to the first direction. The suction port is formed in a side surface of the hydraulic pump.

[0062] According to this aspect, the tank is disposed adjacent to the electric pump device for construction machines in the second direction. The suction port connected to the tank via the suction pipe is formed in the side surface of the hydraulic pump. Therefore, the length of the suction pipe can be reduced.

[0063] From the foregoing description, many modifications and other embodiments of the present disclosure would be obvious to a person having ordinary skill in the art. Therefore, the foregoing description should be interpreted only as an example and is provided for the purpose of teaching the best mode for carrying out the present disclosure to a person having ordinary skill in the art. Substantial changes in details of the structures and/or functions of the present disclosure are possible within the spirit of the present disclosure.

Claims

1. An electric pump device for construction machines that is installed in a construction machine, the electric pump device comprising:

a hydraulic pump that includes a drive shaft and when the drive shaft rotates, discharges working fluid;

an electric motor that is coupled to the drive shaft and rotatably drives the drive shaft; and
a support member that supports the hydraulic pump and the electric motor, wherein the support member stands in a first direction perpendicular to an installation surface of the construction machine and supports the hydraulic pump and the electric motor such that the drive shaft extends in the first direction.

2. The electric pump device for construction machines according to claim 1, wherein

the support member includes, on one side in the first direction, an installation portion to be installed on the installation surface, and the hydraulic pump is supported by the support member so as to be positioned on the one side of the electric motor in the first direction.

3. The electric pump device for construction machines according to claim 2, wherein the support member supports the hydraulic pump such that the hydraulic pump is disposed on the other side of the installation portion in the first direction.

4. The electric pump device for construction machines according to claim 1, further comprising:

a coupling member that couples the hydraulic pump and the electric motor, wherein the support member includes an attachment surface, and the coupling member includes a flange and is secured with the flange mounted on the attachment surface.

5. The electric pump device for construction machines according to claim 4, wherein

the support member includes:

a support part including, on one side in the first direction, an installation portion to be installed on the installation surface;
an attachment part mounted on the support part and including the attachment surface; and
a vibration-isolation member that sup-

presses transmission of vibration from the hydraulic pump and the electric motor to the support part, and

the vibration-isolation member is disposed between the attachment part and the support part or between the attachment part and the coupling member. 5

6. The electric pump device for construction machines according to claim 4, wherein 10

the support member includes a plurality of lifting links that hoist the support member, and the plurality of lifting links are attached to the attachment surface. 15

7. A hydraulic drive system for driving a hydraulic actuator of a construction machine by supplying working fluid thereto, the hydraulic drive system comprising: 20

the electric pump device for construction machines according to claim 1; and
a tank that stores the working fluid and is connected via a suction pipe to a suction port of the hydraulic pump of the electric pump device for construction machines, wherein
the tank is disposed adjacent to the electric pump device for construction machines in a second direction perpendicular to the first direction, and
the suction port is formed in a side surface of the hydraulic pump. 25
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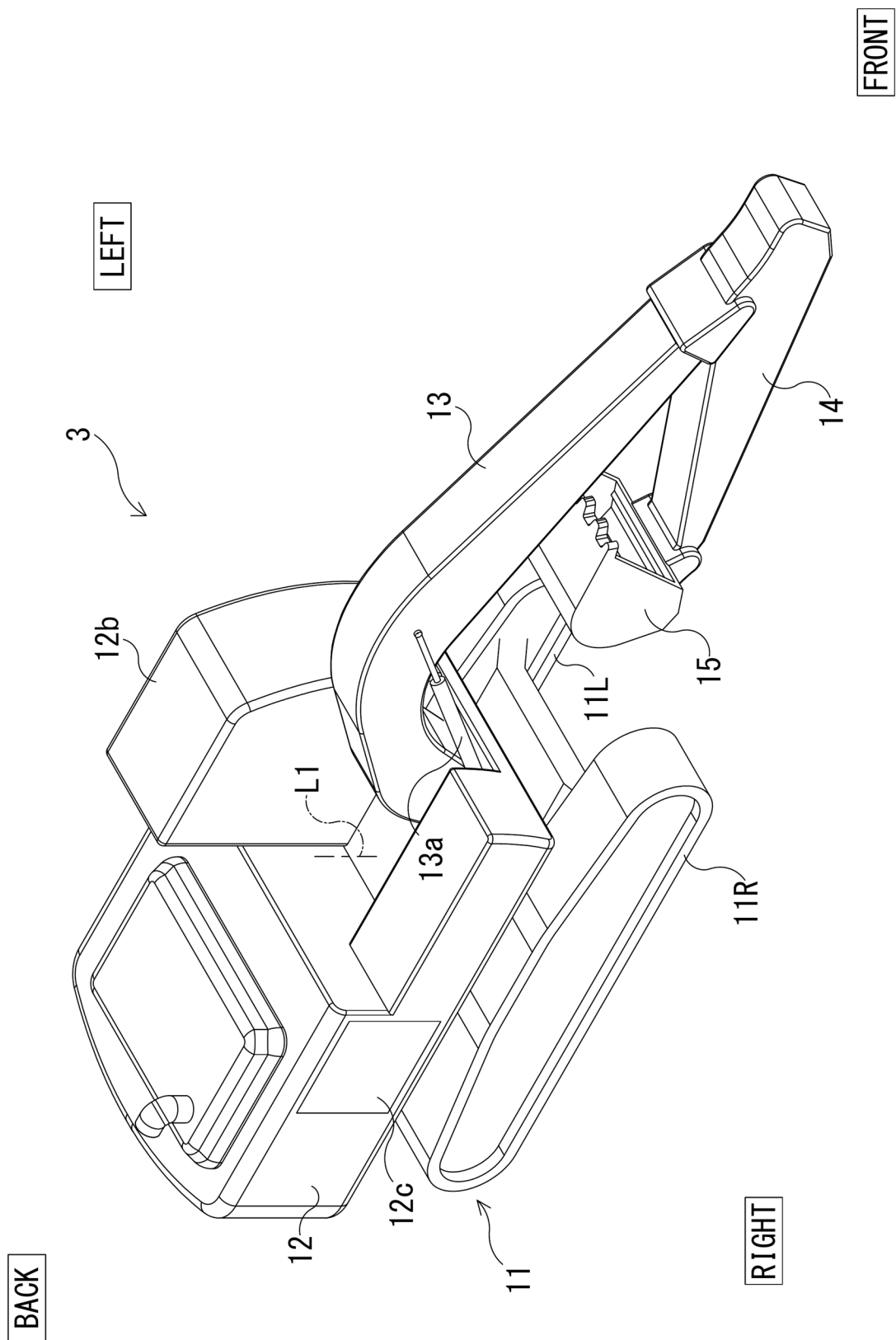


Fig. 1

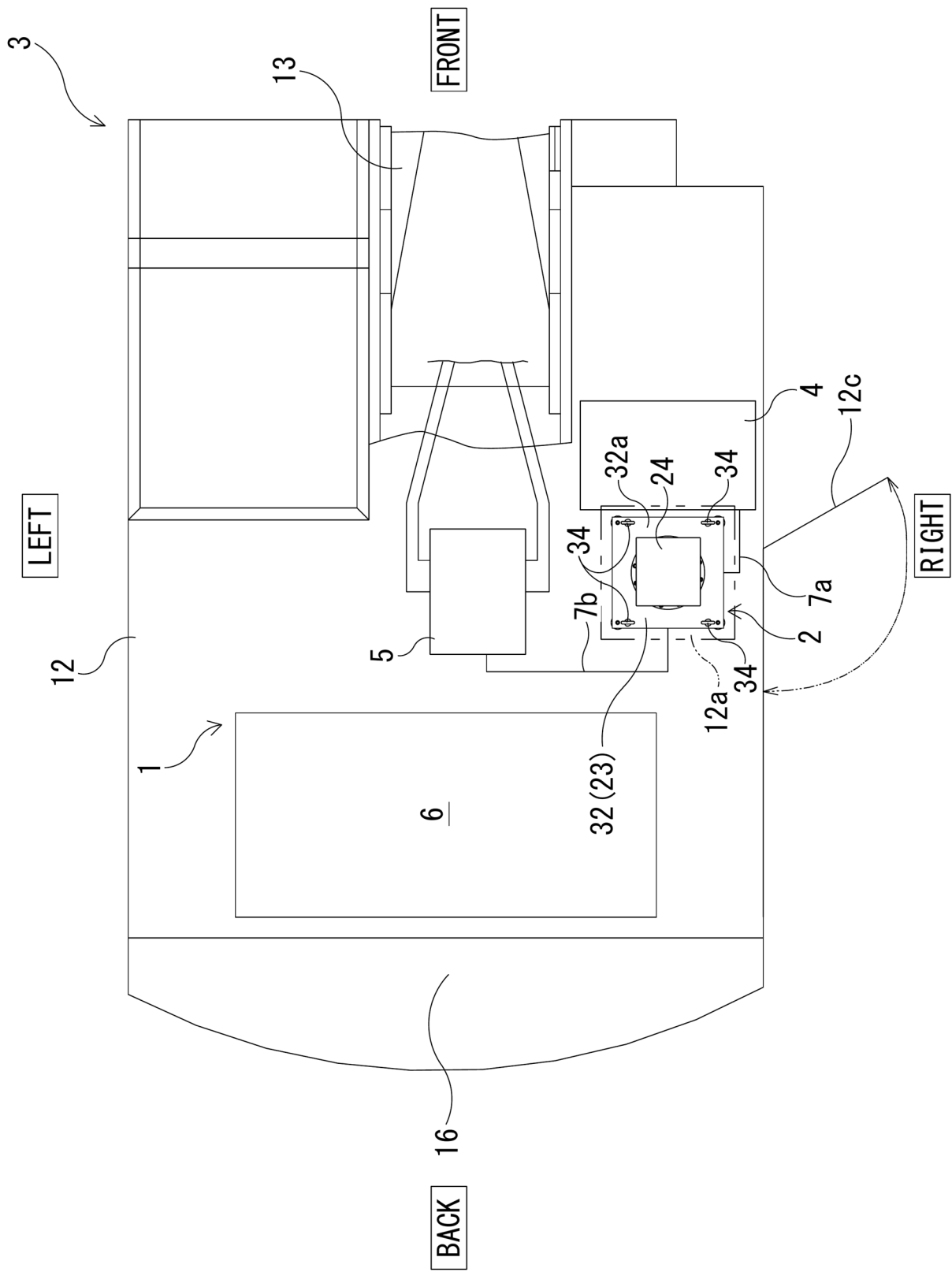


Fig. 2

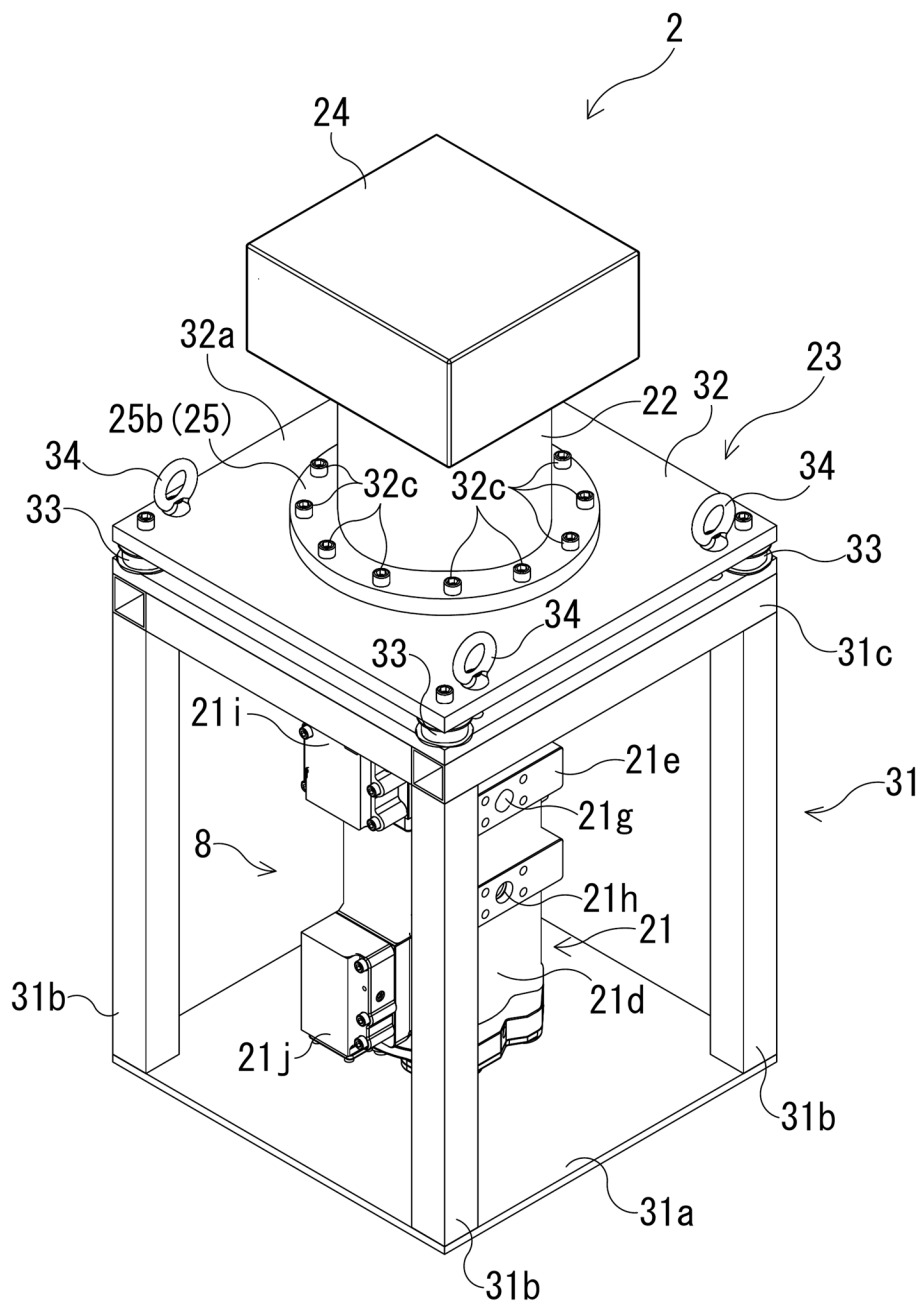


Fig. 3

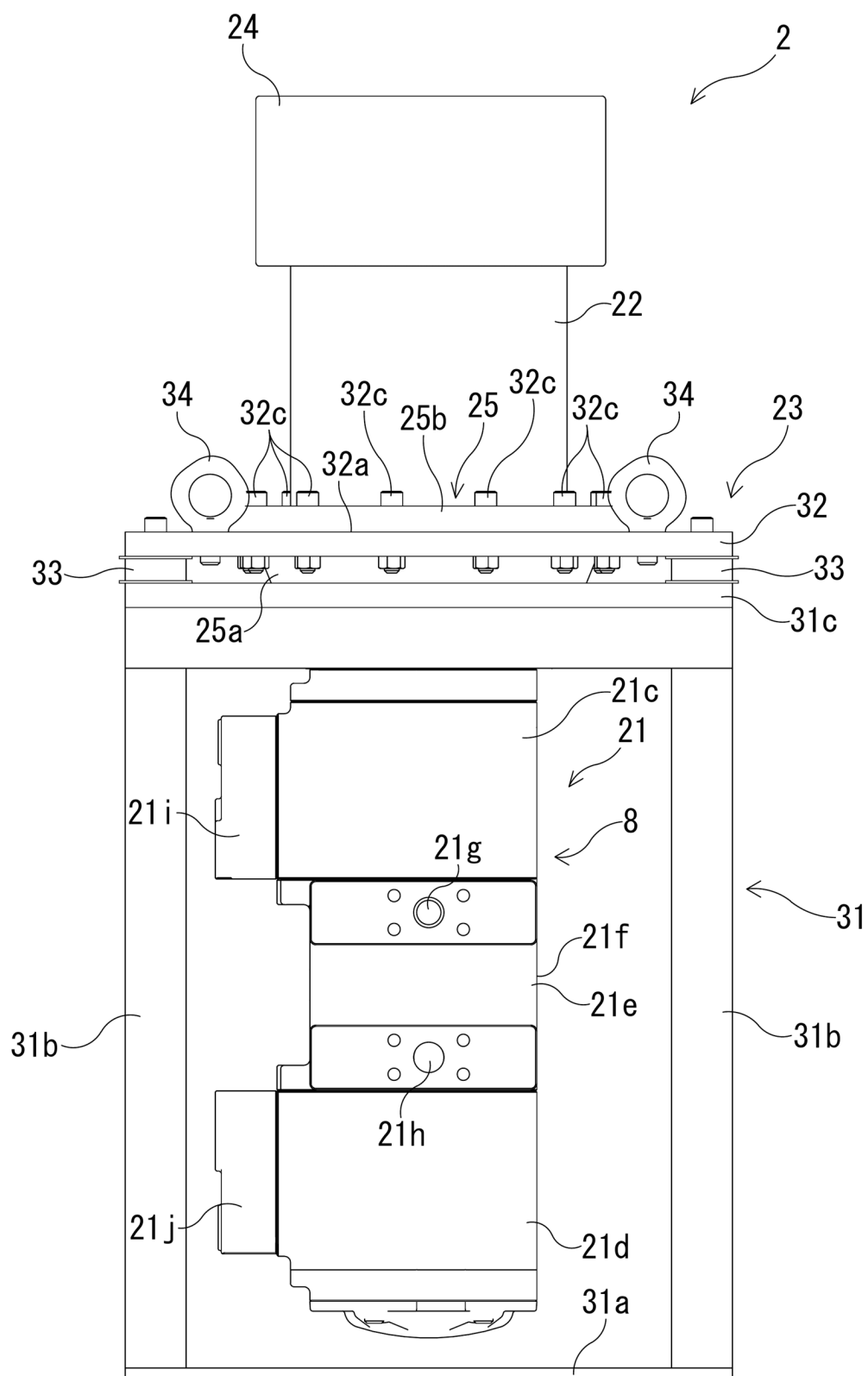


Fig. 4

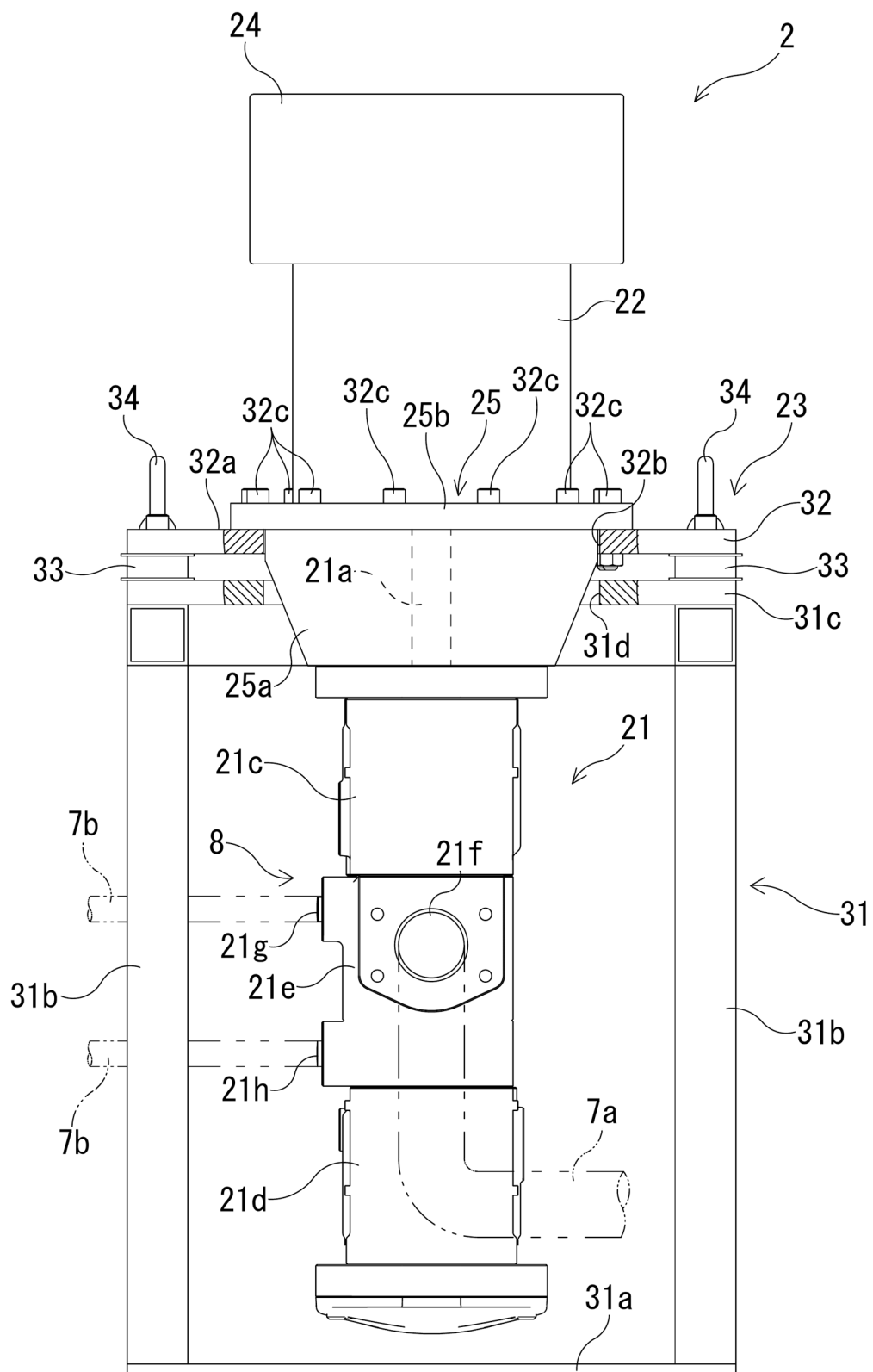


Fig. 5

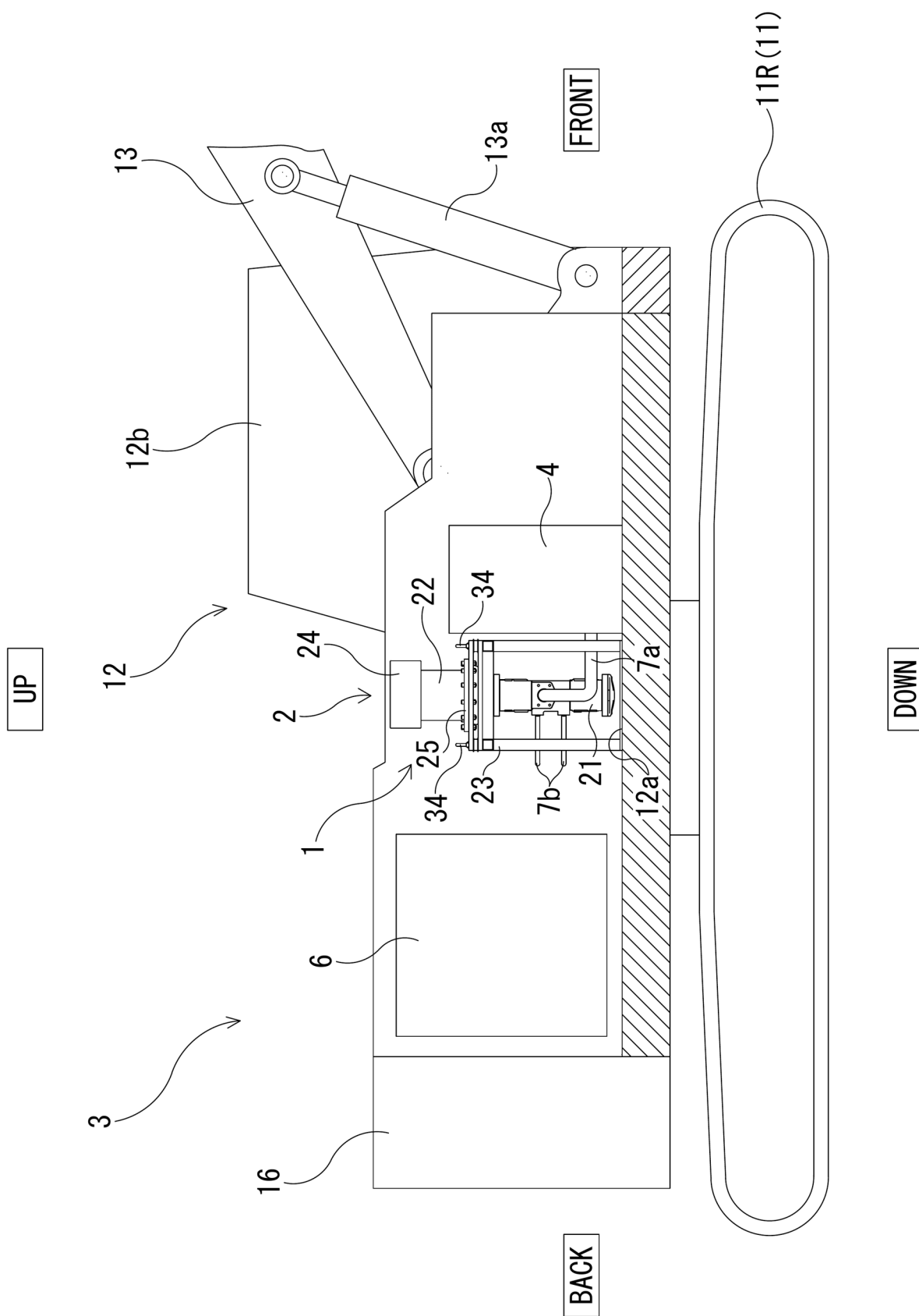


Fig. 6

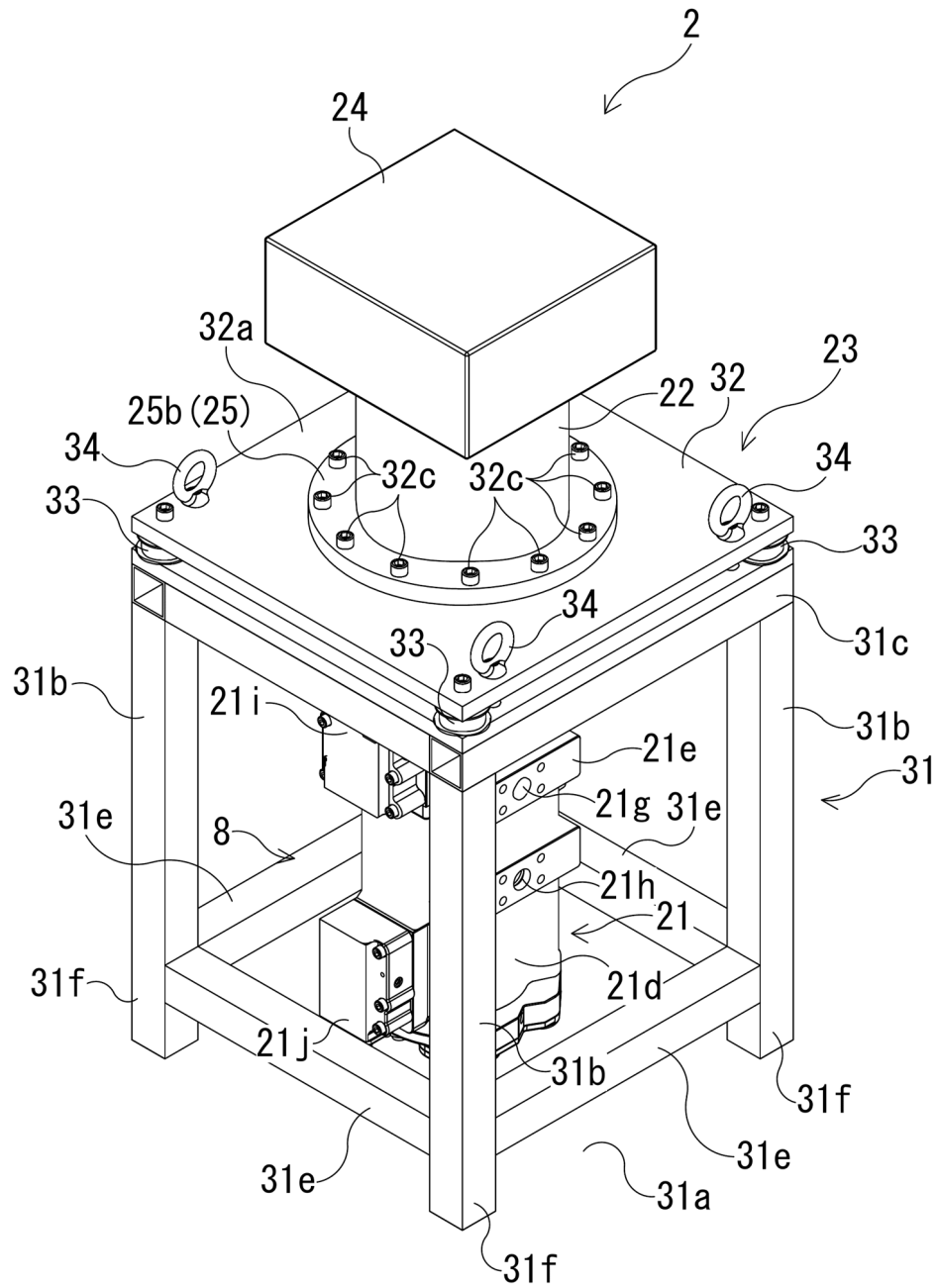


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/023047

A. CLASSIFICATION OF SUBJECT MATTER

E02F 9/00(2006.01)i; **F04B 23/00**(2006.01)i; **F04B 23/06**(2006.01)i
FI: E02F9/00 Z; F04B23/00 Z; F04B23/06

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)

E02F9/00; F04B23/00; F04B23/06

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 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

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.
Y	JP 11-21947 A (YUTANI HEAVY IND LTD.) 26 January 1999 (1999-01-26) paragraphs [0011]-[0013], fig. 1-5	1-3, 7
A		4-6
Y	JP 2011-201622 A (SHINMAYWA INDUSTRIES, LTD.) 13 October 2011 (2011-10-13) paragraphs [0016]-[0025], fig. 1, 4, 6	1-3, 7
A		4-6
Y	JP 2011-241587 A (SUMITOMO (SHI) CONSTRUCTION MACHINERY CO., LTD.) 01 December 2011 (2011-12-01) paragraph [0004], fig. 3	7

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

* Special categories of cited documents:

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09 August 2024

Date of mailing of the international search report

20 August 2024

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.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/023047

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Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 11-21947 A	26 January 1999	EP 879920 A2 p. 3, column 3, line 21 to p. 4, column 5, line 4, fig. 1-5 KR 10-1998-0087314 A	
JP 2011-201622 A	13 October 2011	(Family: none)	
JP 2011-241587 A	01 December 2011	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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- JP 2022163964 A [0003]