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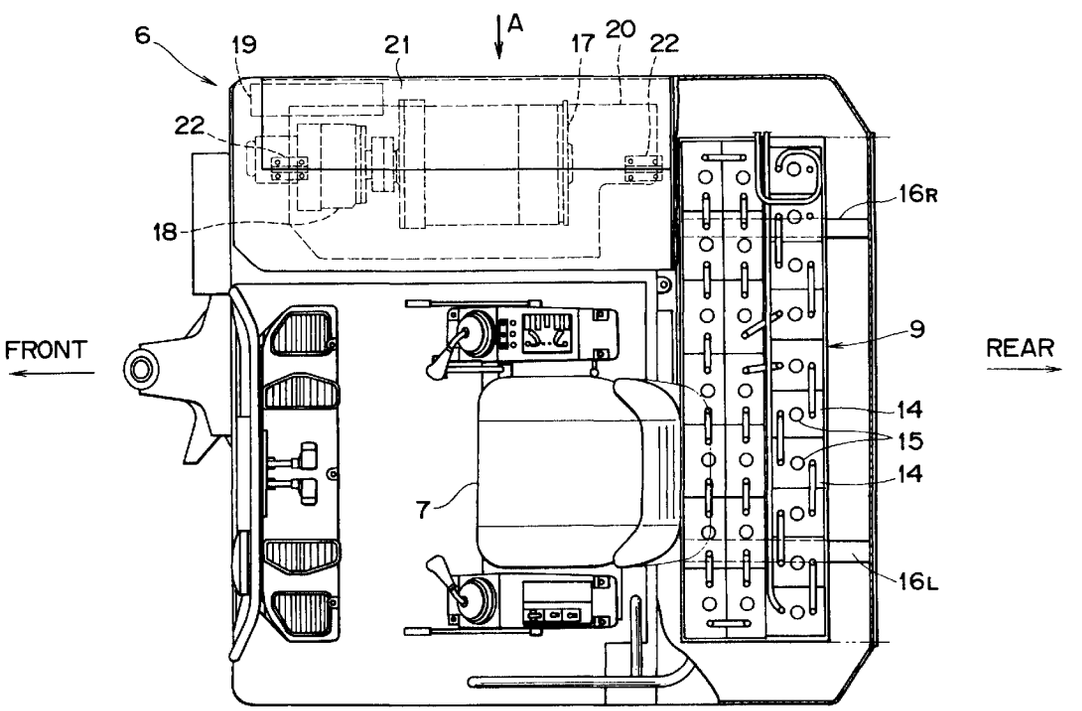
## (54) Battery driven construction machine

(57) There comprises a battery body arranged at the rear of an upper rotating body; an electric motor arranged forwardly of and in the vicinity of the battery body; a hydraulic pump connected to the electric motor a working oil tank arranged in the vicinity of the hydraulic pump; and a directional control valve for an actuator arranged in the vicinity of the hydraulic pump. Thereby, a power energy of a battery-driven construction machine can be utilized efficiently.

FIG. 2

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## Description

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a battery-driven construction machine in which a hydraulic pump is driven by supplying an electric power from a battery to an electric motor.

Description of the Related Art:

In the battery-driven construction machine, it is very important to make use of power energy efficiently without loss.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a battery-driven construction machine capable of making use of power energy efficiently without loss.

The construction machine according to the present invention comprises a battery body arranged at the rear of an upper rotating body, an electric motor arranged forwardly of and in the vicinity of the battery body, a hydraulic pump connected to the electric motor, a working oil tank arranged in the vicinity of the hydraulic pump, and a directional control valve for an actuator arranged in the vicinity of the hydraulic pump.

In the present invention, the electric motor is arranged in the vicinity of the battery body. Accordingly, a power loss caused by an electric-wire resistance can be suppressed, and a battery body having a capacity as small as possible can be mounted to transmit energy of the battery body efficiently and for a long period of time. Further, a working oil tank and a directional control valve for an actuator are arranged in the vicinity of a hydraulic pump. Accordingly, it is possible that hydraulic pipes for connecting the hydraulic pump and the working oil tank, and the hydraulic pump and the directional control valve for an actuator be shortened to reduce an energy loss caused by a piping resistance and to save an energy of the battery body.

Further, if the electric motor and the hydraulic pump are arranged above the working oil tank, the space saving of the interior of the vehicle body of the construction machine can be attained. Therefore, it is possible to improve the layout of various apparatuses inside the vehicle body and to easily perform the maintenance of replacement of a brush with respect to the electric motor above the working oil tank.

Further, a top cover for opening the above of the battery, a rear cover for opening the rear of the battery, and a side cover for opening at least the side of the electric motor may be provided, and further, the battery body may be supported movably in a horizontal direction. In this case, charging of a plurality of batteries and maintenance such as replenishment of battery liquid can be easily performed. Further, in the case where maintenance such as replacement of a battery is necessary, the battery can be easily raised by a crane or the like. When a battery (a zinc type battery) is charged, a hydrogen gas is generated at overcharge, but ventilation above the battery can be improved by opening the top cover, the rear cover, and the side cover. When a DC motor is used as an electric motor, maintenance of replacement of a brush can be easily performed by opening the side cover or the top cover.

Moreover, the electric motor may be mounted on the working oil tank through a buffer member. In this case, shocks during the operation of the construction machine are hard to be propagated to driving systems such as the electric motor, the hydraulic pump and the like.

Further, a connecting frame for integrally connecting the electric motor, the hydraulic pump and the working oil tank may be provided. In this case, the driving system of the electric motor and the hydraulic pump can be formed into a sub-assembly to improve the assembly property of the construction machine.

Further, a bend portion for an oil reservoir may be formed in the midst of a suction pipe for connecting a suction port of a hydraulic pump to a working oil tank, and the bend portion may be positioned at a level higher than a position of the suction port. In this case, even when the hydraulic pump is in a stop state, working oil within the suction pipe can be prevented from slipping-off into the working oil tank. Accordingly, by forming a simple-shaped suction pipe, it is possible to always hold working oil to be supplied to the suction port within the suction pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a battery-driven construction machine showing a first embodiment of the present invention;

FIG. 2 is a plan view of cut-opened main parts of an upper rotating body of FIG. 1;

FIG. 3 is a right-side view of the upper rotating body as viewed from A of FIG. 2;

FIG. 4 is a perspective view of the construction machine according to the first embodiment as viewed leftward obliquely and upward;

FIG. 5 is a perspective view of the construction machine according to the first embodiment as viewed rightward obliquely and upward;

FIG. 6 is a perspective view of main parts showing a state that a battery body of FIG. 2 is supported slidably in a longitudinal horizontal direction.

FIG. 7 is a side view of a battery-driven construction machine showing a second embodiment of the present invention;

FIG. 8 is a plan view of cut-opened main parts of an upper rotating body of FIG. 7;

FIG. 9 is an enlarged view of part A in FIG. 8;
FIG. 10 is a side view of main parts as viewed from B-B of FIG. 8;
FIG. 11 is a view as viewed from C-C of FIG. 8;
FIG. 12 is a side view of main parts showing a modified embodiment of an upper rotating body provided with a hydraulic pump and a suction piping; and
FIG. 13 is perspective view of main parts showing the interior of a construction machine with a part of the second embodiment modified.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiment according to the present invention will be explained hereinafter with reference to FIGS. 1 to 13.

### FIRST EMBODIMENT (FIGS. 1 to 6)

FIG. 1 is a side view of a battery-driven construction machine (a base machine of the present construction machine is a hydraulic excavator) showing one embodiment of the present invention. In FIG. 1, numeral 5 designates a lower travel body of a construction machine; numeral 6 designates an upper rotating body connected to the upper part of the lower travel body 5; numeral 7 designates a driver's seat provided on the upper rotating body 6; numeral 8 designates a working attachment mounted on the front part of the upper rotating body 6; numeral 9 designates a battery body arranged at the rear of the upper rotating body 6 (the battery body 9 is composed of a plurality of batteries); numeral 10 designates a top cover capable of being rotated and opened about a hinge member 11 in a direction of arrow a; and numeral 12 designates a rear cover capable of being rotated and opened about a hinge member 13 in a direction of arrow b. Note, in FIG. 1, a cab, a canopy or the like to cover the driver's seat 7 of the upper rotating body 6 are not shown.

FIG. 2 is a plan view of cut-opened main parts of an upper rotating body of FIG. 1. In FIG. 2, numeral 14 designates a plurality of batteries constituting the battery body 9; numeral 15 designates battery liquid replenishing ports of the respective batteries 14; numerals 16L, 16R designate guide rails which are sliding members slidably supporting the battery body 9 horizontally backward and forward; numeral 17 designates an electric motor arranged sideways of the upper rotating body 6; numeral 18 designates a hydraulic pump; numeral 19 designates a directional control valve for an actuator; numeral 20 designates a working ail tank; and numeral 21 designates a side cover capable of being rotated and opened about a hinge member 22.

FIG. 3 is a right-side view of the upper rotating body 6 as viewed from A of FIG. 2. FIG. 4 is a perspective view of the construction machine as viewed leftward obliquely and upward In FIG. 4, numeral 23 designates a cab for a driver's chamber to cover the driver's seat 7 (shown in FIGS. 1 and 2). FIG. 5 is a perspective view of the construction machine as viewed rightward obliquely and upward In FIG. 5, numeral 21 designates a side cover capable of being rotated and opened about a hinge member 22 in a direction of arrow c. FIG. 6 is a perspective view of main parts showing a state that the battery body 9 is slidably supported horizontally backward and forward (a direction indicated at arrow d).

The constitution of the construction machine according to the present embodiment will be described hereinafter with reference to FIGS. 1 to 6. In the present embodiment, the battery body 9 is arranged at the rear of the upper rotating body 6. The electric motor 17 is arranged forwardly of the battery body 9. The hydraulic pump 18 is connected to the electric motor 17. The working oil tank 20 is arranged in the vicinity of the hydraulic pump 18 (a position below the hydraulic pump 18 and the electric motor 17 as shown in FIG. 3), and the directional control valve for the actuator (for controlling a hydraulic actuator provided on the construction machine) 19 is arranged in the vicinity of the hydraulic pump 18 (a position sideways of the hydraulic pump 18 as shown in FIG. 2). There is provided the upper cover 10 for opening, over the substantially whole area, above at least the battery liquid replenishing ports 15 of the plurality of batteries 14 (shown in FIG. 2) constituting the battery body 9. There are further provided the rear cover 12 for opening, over the substantially whole area, the rear of the battery body 9 (shown in FIGS. 1, 3, 4 and 5) and the side cover 21 for opening the side of the electric motor 17 (shown in FIGS. 2, 3, 5 and 6). Further, the guide rails 16L, 16R for slidably supporting the battery body 9 horizontally backward and forward (shown in FIGS. 6 and 2) are provided within the upper rotating body 6.

In the first embodiment, there can be provided a side cover (not shown) capable of opening a portion opposite one surface of the side of the battery body 9. It is also possible that when a cover member (not shown) is secured to at least one surface of the battery body 9 to receive the battery body 9 within the upper rotating body 6, the cover member is in substantially the same plane as the cover, for example, the side cover 21.

The operation of the construction machine according to the first embodiment will be described below. In the present embodiment, the hydraulic actuator is driven by making use of power of the electric motor 17 driven by electric power from the battery body 9 mounted on the upper rotating body 6. The electric motor 17 is arranged in the vicinity of the battery body 9. With this, a power loss caused by an electric-wire resistance can be suppressed, and the battery having a capacity as small as possible can be mounted to transmit energy of the battery body 9 efficiently and for a long period of time. Further, the working oil tank 20 is arranged in the vicinity of the hydraulic pump 18, accordingly, it is possible that hydraulic pipes (not shown) for connecting the hydraulic pump 18 and the working oil tank 20, and the hydraulic

pump 18 and the directional control valve 19 for an actuator be shortened to reduce an energy loss caused by a piping resistance and to save an energy of the battery body 9.

Further, in the present embodiment, the upper cover 10 for opening above the battery body 9 over the substantially whole area, the rear cover 12 for opening the rear of the battery body 9 over the substantially whole area and the side cover 21 for opening the side of the electric motor 17 are provided, and the battery body 9 is slidably supported horizontally backward and forward. With this, the maintenance such as the charging of the plurality of batteries 14 (shown in FIG. 2), the replenishment of battery liquids, etc. can be performed easily. Further, when the maintenance such as the replacement of the battery 14 is necessary, the battery 14 can be easily lifted by a crane or the like (not shown). When the battery 14 (the zinc type battery) is charged, a hydrogen gas is generated at overcharge, but ventilation above the battery 14 (the battery body 9) can be improved by opening the top cover 10, the rear cover 12, and the side cover 21. Further, when a DC motor is used as the electric motor 17, the side cover 21 is opened whereby maintenance such as replacement of a brush (not shown) can be accomplished

Second Embodiment (FIGS. 7 to 13)

FIG. 7 is a side view of a battery-driven construction machine (a base machine of the present construction machine is a hydraulic excavator) showing a second embodiment of the present invention. In FIG. 7, numeral 5 designates a lower travel body of the construction machine; numeral 6 designates an upper rotating body connected to the upper part of the lower travel body 5; numeral 9 designates battery body arranged at the rear of the upper rotating body 6 (battenes 9 are composed of a plurality of battery individuals, so-called cells); and numeral 8 designates a working attachment mounted on the front portion of the upper rotating body 6.

FIG. 8 is a plan view of cut-opened main parts of an upper rotating body 6 of FIG. 7. In FIG. 8, numeral 14 designates a plurality of battery individuals constituting the battery 9; numeral 17 designates a motor (an electric motor) arranged sideways of the upper rotating body 6; numeral 18 designates a hydraulic pump for discharging a main pressure; numeral 20 designates a working oil tank; and numerals 45a, 45b, 45c and 45d designate seat plate fittings fixedly mounted on the working oil tank 20 for fastening (bolt fastening) the working oil tank 20 to a rotating frame (not shown) of the upper rotating body 2.

FIG. 9 is an enlarged view of part A in FIG. 8, and is a plan view showing a state that a suction pipe 46 is provided In FIG. 9, numeral 47 designates a connecting frame on which the electric motor 17 and the hydraulic pump 18 are fixedly mounted; numeral 49 designates a coupling for concentrically connecting main shafts (not indicated by numerals) of the electric motor 17 and the hydraulic pump 18, respectively, and numerals 51a, 51b and 51c designate buffer mount portions by which the connecting frame 47 is mounted on the upper surface portion of the working oil tank 20.

FIG. 10 is a side view of main parts as viewed from B-B of FIG. 8. In FIG. 10, numeral 52 designates a suction port on the suction side of working oil provided on the lower surface portion of the hydraulic pump 18; numeral 53 designates a port for supplying working oil of the working oil tank 20; and numeral 54 designates a bend portion of the suction pipe 46.

FIG. 11 is a view as viewed from C-C of FIG. 8, but is a view showing a section of the buffer mount portion 51c in FIG. 8. In FIG. 11, numeral 55 designates a internal-threaded boss seat deposited on the upper surface portion of the working oil tank 20; numeral 56 designates a supporting bracket of the connecting frame 47; and numerals 57U, 57L designate rubber buffers which are buffer members.

The constitution of the construction machine according to the second embodiment will be described hereafter with reference to FIGS. 7 to 11. In the present embodiment, above the working oil tank 20, there are arranged the electric motor 17 and the hydraulic pump 18 connected to and driven by the electric motor 17. The electric motor 17 is mounted on the working oil tank 20 through the rubber buffers 57U, 57L (shown in FIG. 11) which are buffer members. The electric motor 17, the hydraulic pump 18, the suction port 52 below (directed downward) the hydraulic pump 18 having the connecting frame 47 for integrally connecting the working oil tank 20, and the port for supplying working oil 53 of the working oil tank 20 are connected by the suction pipe 46. A position height of the bend portion 54 for an oil reservoir formed in the midst of the suction pipe 46 is set higher by a dimension h (shown in FIG. 10) than a position height of the suction port 52.

The operation of the construction machine according to the second embodiment will be described hereinafter. In the present embodiment, since the electric motor 17 for driving the hydraulic pump 18 is mounted above the working oil tank 20, the electric motor 17 and the working oil tank 20 are arranged close to each other. Thereby, the space saving of the interior of the vehicle body of the construction machine can be realized, thus enabling improvement of the layout of various apparatuses inside the vehicle body and enabling accomplishment of maintenance easily when a brush is replaced with respect to the electric motor 17 on the upper side of the working oil tank 20. Further, since the suction pipe 46 for connecting the working oil tank 20 and the hydraulic pump 18 can be suppressed as short as possible, the energy saving can be realized when the hydraulic pump 18 is driven. Further, the bend portion 54 for an oil reservoir is formed in the midst of the suction pipe 46 for connecting the lower (directed downward) suction port 52 of the hydraulic pump 18 and the port 53 for sup-

plying working oil of the working oil tank 20. Since the bend portion 54 is set higher than the position height of the suction port 52, even in the case where the hydraulic pump 18 is in a stopped state, it is possible to prevent working oil in the suction pipe 46 from slipping-off into the working oil tank 20. Accordingly, by forming the simple shaped suction pipe 46, it is possible to always hold working oil to be supplied to the suction port 52 within the suction pipe 46. For materials for the suction pipe 46, a hydraulic hose, a hydraulic tube, etc. can be used.

Further, there is provided the connecting frame 47 for integrally connecting the electric motor 17 and the hydraulic pump 18, and the working oil tank 20, the driving system of the electric motor 17 mounted on the working oil tank 20 and the hydraulic pump 18 can be formed into a sub-assembly, thus enabling enhancement of an assembly property of the construction machine.

Further, since the mounting frame 47 and the working oil tank 20 are mounted through the rubber buffers 57U, 57L which are buffer members, shocks during the operation of the construction machine can be made hard to be propagated to the driving system of the electric motor 17 and the hydraulic pump 18. While in the present embodiment, the rubber buffers are used for the buffer members, not only the rubber buffers but also a spring buffer, a high-viscosity liquid sealed element can be also used.

FIG. 12 is a side view of main parts showing a modified embodiment of an upper rotating body 6' provided with a hydraulic pump 18' and a suction piping 46'. In FIG. 12, those using the same constituent elements as the embodiment shown in FIG. 10 are indicated by the same numerals. In the embodiment shown in FIG. 12, a suction port 52' of the hydraulic pump 18' is directed upward. Thereby, a bend portion 54' for an oil reservoir is formed in the midst of a suction pipe 46' for connecting the upward suction port 52' and the port 53 for supplying working oil of the working oil tank 20. Since the bend portion 54' is set higher by a dimension h' than the position height of the suction port 52', even if the hydraulic pump 18' is in a stopped state, it is possible to prevent working oil within the suction pipe 46' from slipping-off into the working oil tank 20. By the upward provision of the suction port 52' of the hydraulic pump 18' as described above, the curve of the suction pipe 46' can be lessened as compared with the suction pipe 46 shown in FIG. 10.

The arrangement of the electric motor, the hydraulic pump and the working oil tank may be made as shown in FIG. 13. In FIG. 13, numeral 28 designates an electric motor driven by a battery mounted on the construction machine (the same as the battery 7 shown in FIG. 8 though not shown); numeral 29 designates a hydraulic pump for discharging a main pressure; numeral 30 designates a working oil tank; and numeral 31 designates a mounting bracket secured to the side of the working oil tank 30 to fixedly mount the electric motor 28 and the hydraulic pump 29. In the embodiment shown in FIG. 13, the electric motor 28 is mounted sideways of the working oil tank 30 through the mounting bracket 31. Thereby, since the electric motor 28 and the working oil tank 30 can be arranged close to each other, the space saving of the interior of the vehicle body of the construction machine (not shown) can be realized. Further, since the length of the suction pipe 32 for connecting the working oil tank 30 and the hydraulic pump 29 can be made as short as possible, the loss of energy saving during the driving of the hydraulic pump 29 can be realized. Further, since the mounting bracket 31 for mounting the driving system such as the electric motor 28, the hydraulic pump, etc. is integrally secured to the working oil tank 30 (for example, by welding), the driving system to be mounted on the working oil tank can be formed into a sub-assembly to improve an assembly property of the construction machine.

## Claims

1. A battery-driven construction machine, comprising:

   a battery body arranged at the rear of an upper rotating body, said battery body comprising a plurality of batteries;
   an electric motor arranged forwardly of and in the vicinity of said battery body;
   a hydraulic pump connected to said electric motor;
   a working oil tank arranged in the vicinity of said hydraulic pump; and
   a directional control valve for an actuator arranged in the vicinity of said hydraulic pump.

2. The battery-driven construction machine according to claim 1, wherein said electric motor and said hydraulic pump are arranged above said working oil tank.

3. The battery-driven construction machine according to claim 1 or 2, wherein said upper rotating body has a top cover for opening the upper portion of said battery body, said top cover capable of totally opening the upper portion of at least a battery liquid replenishing port of said battery;

4. The battery-driven construction machine according to claim I or 2, wherein said upper rotating body has a rear cover for opening the rear portion of said battery body.

5. The battery-driven construction machine according to claim 4, wherein said battery body is arranged movably in a horizontal direction.

6. The battery-driven construction machine according to claim 1 or 2, wherein said upper rotating body

has a side cover for opening the side of said upper rotating body, at least the side of said electric motor being opened by said side cover.

**7.** The battery-driven construction machine according to claim 1 or 2, wherein said electric motor is mounted on said working oil tank through buffer members.

**8.** The battery-driven construction machine according to claim 1 or 2, further comprising:

a connecting frame for integrally connecting at least said electric motor, said hydraulic pump, and said working oil tank.

**9.** The battery-driven construction machine according to claim 1 or 2, further comprising:

a suction pipe for connecting a suction port of said hydraulic pump and said working oil tank; and

a bend portion for an oil reservoir formed in the midst of said suction pipe, said bend portion being formed at a position higher than said suction port.

FIG. 1

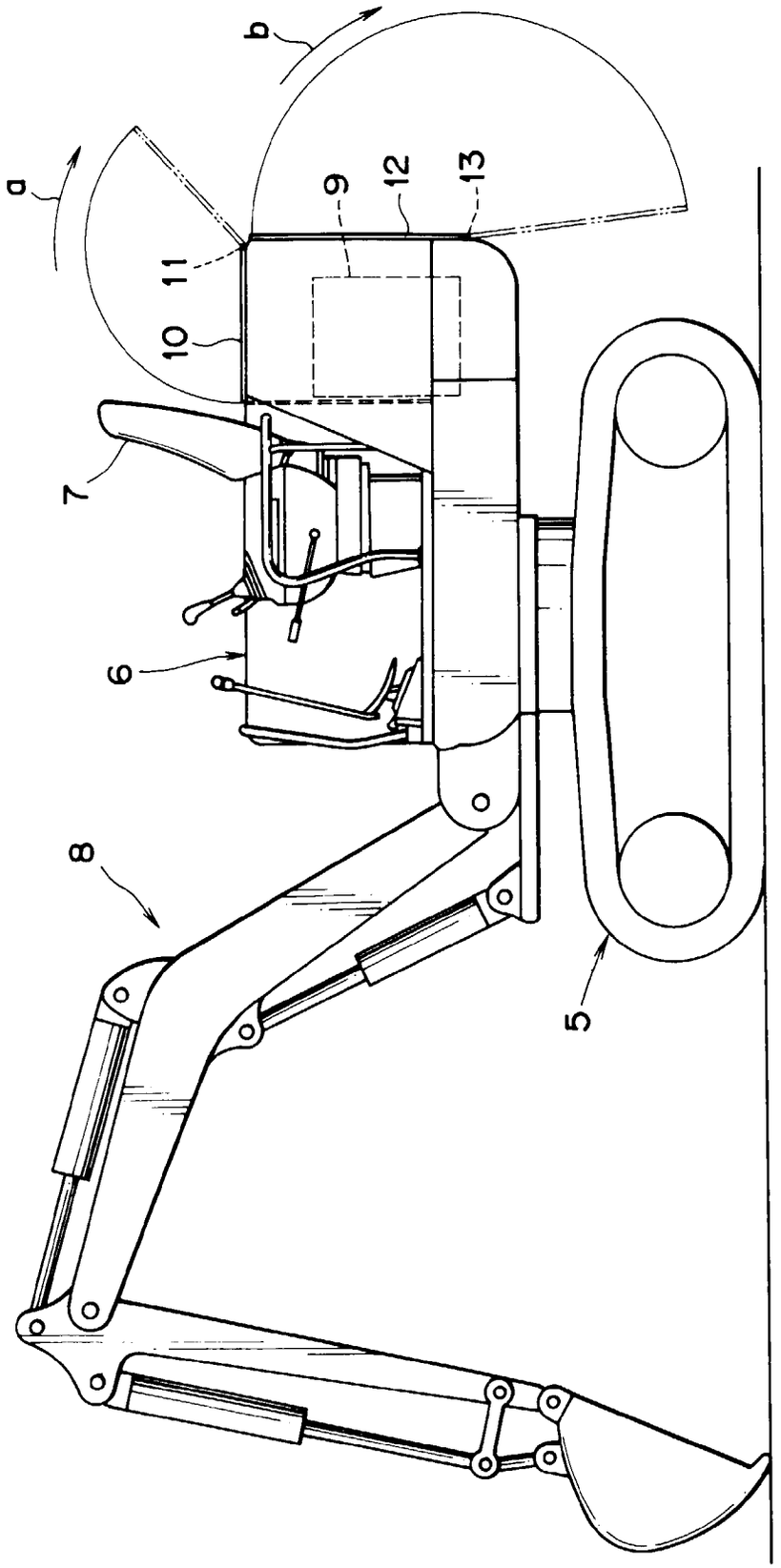

FIG. 2

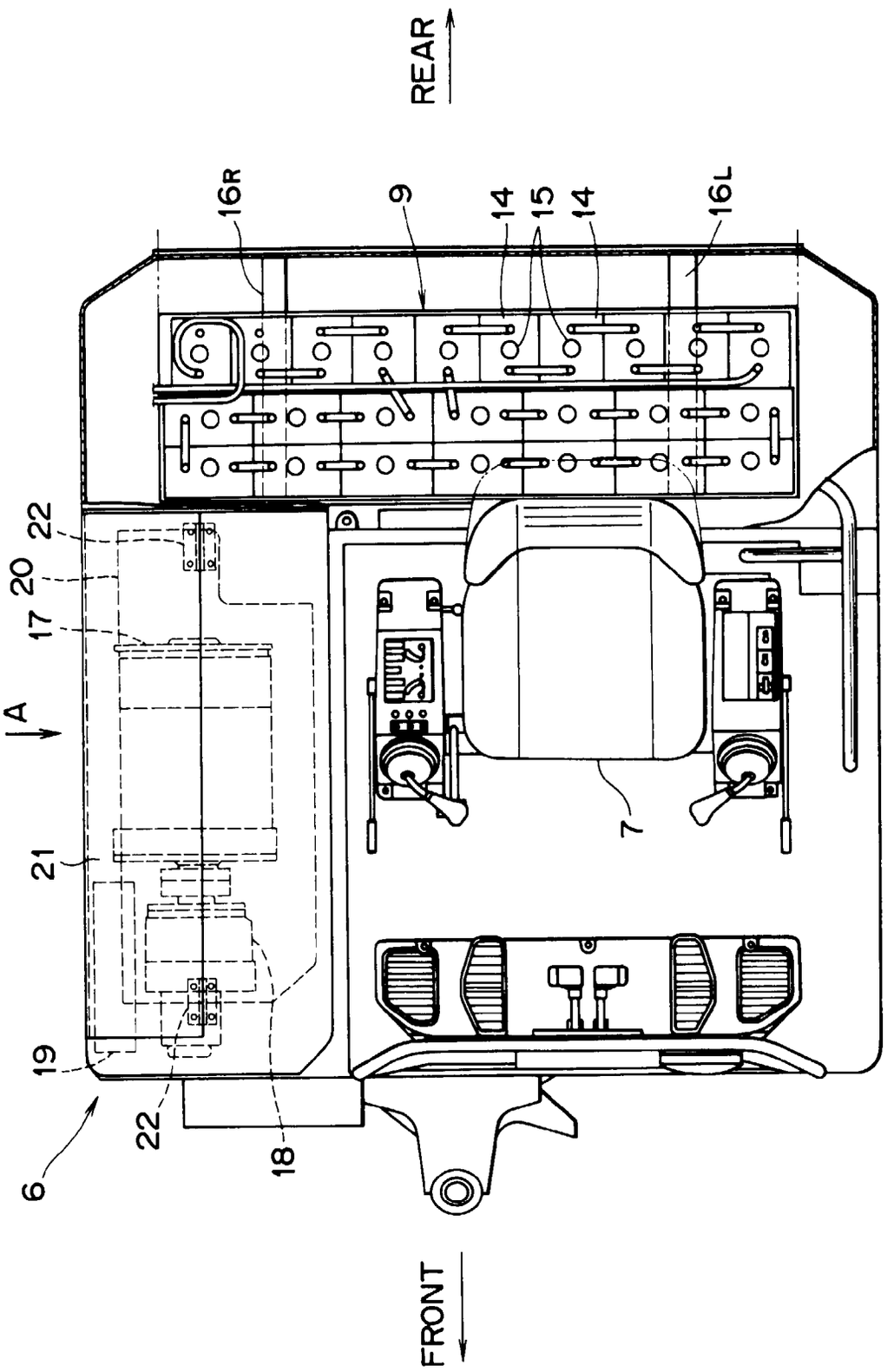

FIG. 3

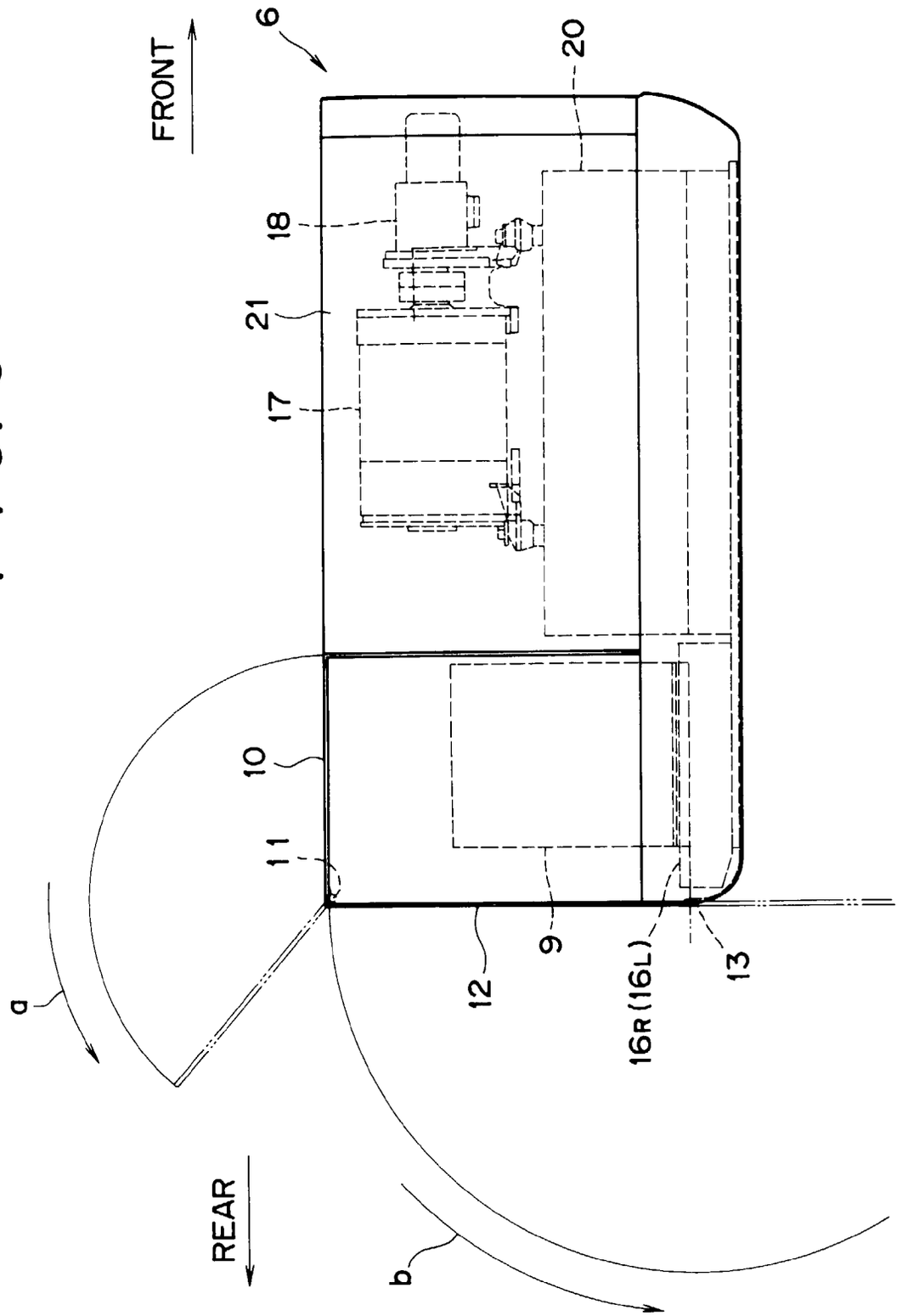

FIG. 4

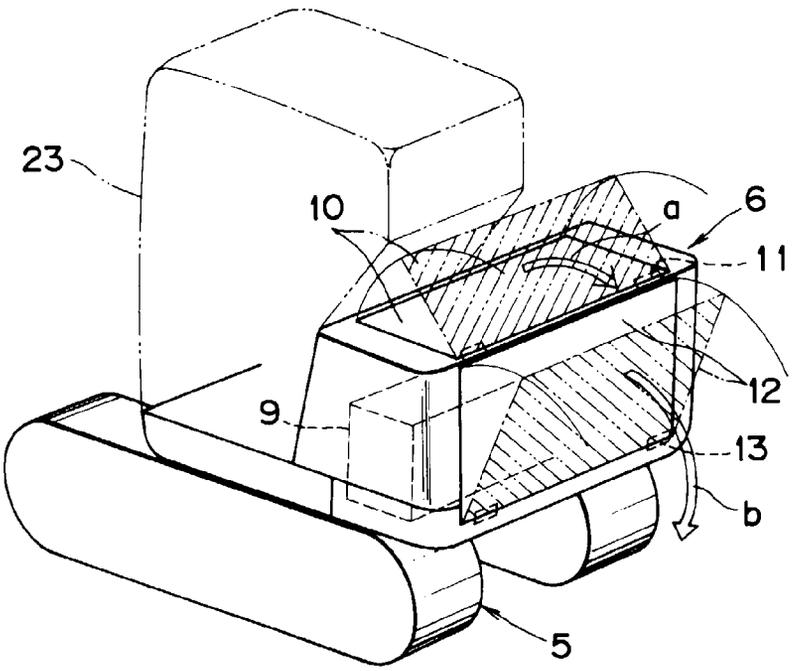


FIG. 5

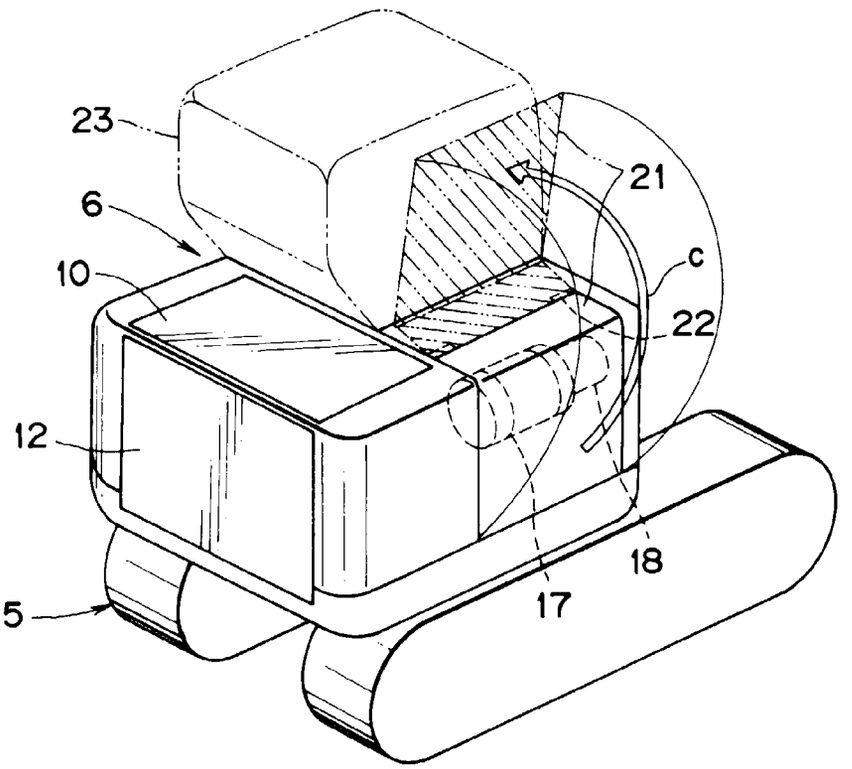

FIG. 6

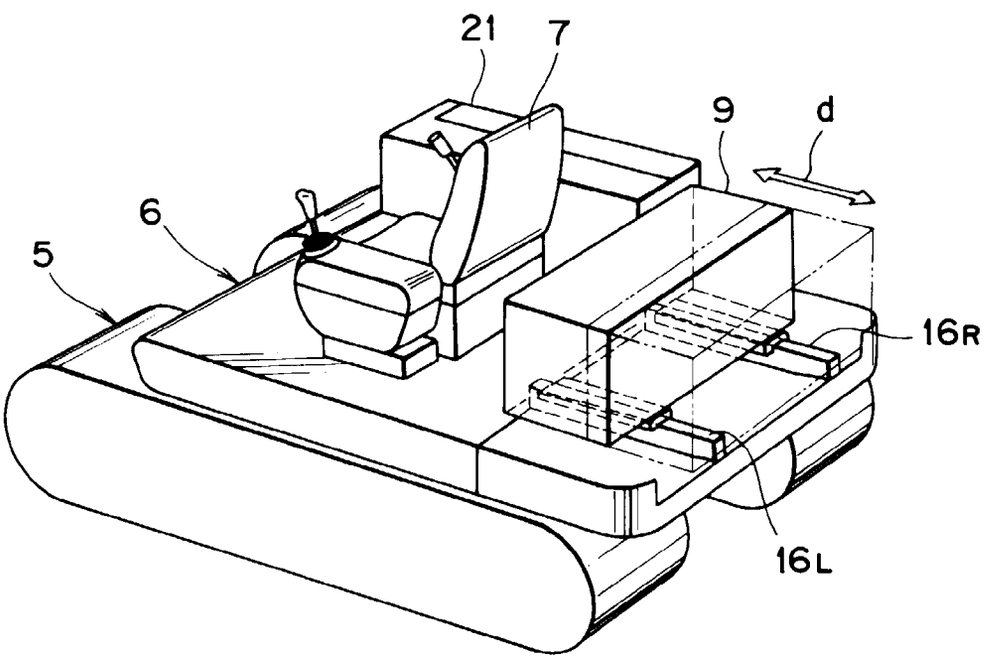

FIG. 7

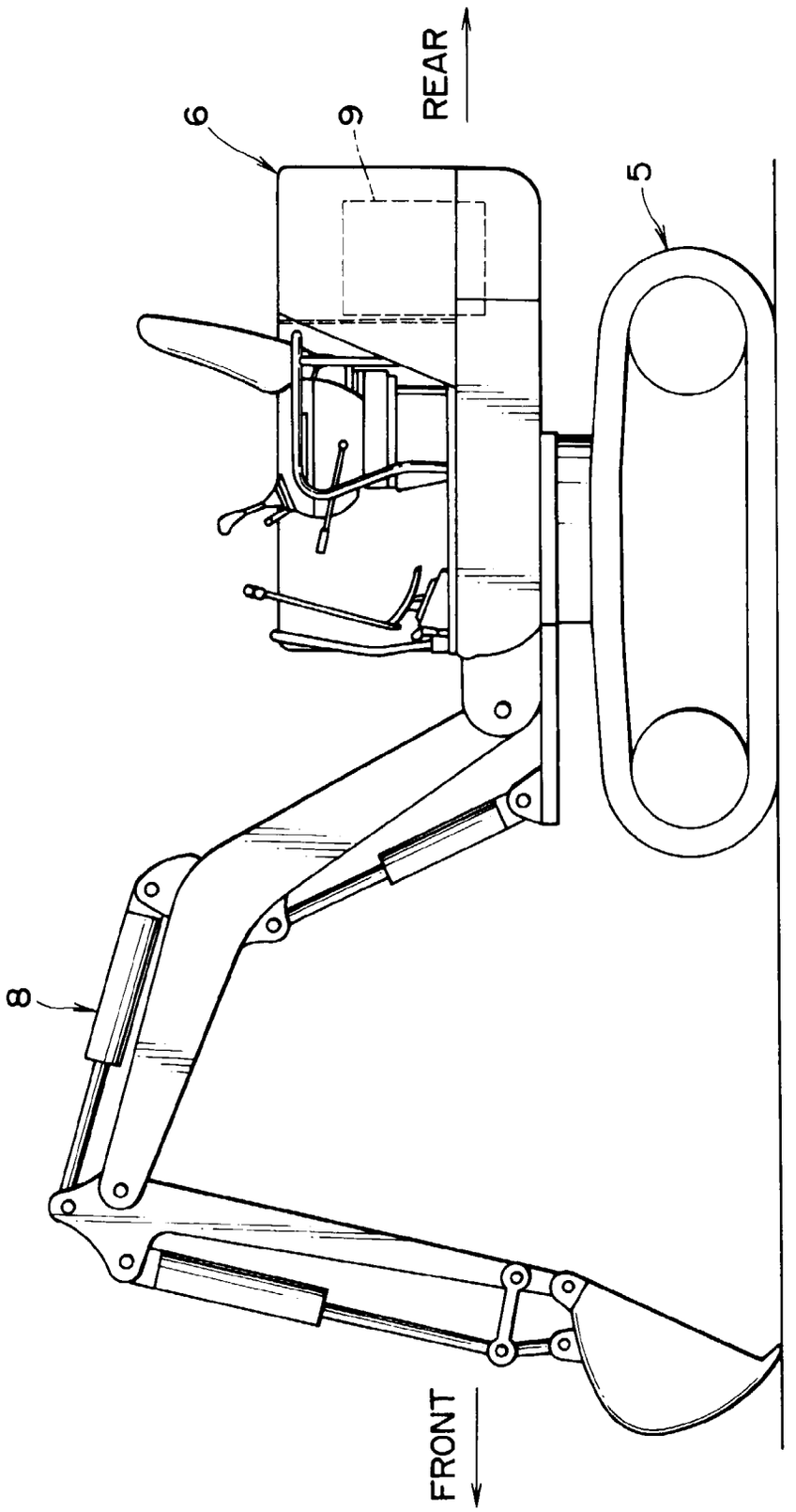

FIG. 8

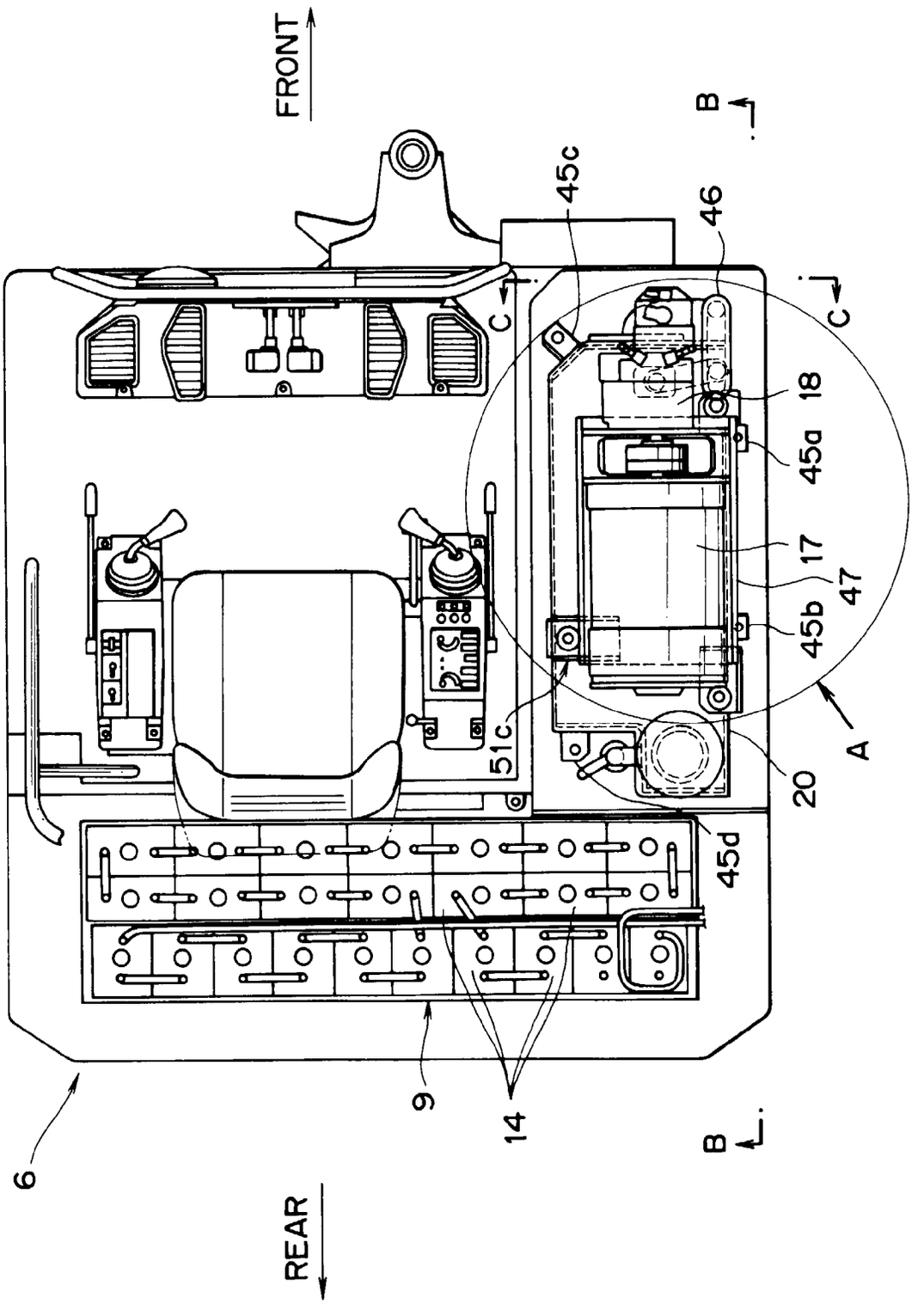

FIG. 9

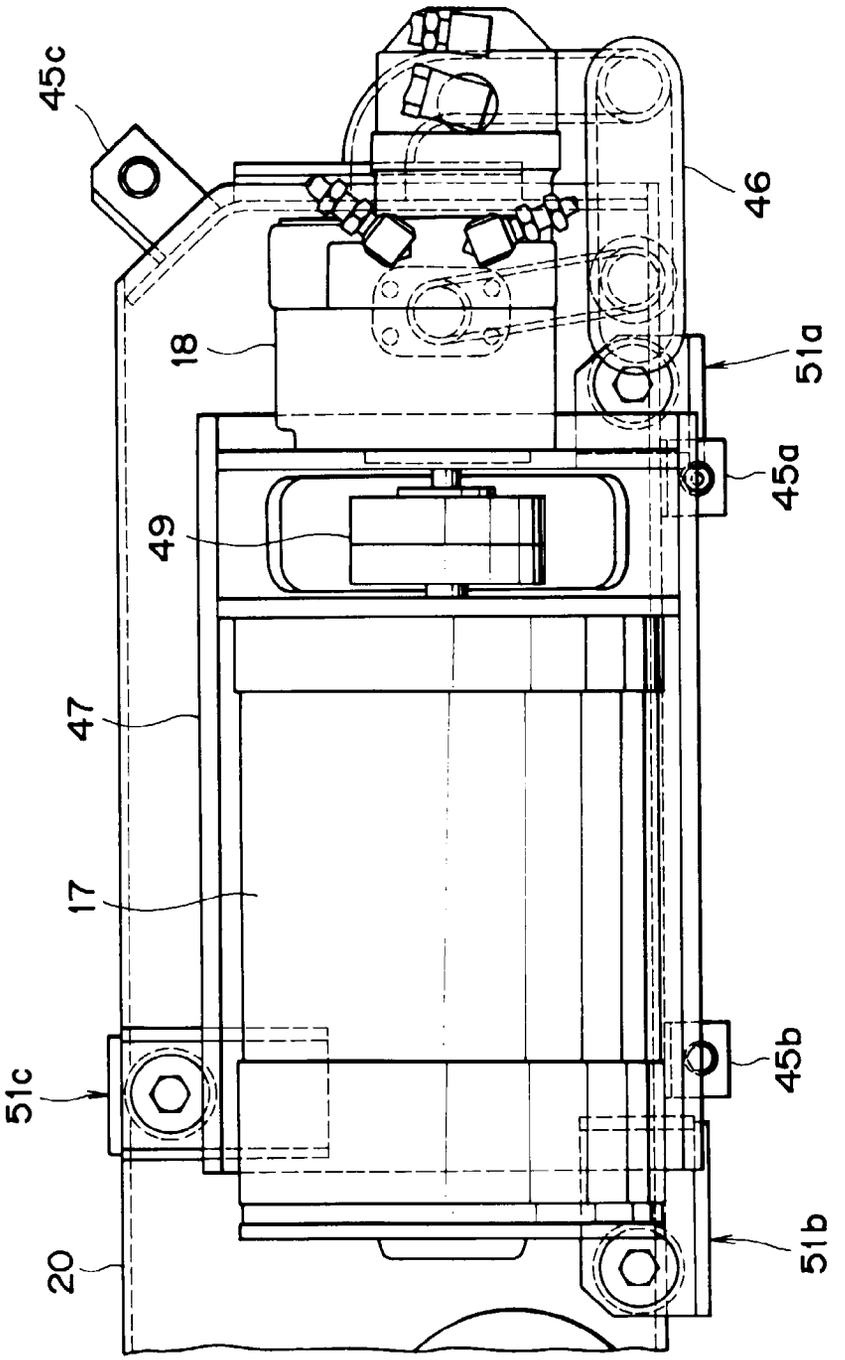

FIG. 10

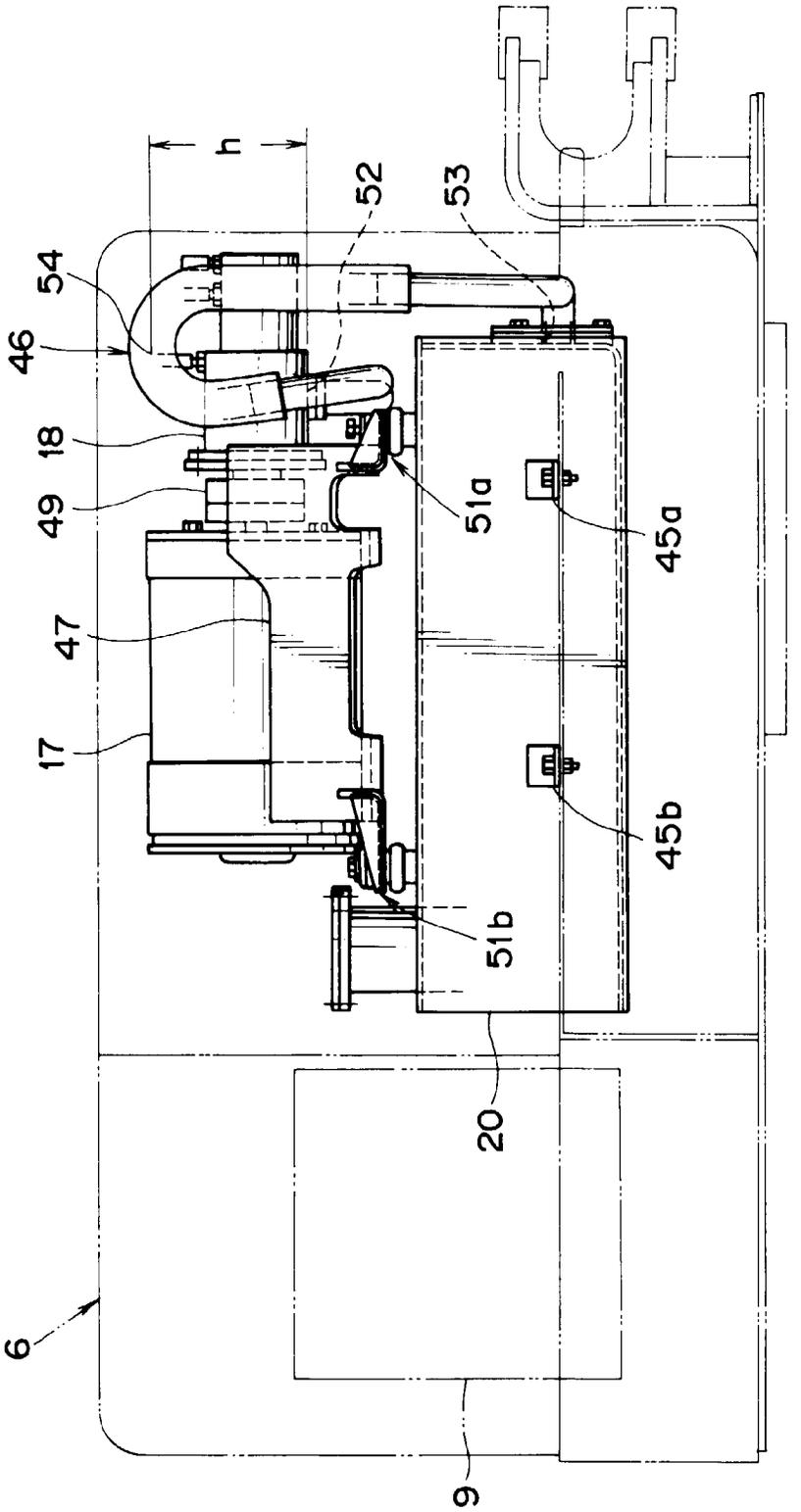

FIG. 11

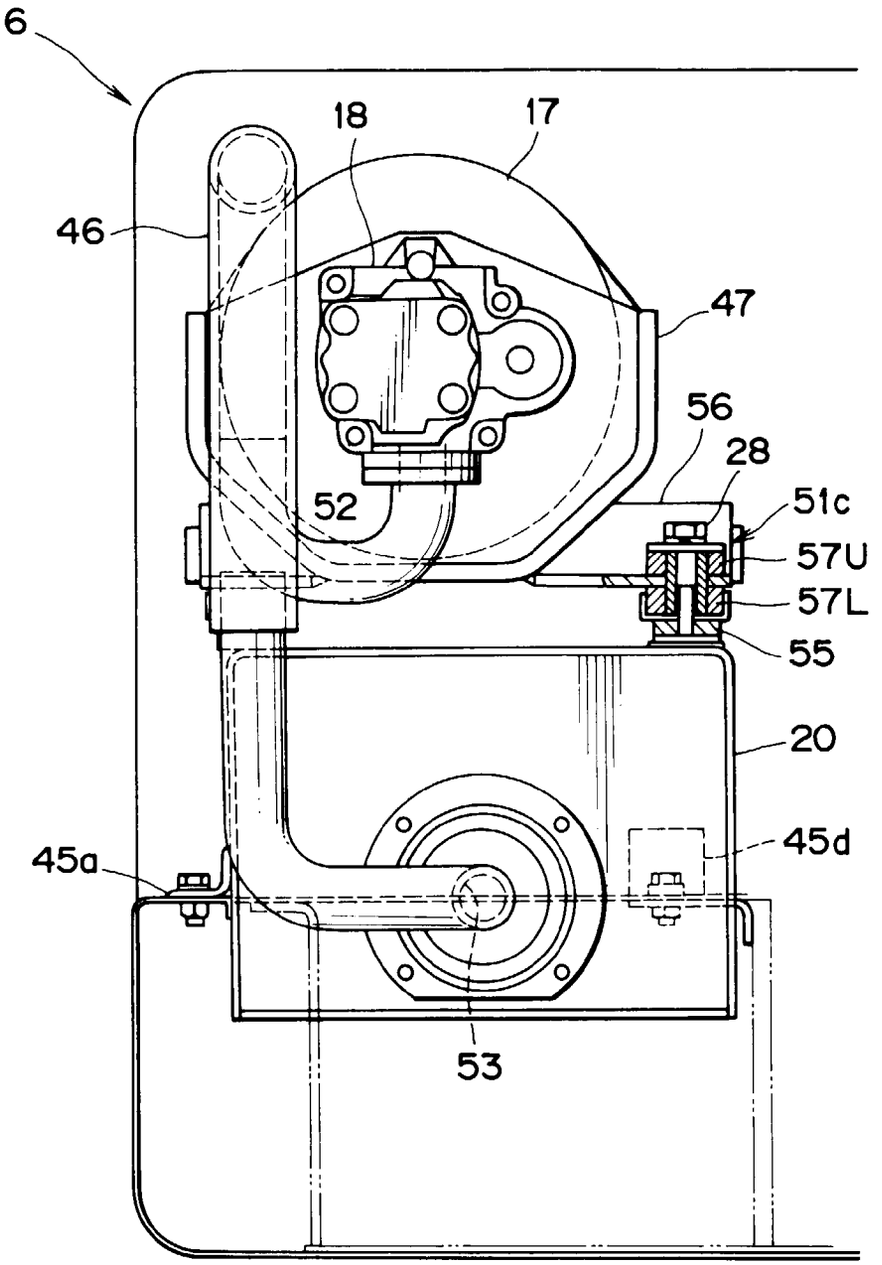

FIG. 12

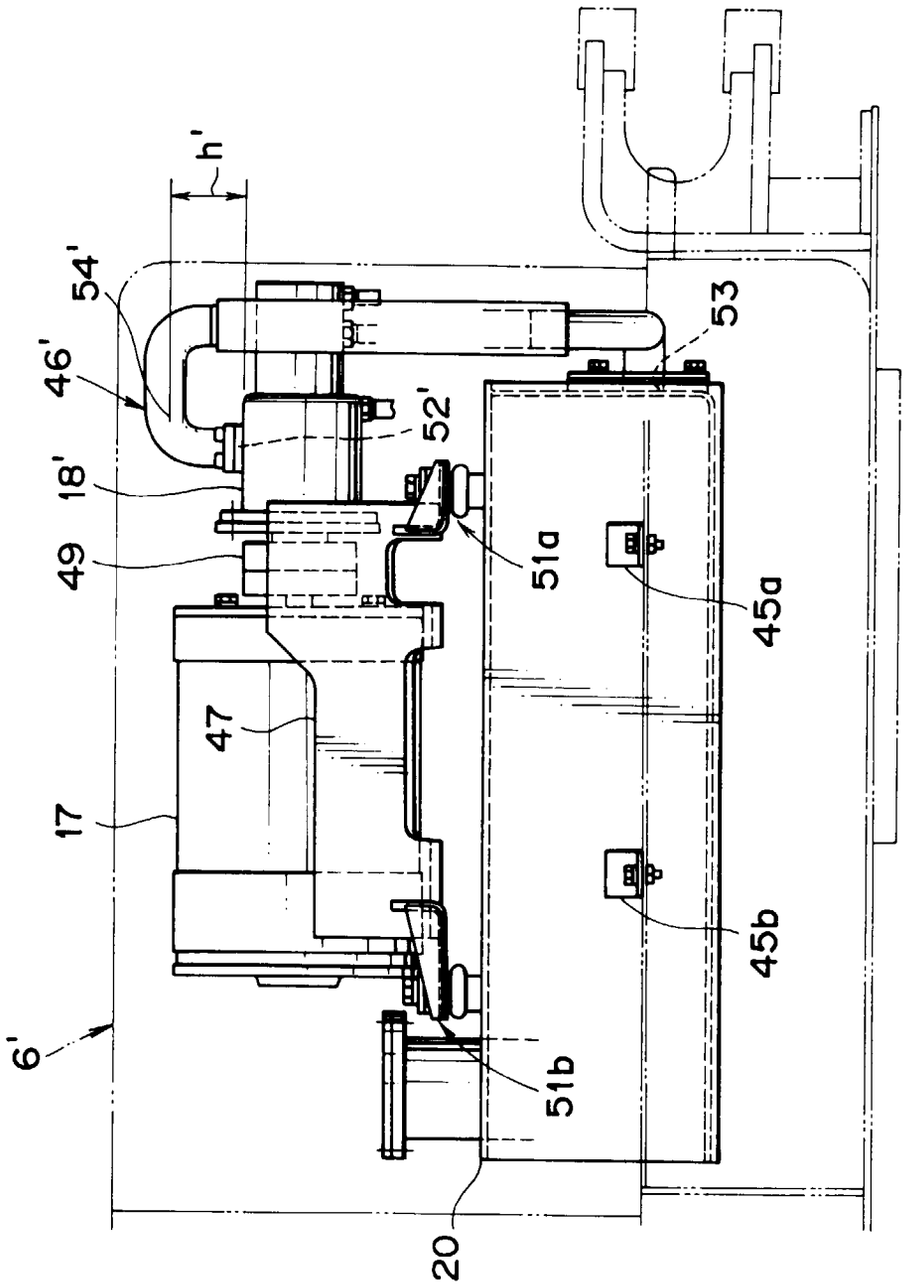

FIG. 13