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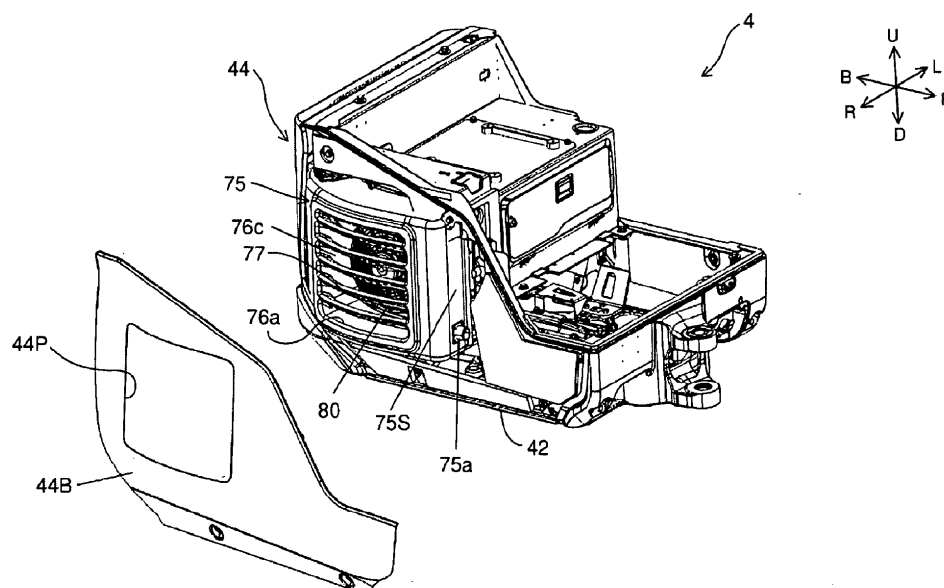
(54) **WORK MACHINE**

(57) [Problem] Provide a work machine that can cool a refrigerant and an oil by placing an oil tank and a heat exchange unit in the minimum necessary space inside a machine body.

[Solution] A hydraulic excavator as a work machine includes a hydraulic pump driven by an engine, an oil tank that stores an oil pumped by the hydraulic pump, a heat exchange unit that cools a refrigerant, which passes

through the engine, and the oil, and a fan that sends air to the heat exchange unit. The oil tank has a hollow portion with open portions at both ends. One of the open portions of the hollow portion is exposed from a side wall of the machine body on which the oil tank is mounted. The fan is placed between the one of the open portions of the hollow portion and the heat exchange unit.

FIG. 2



**Description**

## TECHNICAL FIELD

**[0001]** The present disclosure relates to a work machine.

## BACKGROUND ART

**[0002]** A fluid cooling device that cools an oil (hydraulic oil) in an oil tank by means of a heat exchange unit is disclosed in, for example, Patent Document 1.

## PRIOR ART DOCUMENT

## PATENT DOCUMENT

**[0003]** Patent Document 1: US Patent Application Publication No. 2013/0081387

## SUMMARY OF INVENTION

## TECHNICAL PROBLEM

**[0004]** In a small work machine (e.g., mini excavator), an installation space for an oil tank and a heat exchange unit is limited inside a machine body. When the work machine is provided with an engine, a heat exchange unit that cools a refrigerant (e.g., cooling water) that passes through the engine needs to be installed separately from the heat exchange unit that cools the oil. Therefore, in the small work machine, the oil tank and the heat exchange unit (hereinafter also referred to as oil tank, etc.) needs to be placed in the minimum necessary space inside the machine body that cools the refrigerant and oil.

**[0005]** In this regard, the Patent Document 1 does not at all consider how the fluid cooling device should be installed on the work machine, nor does it consider cooling of the refrigerant that passes through the engine.

**[0006]** The present invention has been made to solve the above problems, an object of which is to provide a work machine that can cool a refrigerant and an oil by placing an oil tank, etc. in the minimum necessary space inside the machine body.

## SOLUTION TO PROBLEM

**[0007]** A work machine according to one aspect of the present invention includes: a hydraulic pump driven by an engine; and an oil tank that stores an oil pumped by the hydraulic pump, wherein the work machine includes a heat exchange unit that cools a refrigerant, which passes through the engine, and the oil, and a fan that sends air to the heat exchange unit, the oil tank has a hollow portion having open portions at both ends, one of the open portions of the hollow portion is exposed from a side wall of the machine body on which the oil tank is mounted, and the fan is placed between the one of the

open portions of the hollow portion and the heat exchange unit.

## ADVANTAGEOUS EFFECTS OF INVENTION

**[0008]** The above configuration can cool a refrigerant and an oil by placing an oil tank and a heat exchange unit in the minimum necessary space inside a machine body.

## BRIEF DESCRIPTION OF DRAWINGS

**[0009]**

Fig. 1 is a side view showing a schematic configuration of a hydraulic excavator which is an example of an electric work machine according to an embodiment of the present invention.

Fig. 2 is a diagram showing a partially disassembled state of an upper swing body provided for the above hydraulic excavator.

Fig. 3 is a diagram schematically showing a configuration of a hydraulic system of the above hydraulic excavator.

Fig. 4 is a perspective view of the above oil tank provided for the above hydraulic excavator, viewed from the right obliquely upward.

Fig. 5 is a perspective view of the above oil tank, viewed from the left diagonally forward.

Fig. 6 is a vertical cross sectional view of the above oil tank.

Fig. 7 is a horizontal cross sectional view of the above oil tank.

## DESCRIPTION OF EMBODIMENTS

**[0010]** The following is a description of an embodiment of the present invention based on the drawings.

## [1. Work Machine]

**[0011]** Fig. 1 is a side view showing a schematic configuration of a hydraulic excavator 1 which is an example of a work machine according to the present embodiment.

The hydraulic excavator 1 includes a down travel body 2, a work instrument 3, and an upper swing body 4.

**[0012]** Here, directions are defined as follows: The direction in which a human operator (manipulator, driver) seated on a driver seat 41a of the upper swing body 4 faces the front is forward, and the opposite direction is backward. Therefore, when the upper swing body 4 is in a non-swing state (swing angle 0°) relative to the down travel body 2, a front/back direction of the upper swing body 4 is the same as the direction in which the down travel body 2 moves forward and backward. Also, the left side is referred to as "left" and the right side is referred to as "right" as viewed from the operator seated on the driver seat 41a. Also, the gravity direction perpendicular

to the front/back direction and right/left direction is defined as the up/down direction, with the upstream side of the gravity direction being "up" and the downstream side of the gravity direction being "down." In the drawings, the hydraulic excavator 1 is shown with the upper swing body 4 in a state of non-swing relative to the down travel body 2. Also, in the drawings, when necessary, forward is denoted by a symbol "F", likewise, backward by "B", rightward by "R", leftward by "L", upward by "U", and downward by "D".

**[0013]** The down travel body 2 is provided with a pair of crawlers 21 on right and left and a pair of travel motors 22 on right and left. Each of the travel motors 22 is a hydraulic motor. The right and left travel motors 22 drive the right and left crawlers 21, respectively, thereby making it possible to move the hydraulic excavator 1 forward and backward. The down travel body 2 is provided with a blade 23 for doing ground leveling work, and a blade cylinder 23a. The blade cylinder 23a is a hydraulic cylinder that rotates the blade 23 in the up/down direction.

**[0014]** The work instrument 3 has a boom 31, an arm 32, and a bucket 33. The boom 31, the arm 32, and the bucket 33 are independently driven, thereby making it possible to do excavating work of earth, sand, etc.

**[0015]** The boom 31, the arm 32, and the bucket 33 are rotated by an unshown boom cylinder, an unshown arm cylinder, and an unshown bucket cylinder, respectively. The boom cylinder, the arm cylinder, and the bucket cylinder are each constituted of a hydraulic cylinder.

**[0016]** A base end portion of the boom 31, i.e., the boom 31's end portion opposite the side connected with the arm 32 is swingably connected via a bracket 34 to a head end portion 42a of a swing frame 42. That is, the hydraulic excavator 1 of the present embodiment has a boom swing function with which the boom 31 swings to the right and left starting from the head end portion 42a.

**[0017]** The upper swing body 4 is placed above the down travel body 2. The upper swing body 4 constitutes a machine body on which an oil tank 75 (see Fig. 3, Fig. 4, etc.) described below is mounted. In the upper swing body 4, a steering portion 41, a swing frame 42, a swing motor 43, an engine room 44, etc. are placed. Being driven by the swing motor 43 which is a hydraulic motor, the upper swing body 4 can swing relative to the down travel body 2 via a swing bearing (not shown).

**[0018]** The driver seat 41a is placed in the steering portion 41. Various levers 41b are placed around the driver seat 41a. The operator being seated on the driver seat 41a and operating the lever 41b drives an actuator 73 (see Fig. 3) to be described below. This allows the down travel body 2 to travel, the blade 23 to do the ground leveling work, the work instrument 3 to do the excavation work, and the upper swing body 4 to swing, etc.

**[0019]** The swing frame 42 is included in the bottom portion of the engine room 44. An engine E is placed inside the engine room 44. The engine E drives a hydraulic pump 71 (see Fig. 3) to be described below.

**[0020]** The engine room 44 is covered from the side

by a hood 44B. Thus, the hood 44B constitutes the side wall of the upper swing body 4 which is the machine body. The hood 44B, which covers the engine room 44 from one side in the right/left direction (right side here as an example) is formed with a rectangular vent 44P.

**[0021]** Fig. 2 is a perspective view showing a partially disassembled state of the upper swing body 4. As shown in Figs. 1 and 2, a part (e.g., first open portion 76a) of the oil tank 75 is exposed from the vent 44P of the hood 44B. Details of the oil tank 75 is to be described below.

**[0022]** The upper swing body 4 is further provided with a lead battery (not shown). The lead battery outputs a low-voltage (e.g., 12 V) direct-current voltage. The output from the lead battery is supplied, as control voltage, to, for example, a system controller, a drive portion of a fan 80 (to be described below), etc. The above system controller is constituted of an electronic control unit, which is also called an ECU, and electrically controls each portion of the hydraulic excavator 1.

**[0023]** The hydraulic excavator 1 may be so configured as to be a combination of a hydraulic instrument such as the actuator 73 and an actuator driven by electric power. Actuators driven by electric power include, for example, an electric travel motor, an electric cylinder, and an electric swing motor.

## [2. Configuration of Hydraulic System]

**[0024]** Fig. 3 is a diagram schematically showing a configuration of a hydraulic system of the hydraulic excavator 1. For convenience, Fig. 3 also shows a flow path of a refrigerant that cools the engine E. The hydraulic excavator 1 is provided with the hydraulic pump 71, a control valve 72, the actuator 73, a heat exchange unit 74, and the oil tank 75.

**[0025]** Being driven by the engine E, the hydraulic pump 71 supplies the oil (hydraulic oil, pressure oil) to the hydraulic motor (e.g., right and left travel motors 22, and swing motor 43 shown in Fig. 1), and the hydraulic cylinder (e.g., blade cylinder 23a, boom cylinder, arm cylinder, bucket cylinder) thereby to drive the above hydraulic motor and hydraulic cylinder. Here, the above hydraulic motors and hydraulic cylinders are collectively referred to here as the actuator 73. That is, the actuator 73 is an example of a hydraulic actuator driven by the oil supplied from the hydraulic pump 71.

**[0026]** Plural hydraulic pumps 71 are provided, for example. The plural hydraulic pumps 71 include a variable displacement and a fixed displacement pump. Fig. 3 shows only one hydraulic pump 71 as an example. Each hydraulic pump 71 is connected to the oil tank 75. When the hydraulic pump 71 is driven by the engine E, the oil in the oil tank 75 is supplied to the actuator 73 via the hydraulic pump 71 and the control valve 72. This drives the actuator 73. The control valve 72 is a direction-switching valve that controls the flow direction and flowrate of the oil supplied from the hydraulic pump 71 to the actuator 73.

**[0027]** The heat exchange unit 74 cools the refrigerant, which passes through engine E, and the above oil. The heat exchange unit 74 as above is composed of an integration (unitization) of a radiator 74a and an oil cooler 74b. The radiator 74a cools the above refrigerant by heat exchange. The refrigerant is, for example, cooling water. The oil cooler 74b cools the above oil by heat exchange. With respect to the oil tank 75, the heat exchange unit 74 is placed on the opposite side of the hood 44B (vent 44P) illustrated in Fig. 2, alongside the oil tank 75.

**[0028]** In the heat exchange unit 74, the positional relation between the radiator 74a and the oil cooler 74b is not particularly limited. For example, viewed from the direction of a rotation axis CA (see Fig. 4) of the fan 80 to be described below, it may be so placed that at least a part of the radiator 74a overlaps with the oil cooler 74b. Also, for example, the radiator 74a and the oil cooler 74b may be so placed as to be arranged in a direction (forward/backward, up/down, right/left, etc.) that intersects the above axial direction.

**[0029]** The oil tank 75 stores oil pumped by the hydraulic pump 71. The oil tank 75 is connected via a first delivery pipe 91 with the hydraulic pump 71, and is connected via a second delivery pipe 92 with the control valve 72. The above oil cooler 74b is placed in the middle of the second delivery pipe 92. Also, the oil tank 75 is directly connected via a third delivery pipe 93 with the control valve 72.

**[0030]** In this configuration, when the actuator 73 is driven, for example, the oil is sucked from the oil tank 75 by the hydraulic pump 71 and is supplied via the control valve 72 to the actuator 73. Then, the return oil from the actuator 73 enters the oil tank 75 from the control valve 72 via the second delivery pipe 92 that passes through the oil cooler 74b. Meanwhile, when the actuator 73 is stopped, for example, the oil discharged from the control valve 72 enters the oil tank 75 via the third delivery pipe 93. It is deemed that the above oil discharged from the control valve 72 includes oil passing through a center bypass of an open center circuit, for example.

### [3. Configuration of Cooling Oil in Two Steps]

**[0031]** Fig. 4 is a perspective view of the oil tank 75, viewed from the right obliquely upward.

**[0032]** Fig. 5 is a perspective view of the oil tank 75, viewed from the left diagonally forward.

**[0033]** Fig. 6 is a vertical cross sectional view of the oil tank 75. For convenience, the above heat exchange unit 74 and fan 80 are omitted from Fig. 5.

**[0034]** The hydraulic excavator 1 (see Fig. 1) of the present embodiment is further provided with the fan 80. Being driven by an electric motor (not shown), the fan 80 rotates, thereby to send air to the heat exchange unit 74. Here, rotating the fan 80 sucks air from outside the machine body (upper swing body 4) via the vent 44P of the hood 44B (see Figs. 1 and 2) into the engine room 44, and sends (applies) the above air to the heat exchange

unit 74. The above type of driving the fan 80 is also referred to as a "suck type". The air, which was sucked in by the fan 80 and flowed toward the heat exchange unit 74, moves across the heat exchange unit 74. That is, the above air flows through a gap of the radiator 74a and a gap of the oil cooler 74b. This cools the heat exchange unit 74. That is, the refrigerant flowing through the radiator 74a and the oil flowing through the oil cooler 74b are each cooled by the heat exchange.

**[0035]** Further, a temperature sensor (not shown) is placed at the outlet side of the heat exchange unit 74, that is, downstream of the heat exchange unit 74 in the air flow direction. The above temperature sensor detects the temperature of the air having passed through the heat exchange unit 74. The rotation speed of the above fan 80 is controlled by the system controller, and properly controlled (adjusted) based on the air temperature detected by the above temperature sensor.

**[0036]** The drive source of the fan 80 is not limited to the above electric motor. For example, it is allowed that a power transmission mechanism (such as a fan belt) which transmits the rotational power of the engine E to the fan 80 is provided, thereby to rotate the fan 80 by using the above rotational power.

**[0037]** The type of driving the fan 80 is not limited to the above "suck type". The type of driving the fan 80 may be a "discharge type". In the discharge type, drive of the fan 80 causes the air (wind), which flows from inside the engine room 44 across the heat exchange unit 74, to be discharged via the vent 44P of the hood 44B to the outside of the machine body. Even with the above discharge type, the air flowing across the heat exchange unit 74 can cool the heat exchange unit 74.

**[0038]** Next, a detailed description is to be made on the above oil tank 75. The oil tank 75 has a hollow portion 76. The hollow portion 76 is formed through the oil tank 75 in one direction. Thus, the oil tank 75 includes a container which is substantially framed viewed from the above one direction above. In the present embodiment, the above one direction is along the rotation axis CA of the fan 80. Also, the above one direction may be inclined relative to the rotation axis CA.

**[0039]** The hollow portion 76 has a first open portion 76a on one side in the above one direction, and a second open portion 76b on another side. That is, the hollow portion 76 has the open portions at both ends in the above one direction.

**[0040]** Thus, in the suck type, for example, the first open portion 76a, relative to the second open portion 76b, is placed upstream in the air flow direction. Conversely, the second open portion 76b, relative to the first open portion 76a, is placed downstream in the air flow direction. The first open portion 76a and the second open portion 76b are connected in one direction by a framed inner wall 76c.

**[0041]** The first open portion 76a of the hollow portion 76, as shown in Figs. 1 and 2, is exposed to the outside of the machine body (upper swing body 4) via the vent

44P of the hood 44B. That is, one open portion of the hollow portion 76 is exposed (via the vent 44P) from the side wall of the machine body on which the oil tank 75 is mounted.

**[0042]** As shown in Fig. 6, the fan 80 described above is placed between the first open portion 76a of the hollow portion 76 and the heat exchange unit 74. That is, the fan 80 is placed between the above one open portion of the hollow portion 76 and the heat exchange unit 74.

**[0043]** As in the present embodiment; in the configuration in which the first open portion 76a of the hollow portion 76 of the oil tank 75 is exposed from the side wall of the machine body, it is possible that, when the fan 80 placed between the first open portion 76a and the heat exchange unit 74 is driven, the air outside the machine body is efficiently sucked into the hollow portion 76 via the first open portion 76a, to be sent to the heat exchange unit 74. Thus, for the oil, cooling can be done in two steps. That is, the air flowing through the hollow portion 76 can cool the oil that is stored in the oil tank 75 and that is around the hollow portion 76 (first step cooling). Then, the above air sent through the hollow portion 76 to the heat exchange unit 74 (especially the oil cooler 74b) cools the heat exchange unit 74, making it possible to cool the oil flowing through the oil cooler 74b (second step cooling). Meanwhile, the refrigerant can be simultaneously cooled, together with the oil, by the air sent to the heat exchange unit 74. Therefore, placing the oil tank 75, the heat exchange unit 74, and the fan 80 in the minimum necessary limited space inside the machine body can cool the refrigerant and the oil, making it possible to cause preferable cooling of the refrigerant and oil to the small hydraulic excavator 1.

**[0044]** As shown in Fig. 6, placing the fan 80 between the first open portion 76a and second open portion 76b of the hollow portion 76 can place the heat exchange unit 74 as close as possible to the second open portion 76b of the hollow portion 76. Therefore, from the viewpoint of compactly placing the oil tank 75, the heat exchange unit 74, and the fan 80 in the limited space inside the machine body, it is desirable that the fan 80 should be placed inside the hollow portion 76.

**[0045]** The hydraulic excavator 1 (see Fig. 1) of the present embodiment is further provided with a beam 77. As shown in Fig. 4, etc., the beam 77 has a shape that extends in the lateral direction (e.g., horizontal direction), as viewed from the direction of the rotation axis CA of the fan 80. Then, the beam 77 is in a position horizontally crossing the first open portion 76a of the hollow portion 76, with both end portions connected to the inner wall 76c of the hollow portion 76. In the present embodiment, the number of the beams 77 is multiple, but at least one is sufficient.

**[0046]** The above beam 77 serves as a fence to prevent any foreign matter (e.g., human hand) from entering into the hollow portion 76 from the outside. In the present embodiment, as described above, the first open portion 76a of the hollow portion 76 is exposed via the vent 44P;

therefore, with the beam 77 not placed, there is a risk that the human hand should enter into the hollow portion 76. That is, from the viewpoint of reducing the risk of the human hand accidentally entering the first open portion 76a of the hollow portion 76, it is desirable that the hydraulic excavator 1 should be provided with the beam 77 connected to the inner wall 76c of the hollow portion 76.

**[0047]** Further, from the viewpoint of preventing the human hand from touching the fan 80 (inside the beam 77), it is desirable that the fan 80 should be placed between beam 77 and heat exchange unit 74, as shown in Fig. 6.

**[0048]** The above beam 77 may be a solid beam filled with a content. From the viewpoint of acquiring the above effect with a configuration lighter in weight than when using the solid beam, however, it is desirable that the beam 77 should be hollow.

**[0049]** Fig. 7 shows a horizontal cross sectional view of the oil tank 75. As shown in Fig. 7, when the hollow beam 77 communicates with the oil tank 75, the oil in the oil tank 75 moves in and out of inside the hollow beam 77. The oil inside the beam 77 is cooled by the air which is sucked in from outside the machine body by the drive of the fan 80 and flows around the beam 77. Therefore, from the viewpoint of further improving efficiency of cooling the oil, it is desirable that the hollow beam 77 should communicate with the oil tank 75, as shown in Fig. 7.

**[0050]** The above describes the configuration in which, as viewed from the first open portion 76a side of the hollow portion 76, the beam 77 extends in the lateral direction (horizontal direction) and is connected to the inner wall 76c of the hollow portion 76; however, the direction in which the beam 77 extends is not limited to the above lateral direction. For example, being viewed from the first open portion 76a side of the hollow portion 76, the direction in which the beam 77 extends may be longitudinal direction (up/down direction), or an oblique direction intersecting the longitudinal direction and lateral direction. Also, the beams 77 extending in different directions may be used in combination. For example, the beam 77 having a lattice shape, which is a combination of the beam 77 extending in the longitudinal direction and the beam 77 extending in the lateral direction, may be used. Further, the beam 77 may have a shape which is radially extending when viewed in the direction of the rotation axis CA.

**[0051]** Here, when the oil stored in the oil tank 75 ripples due to vibration during use of the hydraulic excavator 1, the oil, as the case may be, entrains an air bubble. The oil having entrained the air bubble, as the case may be, causes a malfunction to the hydraulic instrument (e.g., actuator 73 (see Fig. 3)) to which the oil is pumped. To reduce the air bubble's being entrained in the oil, it is desirable to suppress the oil's rippling in the oil tank 75. From the viewpoint of efficiently suppressing the ripple of the oil, it is desirable that, when viewed from one open portion side (first open portion 76a side) of the hollow portion 76, the above beams 77 should laterally extend

and be connected to the inner wall 76c of the hollow portion 76.

**[0052]** As shown in Figs. 4 to 7, in the present embodiment, the plural beams 77 are so placed as to be longitudinally spaced apart to be connected to the inner wall 76c. In this configuration, a narrow gap can be formed between beams 77 and 77 adjacent to each other in the longitudinal direction, making it difficult for the human hand to enter the above gap. Therefore, from the viewpoint of reliably preventing the human hand from accidentally entering the first open portion 76a of the hollow portion 76 from outside the machine body via the vent 44P (see Figs. 1 and 2), it is desirable, as in the present embodiment, that the plural beams 77 should be provided, and so placed as to be longitudinally spaced apart.

**[0053]** By the way, for efficiently cooling the refrigerant and oil in the heat exchange unit 74, it is necessary that the air entering into the hollow portion 76 of the oil tank 75 by the drive of the fan 80 should be efficiently applied to the heat exchange unit 74. To do so, it is desirable that the air entering into the hollow portion 76 of the oil tank 75 by the drive of the fan 80 should be, along the beam 77, guided from the first open portion 76a side to the second open portion 76b side. From the viewpoint of realizing the above guiding of the air, it is desirable, as shown in Fig. 6, that the beam 77 should have the shape that extends (longitudinally) from the one open portion (first open portion 76a) side of the hollow portion 76 toward the other open portion (second open portion 76b) side.

**[0054]** In the present embodiment, the beam 77 has a first end portion 77a and a second end portion 77b, as shown in Fig. 6. The first end portion 77a is positioned on the first open portion 76a side (one open portion side) of the hollow portion 76. The second end portion 77b is positioned on the second open portion 76b side (another open portion side) of the hollow portion 76.

**[0055]** By the way, so as to enhance the effect of cooling the refrigerant and oil in the heat exchange unit 74, it is desirable to cause the beam 77 to have a rectifying action to smoothly flow, to the heat exchange unit 74 side, the air that enters into the hollow portion 76 of the oil tank 75 by the drive of the fan 80 and that flows along the beam 77 inside the hollow portion 76.

**[0056]** In this regard, when the first end portion 77a of the beam 77 is formed in a plane that is perpendicular, for example, to the direction of air flow from the first open portion 76a side to the second open portion 76b side of the hollow portion 76, the air resistance at the first end portion 77a increases. To ensure that the beam 77 has the above rectifying action, it is desirable that the air resistance at the first end portion 77a should be as small as possible. From the viewpoint of reducing the above air resistance at the first end portion 77a, it is desirable that the first end portion 77a of the beam 77 should have a curved shape that bulges to the opposite side of the second end portion 77b, as shown in Fig. 6.

**[0057]** From the viewpoint of suppressing airflow tur-

bulence on the second end portion 77b side of the beam 77, it is desirable that the second end portion 77b should have a curved shape that bulges to the opposite side of the first end portion 77a, as shown in Fig. 6. When the second end portion 77b has the above curved shape, the air resistance at the second end portion 77b is reduced in the case of the discharge type, making it possible to cause the beam 77 to have the rectifying action. Therefore, from the viewpoint of being able to cause the beam 77 to have the rectifying action in both the suck and discharge types as well, it is desirable that the second end portion 77b should have the above curved shape.

**[0058]** By the way, with the first end portion 77a of the beam 77 being positioned below the second end portion 77b, for example; when the fan 80 is driven, the air sucked into the hollow portion 76 from the outside of the machine body flows obliquely upward. This makes it easier for dust near the ground surface to be sucked into the hollow portion 76 together with the air outside the machine body. There is a concern that, when the dust is sucked into the hollow portion 76, the heat exchange unit 74 is contaminated with the dust, thereby to reduce the efficiency of heat exchange by the heat exchange unit 74. So as to prevent the above reducing of the efficiency of heat exchange, it is desirable that the drive of the fan 80 should unlikely to suck, into the hollow portion 76, the dust near the ground surface. For the above purpose, it is desirable that the direction of air flow sucked into the hollow portion 76 should be obliquely downward. From the viewpoint of realizing the above air flow direction, it is desirable that, as shown in Fig. 6, the first end portion 77a of the beam 77 should be placed above the second end portion 77b.

#### [4. Connection Portion of Oil Tank]

**[0059]** As shown in Fig. 3, the oil tank 75 has a first connection portion 75a and a second connection portion 75b. The first connection portion 75a is connected with the above first delivery pipe 91. The first delivery pipe 91 is a delivery pipe through which the oil sucked by the hydraulic pump 71 flows from the oil tank 75.

**[0060]** The second connection portion 75b is connected with the above second delivery pipe 92. The second delivery pipe 92 is a delivery pipe through which the oil discharged from the actuator 73 flows via the control valve 72 and the oil cooler 74b. Further, the second connection portion 75b is connected with the above third delivery pipe 93.

**[0061]** In the above configuration, driving the hydraulic pump 71 causes the oil inside the oil tank 75 to circulate in the order of the first connection portion 75a, the first delivery pipe 91, the hydraulic pump 71, the second delivery pipe 92 (or the third delivery pipe 93), and the second connection portion 75b.

**[0062]** Meanwhile, in the present embodiment, the hollow beam 77, viewed from the first open portion 76a side of the hollow portion 76, laterally extends and communicates with the oil tank 75. In this configuration, the air

having been sucked into the hollow portion 76 by the drive of the fan 80 cools the oil inside the beam 77.

**[0063]** In the configuration where the circulation path of the oil is formed as described above, it is desirable that, so as to use, for driving the actuator 73 (supply to actuator 73), the oil inside the beam 77, i.e., the oil cooled by the drive of the fan 80, the oil inside the beam 77 should be reliably placed on the above circulation path. For this purpose, it is desirable to allow the oil to easily flow, inside the beam 77, from one side to the other side in the above lateral direction. From the above viewpoint, it is desirable that, in the oil tank 75, the oil inlet (second connection portion 75b) should be placed on the one side in the lateral direction in which the beam 77 extends, and the oil outlet (first connection portion 75a) should be placed on the other side in the above lateral direction. That is, in the lateral direction in which the beam 77 extends, the first connection portion 75a and second connection portion 75b of the oil tank 75 should be placed on opposite sides of each other with respect to the beam 77.

**[0064]** When the hydraulic pump 71 sucks the oil in the oil tank 75 from the upper portion of the oil tank 75, for example, there is a risk of sucking, together with the oil, air staying above in the oil tank 75. The above sucking of the air may lead to a malfunction of the hydraulic instrument (e.g., actuator 73), as described above. So as to reduce the hydraulic instrument's malfunction due to the above sucking of air, it is desirable to make a circulation path in which the oil in the oil tank 75 is sucked from the down portion of the oil tank 75, and the oil discharged from the actuator 73 is caused to flow into the oil tank 75 from the upper portion. Therefore, it is desirable that, as shown in Fig. 4 and the like, the first connection portion 75a of the oil tank 75 should be placed below the second connection portion 75b.

**[0065]** Further, it is desirable that the configuration should be such that the oil tank 75 and the heat exchange unit 74 are so close to each other as to be compactly placed, while, so as to take the oil out of the oil tank 75 and circulate the oil, the oil inside the oil tank 75 is taken out in a direction (for example, front/back direction of machine body) different from the direction (direction for blowing air by the fan 80) in which the oil tank 75 and the heat exchange unit 74 are arranged. From the above viewpoint, as shown in Fig. 4, etc., it is desirable that, in the oil tank 75, the above first connection portion 75a should be placed on a side face 75S that intersects with the front/back direction of the machine body (upper swing body 4 (see Fig. 1)).

**[0066]** The description has been made with the hydraulic excavator 1, which is a construction machine, as the example of the work machine, but the work machine is not limited to the hydraulic excavator 1 and may be any other construction machine such as a wheel loader, or a compact truck loader. Also, the work machine may be an agricultural machine such as a combine harvester, or a tractor.

[5. Appendices]

**[0067]** The hydraulic excavator 1 described in the present embodiment can also be expressed as a work machine as shown in the following appendices.

**[0068]** A work machine of appendix (1) includes:

a hydraulic pump driven by an engine; and  
an oil tank that stores an oil pumped by the hydraulic pump,

wherein

the work machine includes

a heat exchange unit that cools a refrigerant, which passes through the engine, and the oil, and  
a fan that sends air to the heat exchange unit,

the oil tank has a hollow portion having open portions at both ends,

one of the open portions of the hollow portion is exposed from a side wall of the machine body on which the oil tank is mounted (via the vent on the side wall), and

the fan is placed between the one of the open portions of the hollow portion and the heat exchange unit.

**[0069]** Concerning the work machine of appendix (2), in the work machine described in appendix (1), the fan is placed inside the hollow portion.

**[0070]** The work machine of appendix (3), in the work machine described in appendix (2), further includes a beam connected to an inner wall of the hollow portion.

**[0071]** Concerning the work machine of appendix (4), in the work machine described in appendix (3), the fan is placed between the beam and the heat exchange unit.

**[0072]** Concerning the work machine of appendix (5), in the work machine described in appendix (3) or (4), the beams is hollow.

**[0073]** Concerning the work machine of appendix (6), in the work machine described in appendix (5), the beam communicates with the oil tank.

**[0074]** Concerning the work machine of appendix (7), in the work machine described in appendix (6), the beam laterally extends as viewed from the one open portion side of the hollow portion.

**[0075]** Concerning the work machine of appendix (8), in the work machine described in appendix (7), the plural beams are provided, and are so placed as to be longitudinally spaced apart.

**[0076]** Concerning the work machine of appendix (9), in the work machine described in appendix (7) or (8), the beam has a shape extending from the one open portion side of the hollow portion to the other open portion

side.

**[0077]** Concerning the work machine of appendix (10), in the work machine described in appendix (9),

the beam has

a first end portion positioned on the one open portion side of the hollow portion, and  
a second end portion placed on the other open portion side of the hollow portion, and

the first end portion has a curved shape that bulges to an opposite side of the second end portion.

**[0078]** Concerning the work machine of appendix (11), in the work machine described in appendix (10), the second end portion has a curved shape that bulges to an opposite side of the first end portion.

**[0079]** Concerning the work machine of appendix (12), in the work machine described in appendix (10) or (11), the first end portion is positioned above the second end portion.

**[0080]** Concerning the work machine of appendix (13), in the work machine described in any of appendices (7) to (12),

the work machine further includes an actuator driven by the oil supplied from the hydraulic pump, the oil tank has

a first connection portion connected with a first delivery pipe, and  
a second connection portion connected with a second delivery pipe,

the first delivery pipe is a pipe through which the oil sucked by the hydraulic pump flows from the oil tank, and the second delivery pipe is a pipe through which the oil discharged from the actuator flows, and in the lateral direction, the first connection portion and the second connection portion are placed opposite to each other with respect to the beam.

**[0081]** Concerning the work machine of appendix (14), in the work machine described in appendix (13), the first connection portion is placed below the second connection portion.

**[0082]** Concerning the work machine of appendix (15), in the work machine described in appendix (13) or (14), in the oil tank, the second connection portion is placed on a side face that intersects with a front/back direction of the machine body.

**[0083]** The embodiment of the present invention has been described above, but the scope of the present invention is not limited thereto and can be carried out within an extended or modified range without departing from the gist of the present invention.

## INDUSTRIAL APPLICABILITY

**[0084]** The present invention is applicable to work machine such as a construction machine and an agricultural machine, for example.

## REFERENCE SIGNS LIST

### [0085]

1: hydraulic excavator (work machine)  
4: upper swing body (machine body)  
44b: hood (side wall)  
71: hydraulic pump  
73: actuator  
74: heat exchange unit  
75: oil tank  
75S: side face  
75a: first connection portion  
75b: second connection portion  
76: hollow portion  
76a: first open portion  
76b: second open portion  
76c: inner wall  
77: beam  
77a: first end portion  
77b: second end portion  
80: fan  
91: first delivery pipe  
92: second delivery pipe  
E: engine

## Claims

### 1. A work machine comprising:

a hydraulic pump driven by an engine; and  
an oil tank that stores an oil pumped by the hydraulic pump,

wherein

the work machine includes

a heat exchange unit that cools a refrigerant, which passes through the engine, and the oil, and  
a fan that sends air to the heat exchange unit,

the oil tank has a hollow portion having open portions at both ends,

one of the open portions of the hollow portion is exposed from a side wall of the machine body on which the oil tank is mounted, and



the fan is placed between the one of the open portions of the hollow portion and the heat exchange unit.

2. The work machine as claimed in claim 1, wherein the fan is placed inside the hollow portion. 5
3. The work machine as claimed in claim 2, further comprising a beam connected to an inner wall of the hollow portion. 10
4. The work machine as claimed in claim 3, wherein the fan is placed between the beam and the heat exchange unit. 15
5. The work machine as claimed in claim 3 or 4, wherein the beams is hollow. 20
6. The work machine as claimed in claim 5, wherein the beam communicates with the oil tank. 25
7. The work machine as claimed in claim 6, wherein the beam laterally extends as viewed from the one open portion side of the hollow portion. 30
8. The work machine as claimed in claim 7, wherein the plural beams are provided, and are so placed as to be longitudinally spaced apart. 35
9. The work machine as claimed in claim 7 or 8, wherein the beam has a shape extending from the one open portion side of the hollow portion to the other open portion side. 40
10. The work machine as claimed in claim 9, wherein 45

the beam has

a first end portion positioned on the one open portion side of the hollow portion, and a second end portion placed on the other open portion side of the hollow portion, and 40

the first end portion has a curved shape that bulges to an opposite side of the second end portion. 45

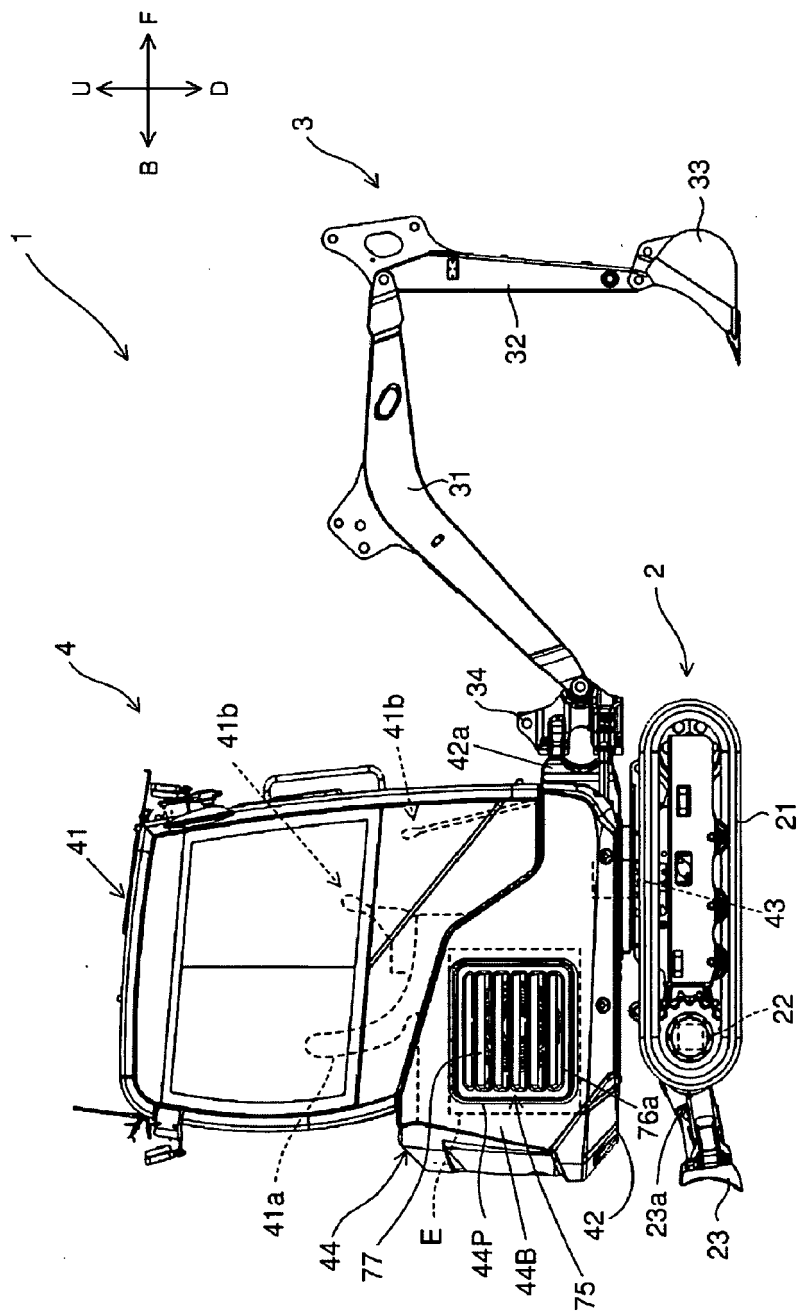
11. The work machine as claimed in claim 10, wherein the second end portion has a curved shape that bulges to an opposite side of the first end portion. 50
12. The work machine as claimed in claim 10 or 11, wherein the first end portion is positioned above the second end portion. 55
13. The work machine as claimed in any of claims 7 to 12, wherein

the work machine further comprises an actuator driven by the oil supplied from the hydraulic pump, the oil tank has

a first connection portion connected with a first delivery pipe, and a second connection portion connected with a second delivery pipe,

the first delivery pipe is a pipe through which the oil sucked by the hydraulic pump flows from the oil tank, and the second delivery pipe is a pipe through which the oil discharged from the actuator flows, and in the lateral direction, the first connection portion and the second connection portion are placed opposite to each other with respect to the beam.

14. The work machine as claimed in claim 13, wherein the first connection portion is placed below the second connection portion.
15. The work machine as claimed in claim 13 or 14, wherein in the oil tank, the second connection portion is placed on a side face that intersects with a front/back direction of the machine body.



**FIG. 1**

FIG. 2

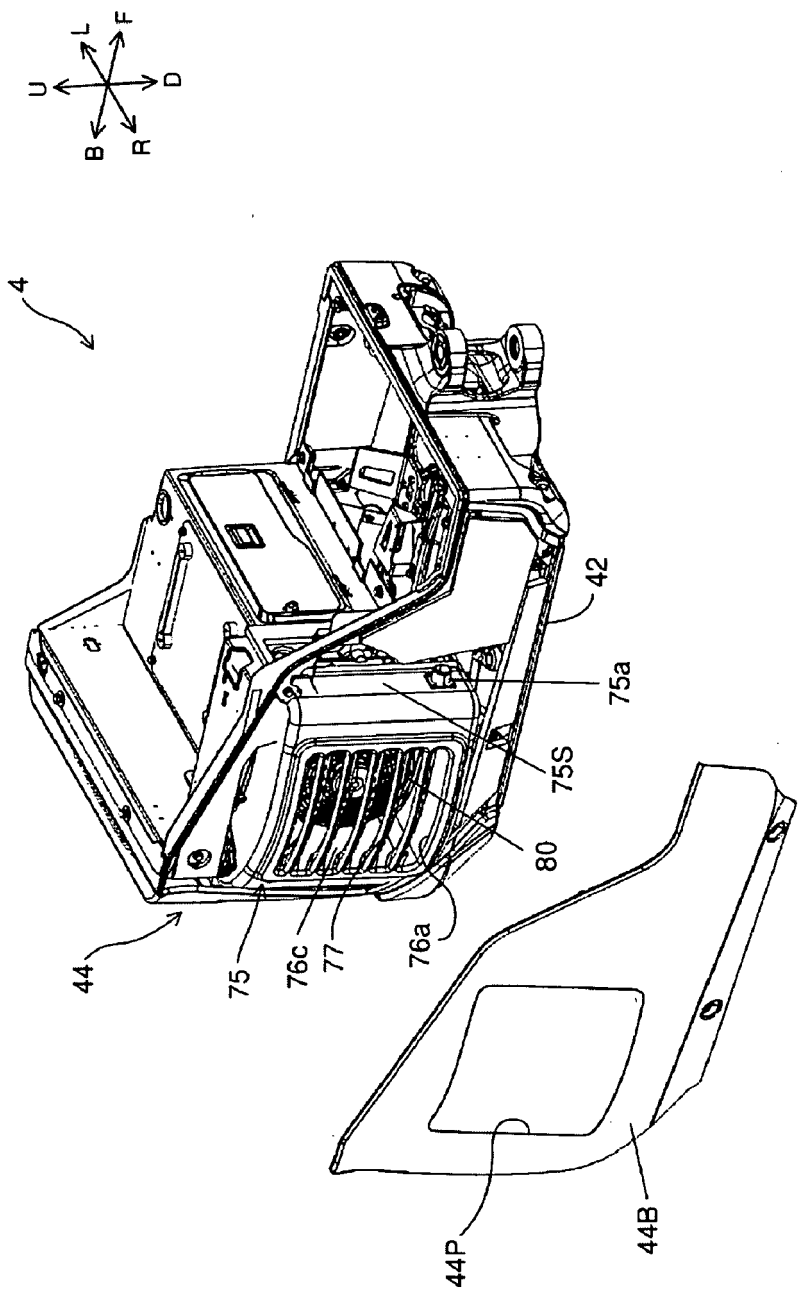


FIG. 3

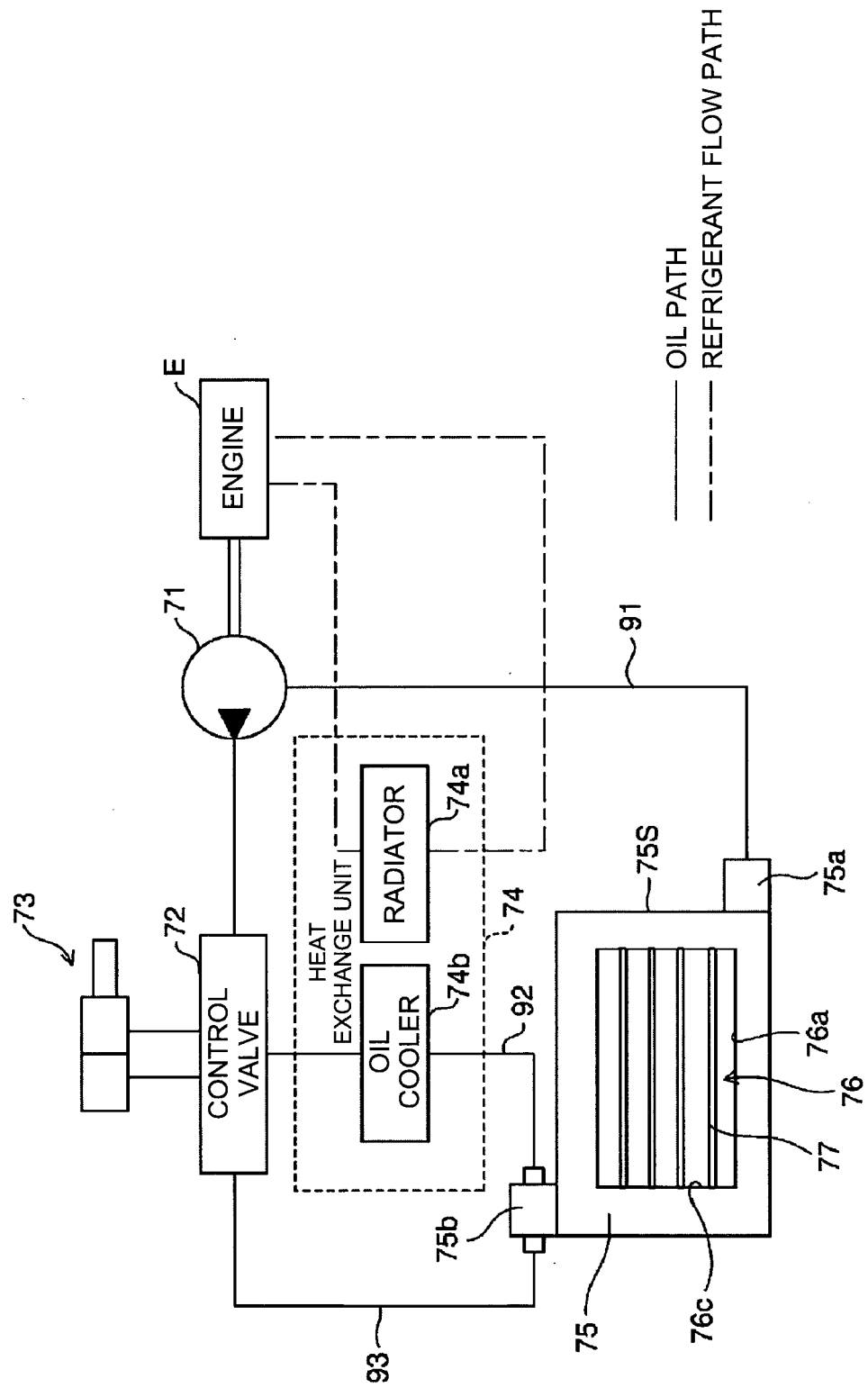


FIG. 4

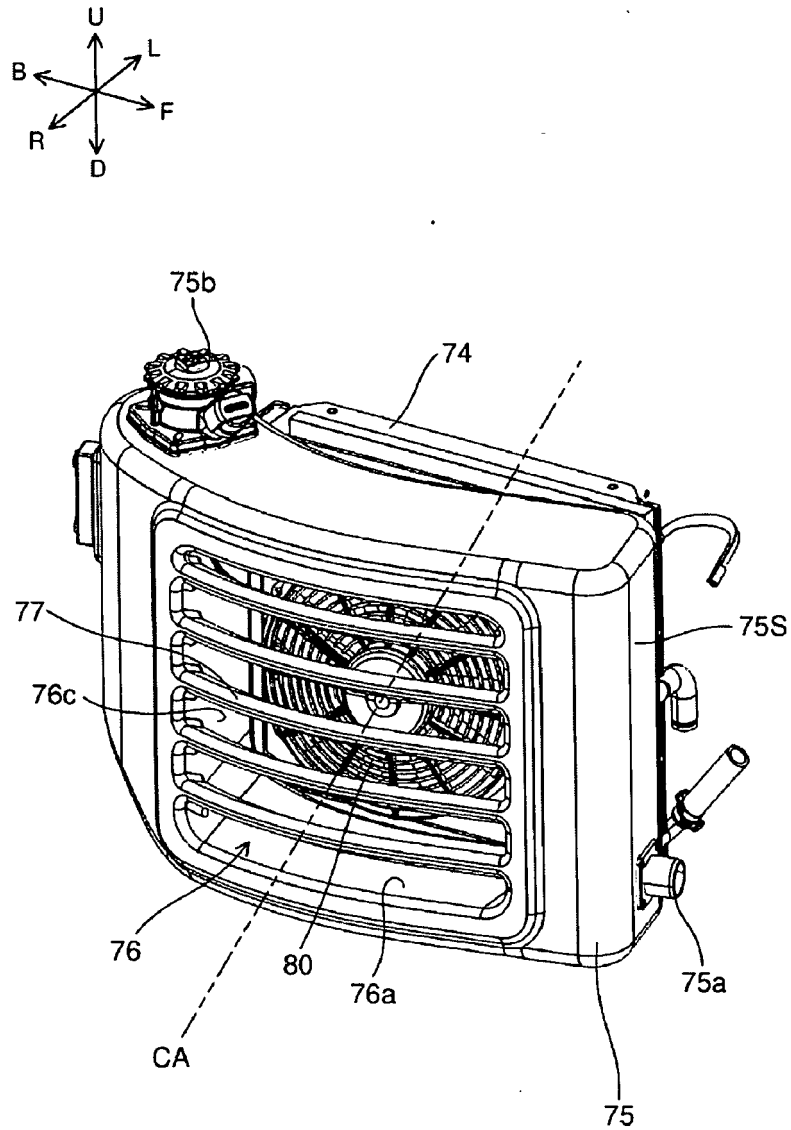


FIG. 5

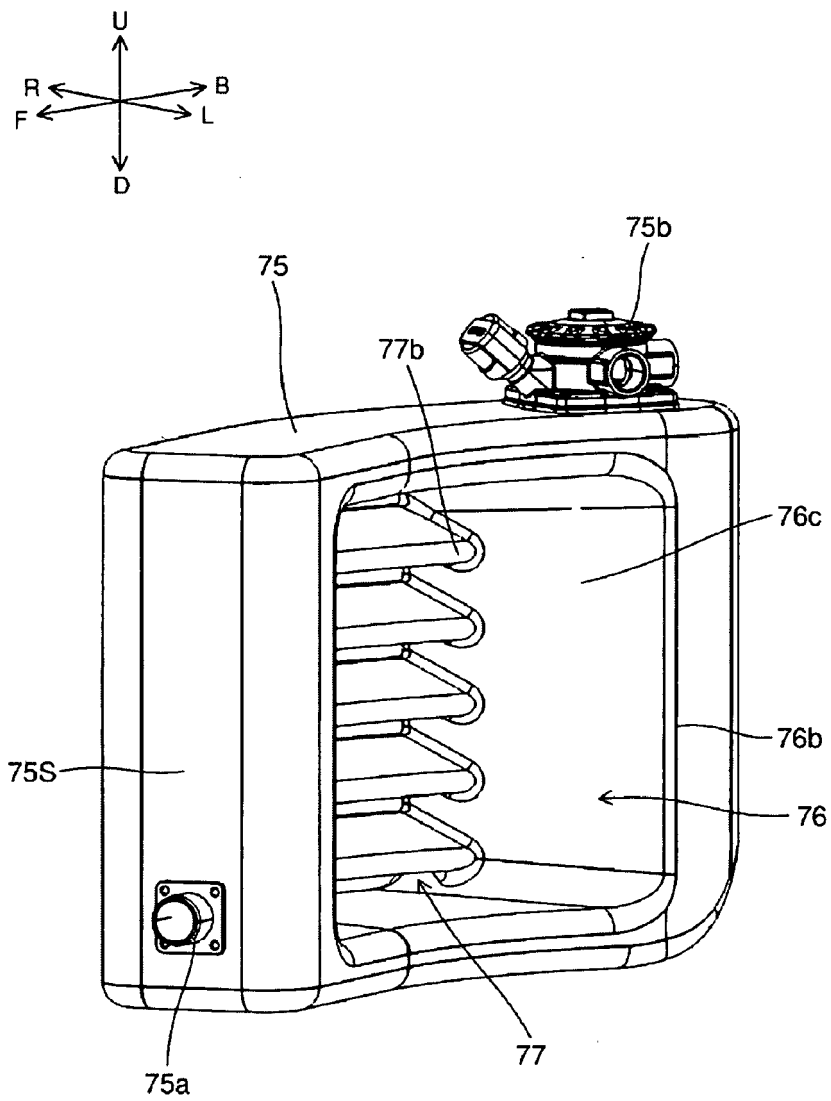


FIG. 6

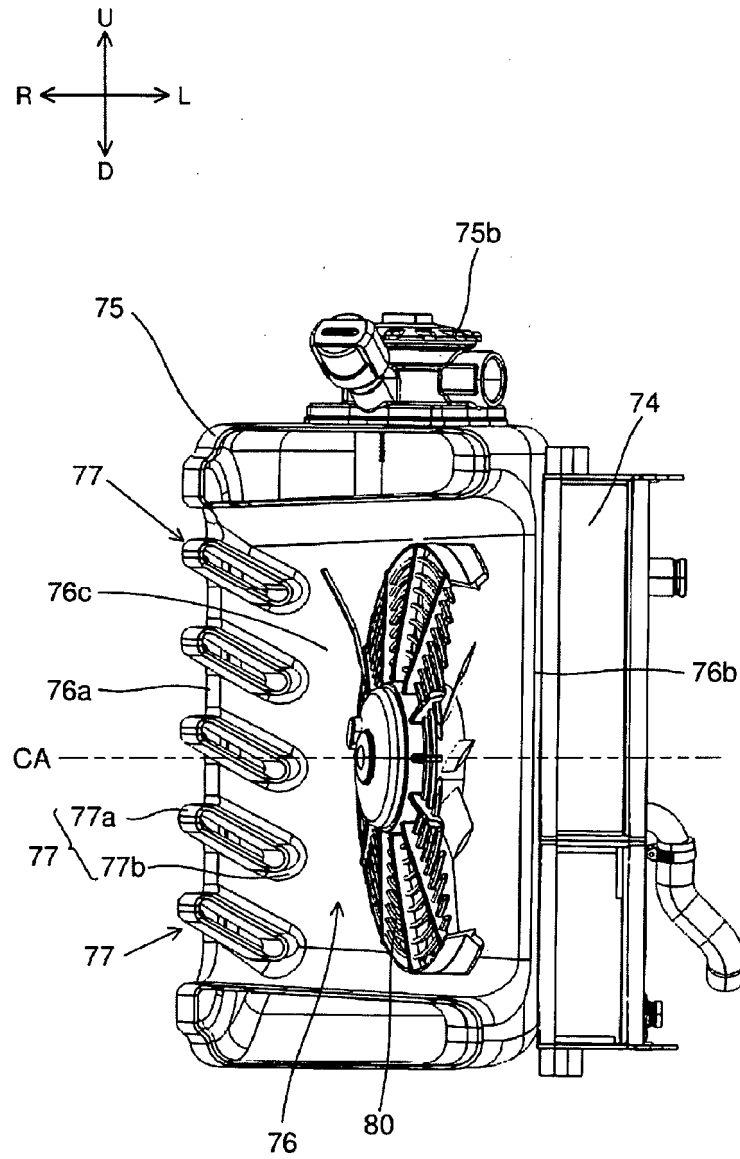
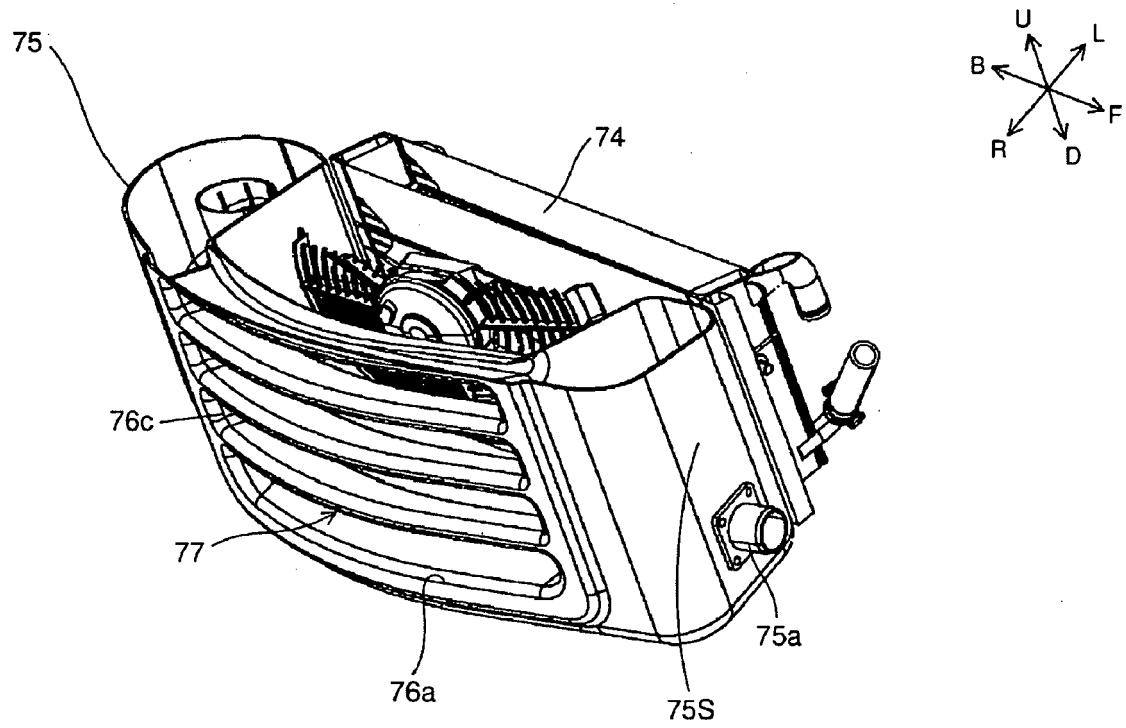


FIG. 7







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