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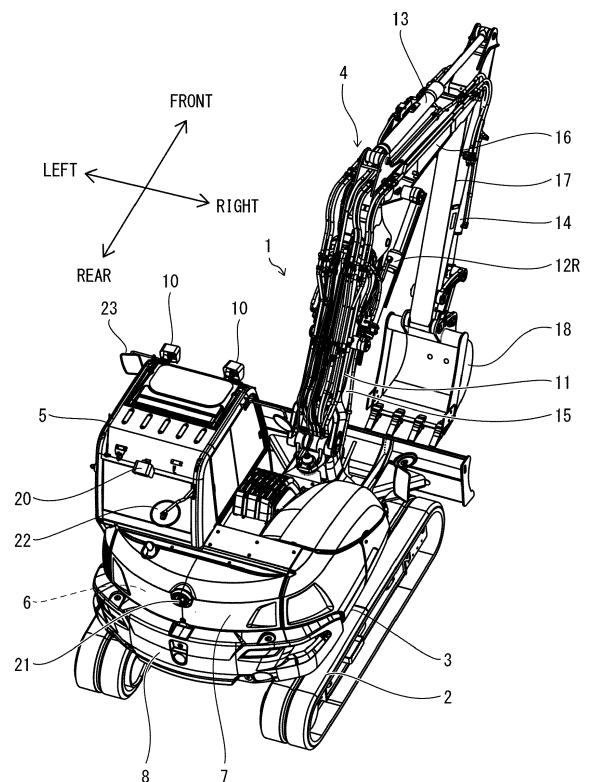
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(54) **WORK MACHINE**

(57) In order to appropriately illuminate an image-capturing region of a rear camera and a field of view of an operator and to improve workability under a dark environment, a work machine (1) includes: a machine body (3); a cabin (5) installed on the machine body; an engine (6) installed in a rear portion of the machine body; a hood (7) covering the rear of the engine in a manner such that the hood is openable and closable; a counterweight (8) provided on a lower side of the hood; a rear light (20) which is installed at a rear upper portion of the cabin and which is configured to illuminate a region lying behind the machine body; and a rear camera (21) which is disposed on the hood and which is configured to take an image of the region lying behind the machine body.

FIG. 1



Description

Technical Field

[0001] The present invention relates to, for example, a work machine such as an excavator.

Background Art

[0002] Work machines (a work machine and a construction machine) disclosed in Patent Literatures 1 and 2 have conventionally been known. The work machines disclosed in Patent Literatures 1 and 2 each include a rear light (a rearview light and a light) for illuminating a region lying behind a machine body of the work machine and a rear camera (a rearview camera and a rear camera) for capturing an image of the region lying behind the machine body. These conventional work machines make it possible to conduct work with viewing of an image of the region lying behind the machine body captured by the rear camera, even under a dark environment, for example, at night.

Citation List

[Patent Literature]

[0003]

[Patent Literature 1]
Japanese Patent Application Publication Tokukai No. 2008-202331
[Patent Literature 2]
Japanese Patent No. 6106408

Summary of Invention

Technical Problem

[0004] The conventional arts as described above all relate to large-sized work machines. Such a large-sized work machine includes a machine body having a rear portion that greatly protrudes toward a rearward side of a cabin of the work machine, and the protruding portion of the machine body is provided with a counterweight for maintaining balance with a work device of the work machine. The rear camera and the rear light are disposed in a pair on the counterweight, which is a rear end part of the machine body, so as to form a group.

[0005] Thus, the above-described conventional art has the problem that the rear light can illuminate an image-capturing region of the rear camera, but cannot illuminate a sufficient area of a field of view of an operator in the cabin in a case where the operator directly views a rearward side.

[0006] It is an object of an aspect of the present invention to appropriately illuminate an image-capturing region of a rear camera and a field of view of an operator and

improve workability under a dark environment.

Solution to Problem

[0007] In order to solve the foregoing problem, a work machine in accordance with an aspect of the present invention includes: a machine body; a cabin located on the machine body; a rear light that is located at a rear upper portion of the cabin and that is configured to illuminate (i) a region lying behind the cabin and above a rear portion of the machine body and (ii) a region lying behind the machine body; and a rear camera that is located in the rear portion of the machine body and behind the cabin and that is configured to capture an image of the region lying behind the machine body.

Advantageous Effects of Invention

[0008] An aspect of the present invention makes it possible to appropriately illuminate an image-capturing region of a rear camera and a field of view of an operator and improve workability under a dark environment.

Brief Description of Drawings

[0009]

Fig. 1 is a perspective view schematically illustrating an entire configuration of a work machine in accordance with an embodiment.

Fig. 2 is a plan view schematically illustrating the work machine.

Fig. 3 is a left-side view schematically illustrating the work machine.

Fig. 4 is a perspective view schematically illustrating a main part of a rear portion of the work machine.

Fig. 5 is a view illustrating an example of an illuminating area, on a ground surface, of a rear light when viewed from above the work machine and an example of an image-capturing area, on the ground surface, of a rear camera when viewed from above the work machine.

Fig. 6 is a view illustrating an example of the illuminating area of the rear light when viewed from a left side of the work machine.

Fig. 7 is view illustrating a work machine suitable to have a configuration in which a rear light is disposed on a cabin of the work machine and a rear camera is disposed on a hood of the work machine.

Description of Embodiments

(Outline of Work Machine 1)

[0010] The following will describe an embodiment of the present invention with reference to drawings as appropriate. Fig. 1 is a perspective view schematically illustrating an entire configuration of a work machine 1 in

accordance with the present embodiment. Fig. 2 is a plan view schematically illustrating the work machine 1. Fig. 3 is a left-side view schematically illustrating the work machine 1. In the present embodiment, an excavator which is a swivel work machine is taken as an example of the work machine 1.

[0011] As illustrated in Figs. 1 to 3, the work machine 1 includes a traveling device 2, a machine body 3, and a work device 4. The machine body 3 is supported on a frame of the traveling device 2 with a bearing member interposed between the machine body 3 and the frame, so as to enable the machine body 3 to swivel about a vertical axis (an axis in an up-and-down direction). Installed in the machine body 3 are an engine 6, a hood 7, a counterweight 8, the work device 4, and the like.

[0012] The cabin 5 has therein an operator seat on which an operator (driver) is to be seated. The following description will assume that a front side of the operator seated on the operator seat is the front, a rear side of the operator is the rear, a left side of the operator is the left, and a right side of the operator is the right. The cabin 5 is installed on the machine body 3 so as to be close to a left side of the machine body 3. The cabin 5 has, on a front upper portion thereof, two front lights 10 installed for illuminating a work area in front of the work machine 1. In an example illustrated in each of Figs. 1 and 2, the two front lights 10 are installed so as to be spaced apart from each other on left and right sides. A rear mirror 22 is installed on a right side of a rear upper portion of the cabin 5, and a front-left mirror 23 is installed on a left side of the front upper portion of the cabin 5.

[0013] The engine 6 is located in a rear portion of the machine body 3. The engine 6 is located on a side rearward of the cabin 5. The engine 6 is covered with the hood 7. The hood 7 is provided in the rear portion of the machine body 3 and covers the rear of the engine 6 in a manner such that the hood 7 is openable and closable. The hood 7 is openable and closable about an axis located on a front side of the hood 7 closer to the rear portion of the cabin 5.

[0014] The counterweight 8 is a weight for maintaining weight balance with respect to the work device 4 and is located on a lower side of the hood 7 (below the hood 7). As described above, in the work machine 1 in which the counterweight 8 is disposed on the lower side of the hood 7, the rear portion of the cabin 5 is located in the rear portion of the machine body 3. In addition, in the work machine 1, the counterweight 8 has a rear end part protruding rearward of a rear end part of the hood 7.

[0015] The work device 4 is operated with use of working hydraulic pressures as working fluid pressures and is installed in a front portion of the machine body 3. The work device 4 includes, for example, a first boom 15 rotationally moved by a hydraulic cylinder 11, a second boom 16 rotationally moved by hydraulic cylinders 12R and 12L, an arm 17 rotationally moved by a hydraulic cylinder 13, and a bucket 18 rotationally moved by a hydraulic cylinder 14.

(Configuration for Rearview of Machine Body)

[0016] Fig. 4 is a perspective view schematically illustrating a main part of a rear portion of the work machine 1. As illustrated in Fig. 4, the work machine 1 includes: a rear light 20 that is located at the rear upper portion of the cabin 5 and that is configured to illuminate (i) a region lying behind the cabin 5 and above the rear portion of the machine body 3 and (ii) a region lying behind the machine body 3; and a rear camera 21 that is located in the rear portion of the machine body 3 and behind the cabin 5 and that is configured to capture an image of the region lying behind the machine body 3. Specifically, the rear camera 21 is located on the hood 7. That is, the work machine 1 is, for rearview checking of the machine body 3, provided with: the rear camera 21 that is disposed on the hood 7 and that is configured to capture an image of the region lying behind the machine body 3; and a rear light 20 that is disposed at the rear upper portion of the cabin 5 and that is configured to illuminate (i) the region lying behind the cabin 5 and above the rear portion of the machine body 3 and (ii) the region lying behind the machine body 3.

[0017] As such, the provision of the rear light 20 allows the work machine 1 to supply light to (i) the region lying behind the cabin 5 and above the rear portion of the machine body 3 and (ii) the region lying behind the machine body 3. This makes it possible to conduct work, simultaneously with viewing of a captured image of the region lying behind the machine body 3, with good visibility, even under a dark environment, for example, at night.

[0018] The rear light 20 is installed on a frame part 5b above a rear opening 5a of the cabin 5 in a manner such that a main bundle of light beams from the rear light 20 is pointed in a diagonally downward direction. The rear camera 21 is attached to a center portion of the hood 7 in a left-and-right direction. Specifically, the rear camera 21 is installed on a lower side of an emblem 24 which is attached to a curved portion extending from an upper surface of the hood 7 to a rear surface thereof so as to protrude rearwards.

[0019] One possible option for installing the rear light 20 is that the rear light 20 is installed in the vicinity of the rear camera 21 such that the rear light 20 and the rear camera 21 are paired with each other, as in the conventional large-sized work machine as described above. That is, such an option is a configuration in which the rear light 20 is disposed on the hood 7 together with the rear camera 21. Such a configuration in which the rear light 20 is installed in the vicinity of the rear camera 21 such that the rear light 20 and the rear camera 21 are paired with each other has, for example, an advantage that wiring for the pair required on an under side of the hood 7 can be done collectively.

[0020] In the work machine 1, in fact, the rear light 20 is spaced apart from the rear camera 21 and is installed at the rear upper portion of the cabin 5. This positioning is achieved utilizing the feature in which, in the work ma-

chine 1 provided with the counterweight 8 disposed on the lower side of the hood 7, the rear portion of the cabin 5 is located in the rear portion of the machine body 3.

[0021] This makes it possible to emit light from a higher position than the hood 7 to a broader illumination region behind the machine body 3 than an illumination region behind the machine body 3 in the case where the rear light 20 is disposed on the hood 7 such that the rear light 20 and the rear camera 21 are paired with each other. Specifically, the region lying behind the machine body 3, including, for example, the upper surface of the hood 7, part of the counterweight 8, and a rear end part of the traveling device 2, is illuminated.

[0022] Further, in a case where the rear light 20 is disposed on the hood 7 so as to be paired with the rear camera 21, only a place lower than the hood 7 can be illuminated. Thus, in a case where an operator in the cabin 5 looks back to directly view the region lying behind the machine body 3, only an area close to a ground surface is illuminated with light. This situation cannot be said to provide good visibility.

[0023] In contrast, in a case where the rear light 20 is installed at the rear upper portion of the cabin 5, the light is emitted from a position higher than the head of the operator in the cabin 5. This allows a higher place apart from the ground surface in the region lying behind the machine body 3, including a place above the hood 7, to be illuminated with the light. Thus, in a case where the operator in the cabin 5 looks back to directly view the region lying behind the machine body 3, the operator can view the region lying behind the machine body 3, including a place higher than the hood 7. This leads to improvement in visibility in such direct viewing.

[0024] Note that the light can also be emitted from the rear light 20 toward the engine 6 in a state of being located on an inner side of the hood 7 which is open or in a state where the hood 7 is detached. This eliminates the need for another light for illuminating the engine 6 and thus improves convenience during maintenance.

[0025] Further, a configuration may be employed in which the light from the rear light 20 is guided to the engine 6 through reflection on the rear mirror 22 by adjusting an orientation of the rear light 20 and an angle of the rear mirror 22 installed on a right side of the rear upper portion of the cabin 5. Furthermore, also the rear end part of the machine body 3 in an image-capturing area of the rear camera 21 is illuminated through the reflection of the light from the rear light 20 on the rear mirror 22.

[0026] A configuration may be employed in which an angle of the rear light 20 is adjustable in an up-and-down direction, in a left-and-right direction, or in the both directions within a predetermined range, with respect to an angle of the rear light 20 at which the main bundle of light beams from the rear light 20 is pointed in a diagonally downward direction.

[0027] Fig. 5 is a view illustrating an example of an illuminating area, on a ground surface, of the rear light 20 when viewed from above the work machine 1 and an

example of an image-capturing area, on the ground surface, of the rear camera 21 when viewed from above the work machine 1. Fig. 6 is a view illustrating an example of the illuminating area of the rear light 20 when viewed from a left side of the work machine 1.

[0028] It is preferable that the rear light 20 is installed so as to illuminate a vicinity of the machine body 3 in an image-capturing area RB of the rear camera 21, as illustrated in Fig. 5. For example, when seen in a side view as illustrated in Fig. 6, a separation distance (minimum distance) L4 between (i) an extended line L2 extending from a line L1 passing through the rear light 20 and the rear camera 21 and (ii) the rear end part of the machine body 3 is preferably not more than 50 cm and more preferably not more than 30 cm. It is still more preferable that the extended line L2 and the rear portion of the machine body 3 cross. Further, when seen in the side view, a separation distance L6 on a ground surface 30 between (i) the extended line L2 extending from the line L1 passing through the rear light 20 and the rear camera 21 and (ii) a line L3 extending vertically downward from the rear end part of the machine body 3 is preferably not more than 1 m and more preferably not more than 50 cm.

[0029] According to the above configuration, in a case where the rear camera 21 is used under a dark environment, illuminating with light the vicinity of the machine body 3 in the image-capturing area RB of the rear camera 21 makes it possible for the operator to check, with good visibility, a state of a vicinity of the rear end part of the machine body 3 which vicinity the operator desires to check the most. This further improves the workability under a dark environment.

[0030] The work machine 1 is configured such that the illuminating area RA, on the ground surface 30, of the rear light 20, except for an area closer to a front side of the machine body 3 than a position at which the rear camera 21 is mounted, is located within the image-capturing area RB of the rear camera 21. The illuminating area RA is an area, on the ground surface 30, illuminated with light of not less than 1 Lx.

[0031] As an example, in the work machine 1, the rear light 20 is set to be able to illuminate, with light of not less than 1 Lx, a region on the ground surface 30 from a rear end (line L3) of the counterweight 8, which is the rearmost part of the machine body 3, to a position (L5 = 5 m) that is 5 m behind the rear end of the counterweight 8, as illustrated in Fig. 6. This makes it possible to capture an image of the region from the rear end of the counterweight 8 to the position that 5 m behind the rear end of the counterweight 8, with good visibility with use of the rear camera 21, even under a dark environment. Note that, the distance L5 = 5m is merely one example.

[0032] In addition, the work machine 1 is preferably configured such that the rear camera 21 is installed so that the counterweight 8 (or the rear end part of the machine body 3) is included in the image-capturing area RB, as illustrated in Fig. 5. Such a configuration allows the counterweight 8 to be included in an image captured by

the rear camera 21. This allows the operator to easily gain a sense of distance between the rear end part of the machine body 3 and an obstacle located behind the machine body 3.

[0033] In addition, the rear light 20 may be installed at the center of the cabin 5 in a left-and-right direction, as illustrated in Fig. 1. Such a configuration makes it possible to appropriately illuminate a field of view of the operator in the cabin 5 in a case where the operator directly views the region lying behind the machine body 3. Further, the configuration prevents the rear light 20 from impairing viewability of the rear mirror 22 installed on the right side of the rear upper portion of the cabin 5. Furthermore, the configuration makes it possible to also illuminate an underbody part of the rear portion on the left side of the machine body 3 which is the portion provided with an entrance of the cabin 5. This allows the operator to easily view the feet of the operator, when the operator steps onto and down from the work machine 1.

(Configuration Suitable for Installation of Rear Light on Rear Upper Portion of Cabin)

[0034] The following will describe a work machine suitable to have a configuration in which the rear light 20 is disposed at the rear upper portion of the cabin 5 and the rear camera 21 is disposed on the hood 7. Fig. 7 is a view illustrating the work machine 1 that is suitable to have a configuration in which the rear light 20 is disposed at the rear upper portion of the cabin 5 and the rear camera 21 is disposed on the hood 7.

[0035] A preferable configuration is a configuration in which an angle θ between (i) a line L7 extending vertically downward from the rear light 20 and (ii) the line L1 passing through the rear light 20 and the rear camera 21, when viewed from the side of the work machine 1 as illustrated in Fig. 7, is not more than 45° . A more preferable configuration is a configuration in which the angle θ is not more than 34° . According to such a configuration, it is possible to prevent, for example, the hood 7 protruding further rearward of the machine body 3 than the cabin 5 from blocking the light from the rear light 20 installed on the cabin 5, and to illuminate the region lying behind the machine body 3 from a position close to the machine body 3 with use of the rear light 20 installed on the cabin 5. As the angle θ is smaller, an amount of the emitted light blocked by the rear portion of the machine body 3 becomes smaller. Thus, the angle θ is preferable as small as possible.

[0036] Aspects of the present invention can also be expressed as follows:

A work machine in accordance with an aspect of the present invention includes: a machine body; a cabin located on the machine body; a rear light that is located at a rear upper portion of the cabin and that is configured to illuminate (i) a region lying behind the cabin and above a rear portion of the machine body and (ii) a region lying behind the machine body; and a rear camera that is lo-

cated in the rear portion of the machine body and behind the cabin and that is configured to capture an image of the region lying behind the machine body.

[0037] According to the above configuration, the provision of the rear light improves visibility when the rear camera is used, even under a dark environment and thus improves the workability under a dark environment.

[0038] Further, in the above configuration, when the rear light is disposed, the rear light is intentionally separated from the rear camera and is installed at the rear upper portion of the cabin, instead of being disposed in the vicinity of the rear camera such that the rear light and the rear camera are paired with each other.

[0039] This makes it possible to emit light from a higher position than the hood to a broader illumination region behind the machine body than an illumination region behind the machine body in the case where the rear light and the rear camera are disposed in a pair. This further improves the workability under a dark environment.

[0040] In addition, in a case where an operator in the cabin looks back to directly view the region lying behind the machine body, it is possible to allow the operator to view the region lying behind the machine body, including a place higher than the hood, resulting in improvement in the visibility in the direct viewing. This also further improves the workability under a dark environment.

[0041] A work machine in accordance with an aspect of the present invention may be configured such that the rear light is installed so as to illuminate a vicinity of the machine body in an image-capturing area of the rear camera.

[0042] According to the above configuration, the vicinity of the machine body in the image-capturing area of the rear camera is illuminated with light. This makes it possible for the operator to use the rear camera to check, with good visibility, a state of a vicinity of the rear end part of the machine body which vicinity the operator desires to check the most. This further improves the workability under a dark environment.

[0043] A work machine in accordance with an aspect of the present invention may be configured such that the rear camera is installed such that a rear end part of the machine body is included in an image-capturing area of the rear camera.

[0044] According to the above configuration, since the rear end part of the machine body is included in the image-capturing area of the rear camera, the operator easily gains a sense of distance between the rear end part of the machine body and, for example, an obstacle located behind the machine body.

[0045] A work machine in accordance with an aspect of the present invention may be configured such that the rear light is installed at a center of the cabin in a left-and-right direction thereof.

[0046] According to the above configuration, it is possible to appropriately illuminate a field of view of the operator in the cabin in a case where the operator directly views the region lying behind the machine body.

[0047] A work machine in accordance with an aspect of the present invention may be configured such that, when seen in a side view, an angle between a line extending vertically downward from the rear light and a line passing through the rear light and the rear camera is not more than 45°.

[0048] According to the above configuration, it is possible to prevent, for example, the hood protruding further rearward of the machine body than the cabin from blocking the light from the rear light installed on the cabin, and to illuminate the region lying behind the machine body from a position close to the machine body with use of the rear light installed on the cabin.

[0049] A work machine in accordance with an aspect of the present invention may be configured such that, when seen in a side view, a separation distance between an extended line extending from a line passing through the rear light and the rear camera and a rear end part of the machine body is not more than 50 cm.

[0050] According to the above configuration, it is possible to allow the operator to use the rear camera to view, with good visibility, a state of a vicinity of the rear end part of the machine body which vicinity the operator desires to check the most. This can further improve the workability under a dark environment.

[0051] A work machine in accordance with an aspect of the present invention may include: a hood being provided in the rear portion of the machine body and covering a part on a side rearward of the cabin in a manner such that the hood is openable and closable; and a counterweight located on a lower side of the hood, and the rear camera may be disposed on the hood.

[0052] According to the above configuration, it is possible to illuminate a region lying above the hood and behind the machine body with use of the rear light provided at the rear upper portion of the cabin.

[0053] The present invention is not limited to the embodiments, but can be altered by a skilled person in the art within the scope of the claims. The present invention also encompasses, in its technical scope, any embodiment derived by combining technical means disclosed in differing embodiments.

Reference Signs List

[0054]

1	Work machine
2	Traveling device
3	Machine body
4	Work device
5	Cabin
6	Engine
7	Hood
8	Counterweight
10	Front light
20	Rear light
21	Rear camera

22	Rear mirror
30	Ground surface
L1	Line passing through the rear light and the rear camera
L2	Extended line
L3	Line extending vertically downward from a rear end part of the machine body
L4	Separation distance
L7	Line extending vertically downward from the rear light
RA	Illuminating area
RB	Image-capturing area

15 **Claims**

1. A work machine (1) comprising:

a machine body (3);
a cabin (5) located on the machine body;
a rear light (20) that is located at a rear upper portion of the cabin and that is configured to illuminate (i) a region lying behind the cabin and above a rear portion of the machine body and (ii) a region lying behind the machine body; and
a rear camera (21) that is located in the rear portion of the machine body and behind the cabin and that is configured to capture an image of the region lying behind the machine body.

2. The work machine according to claim 1, wherein the rear light (20) is installed so as to illuminate a vicinity of the machine body (3) in an image-capturing area of the rear camera (21).

3. The work machine according to claim 1 or 2, wherein the rear camera (21) is installed such that a rear end part of the machine body (3) is included in an image-capturing area (RB) of the rear camera.

4. The work machine according to any one of claims 1 to 3, wherein the rear light (20) is installed at a center of the cabin (5) in a left-and-right direction thereof.

45 5. The work machine according to any one of claims 1 to 4, wherein, when seen in a side view, an angle between a line extending vertically downward from the rear light (20) and a line passing through the rear light and the rear camera (21) is not more than 45°.

50 6. The work machine according to claim 2, taken in combination with any one of claims 1 to 5, wherein, when seen in a side view, a separation distance (L4) between an extended line (L2) extending from a line (L1) passing through the rear light (20) and the rear camera (21) and a rear end part of the machine body is not more than 50 cm.

7. The work machine according to any one of claims 1 to 6, comprising:

a hood (7) being provided in the rear portion of the machine body (3) and covering a part on a side rearward of the cabin (5) in a manner such that the hood is openable and closable; and a counterweight (8) located on a lower side of the hood, the rear camera (21) being disposed on the hood.

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FIG. 1

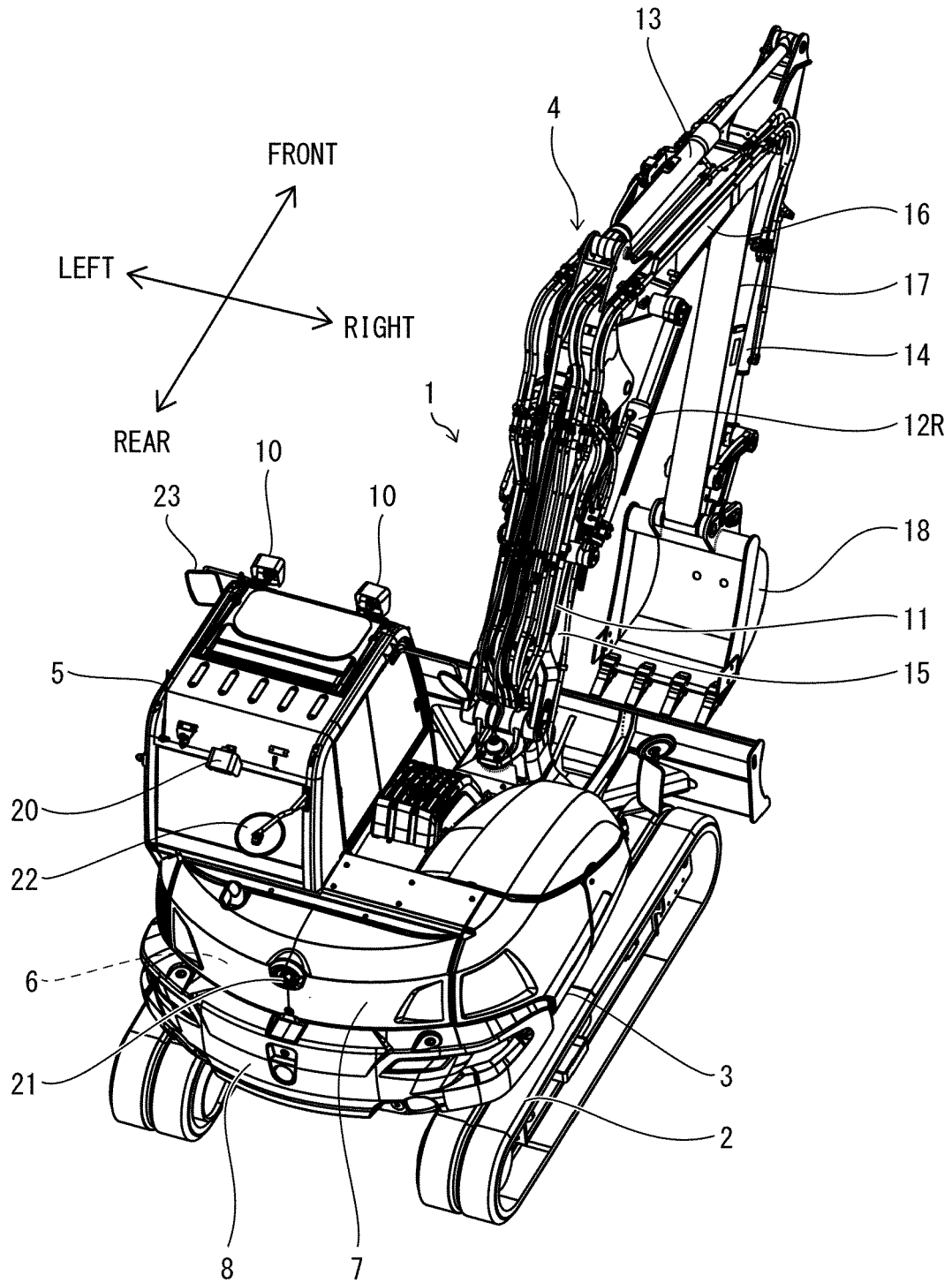


FIG. 2

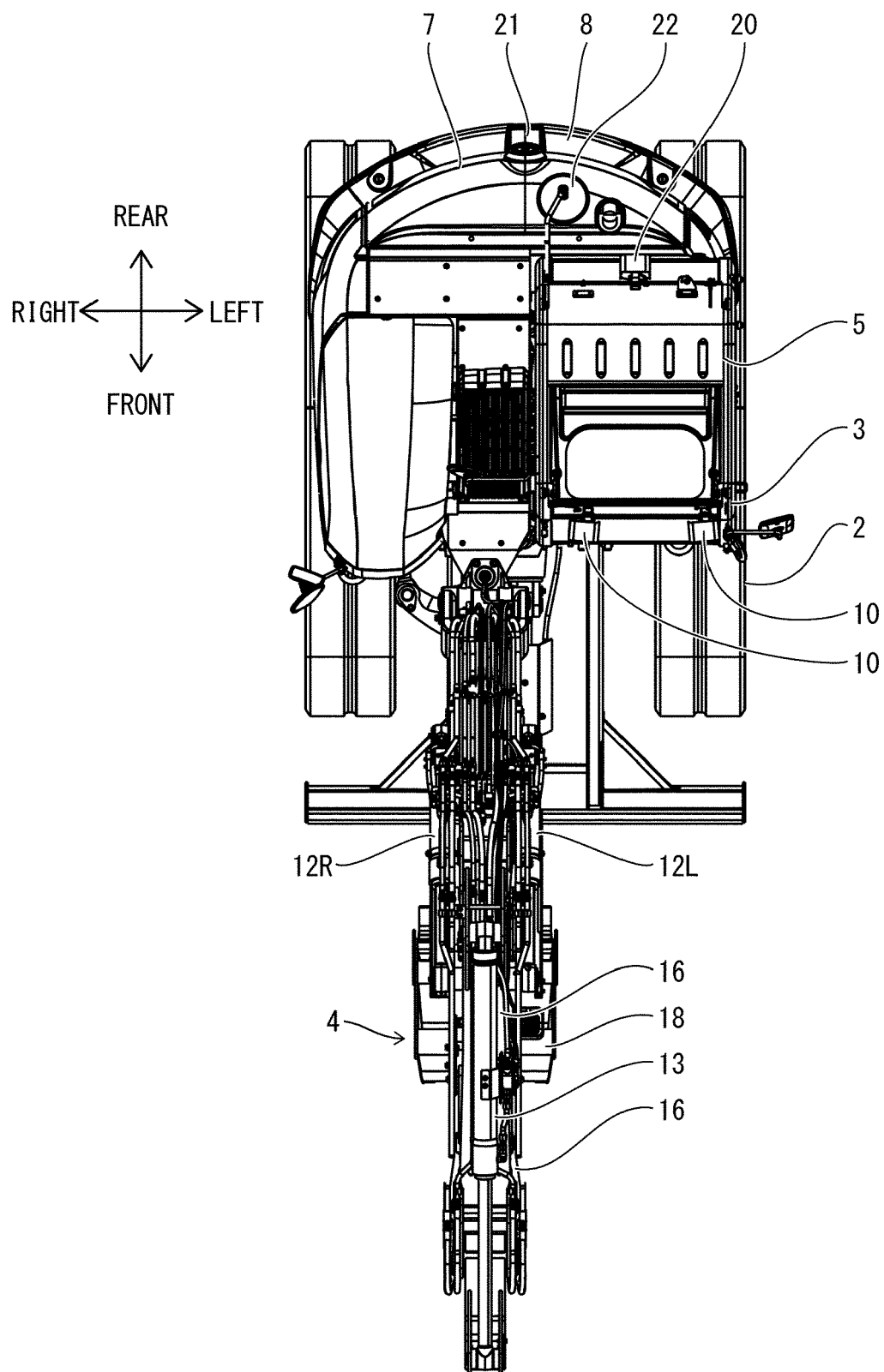


FIG. 3

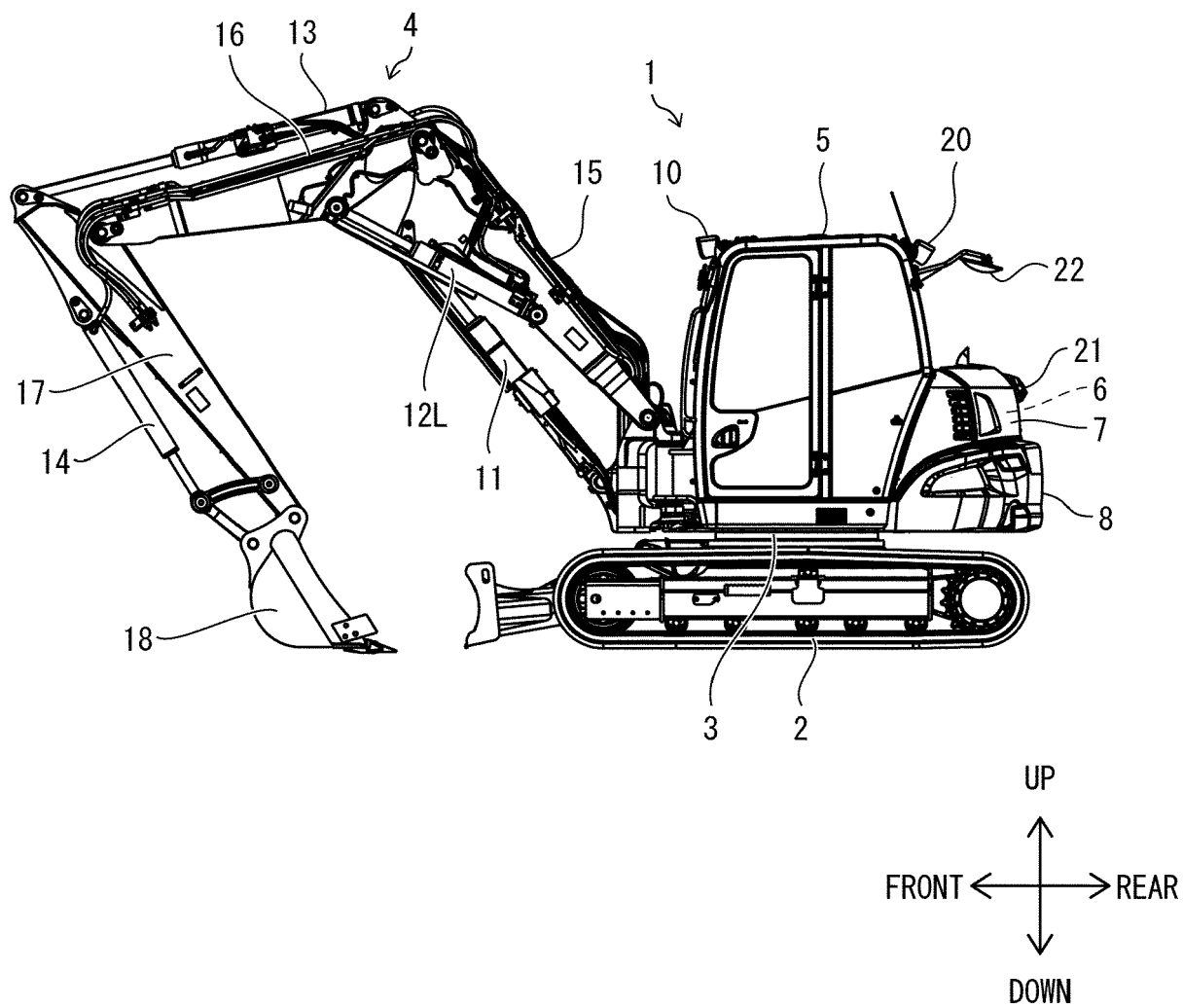


FIG. 4

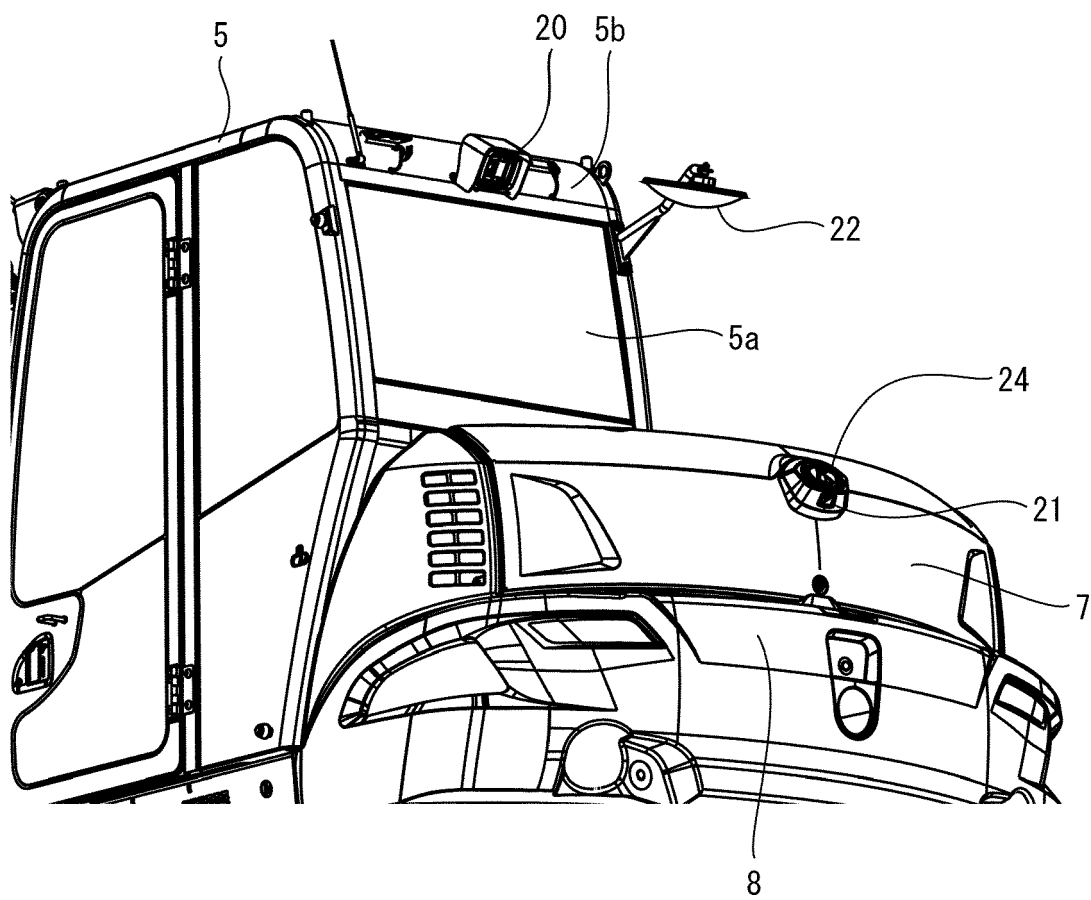


FIG. 5

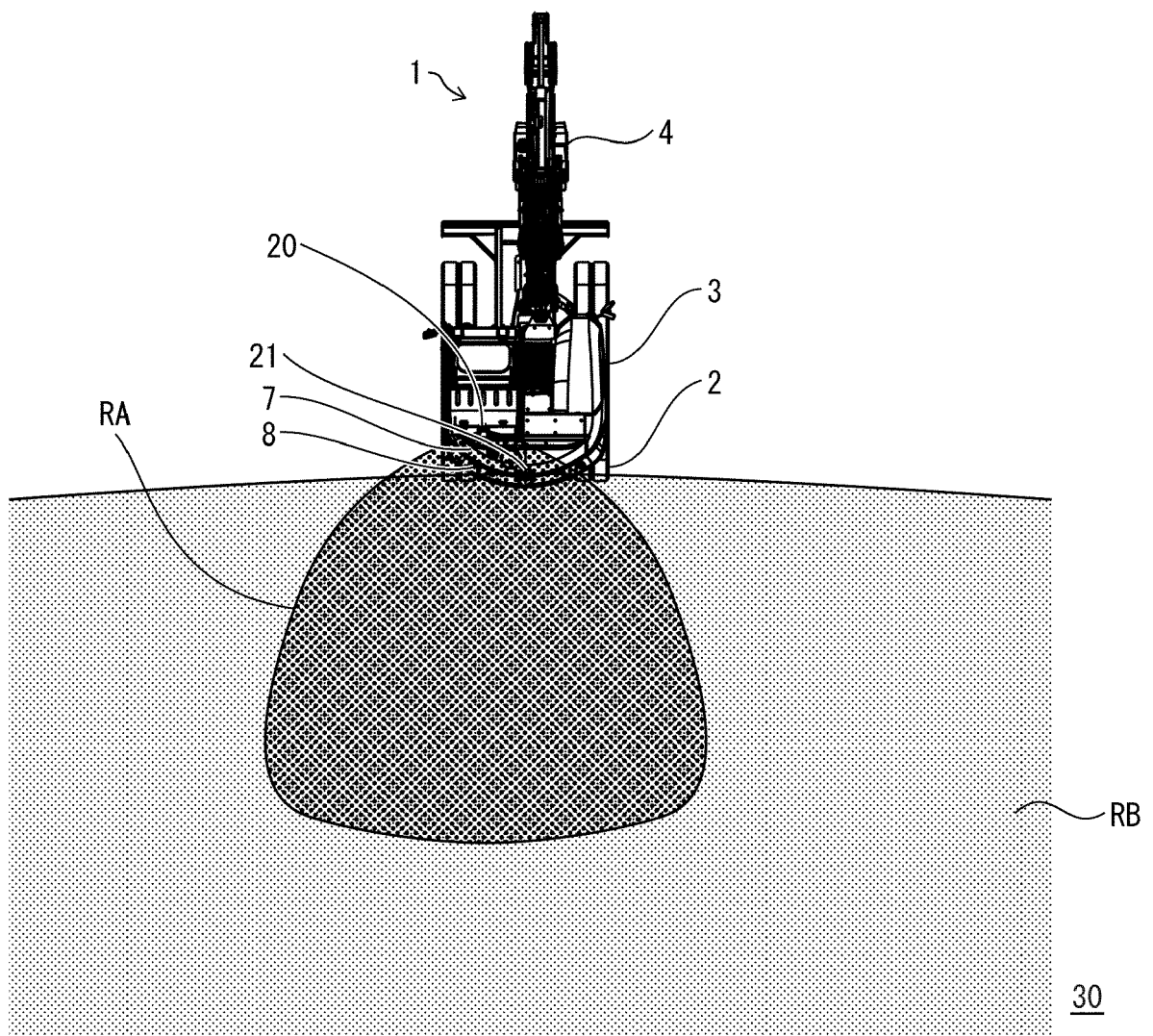


FIG. 6

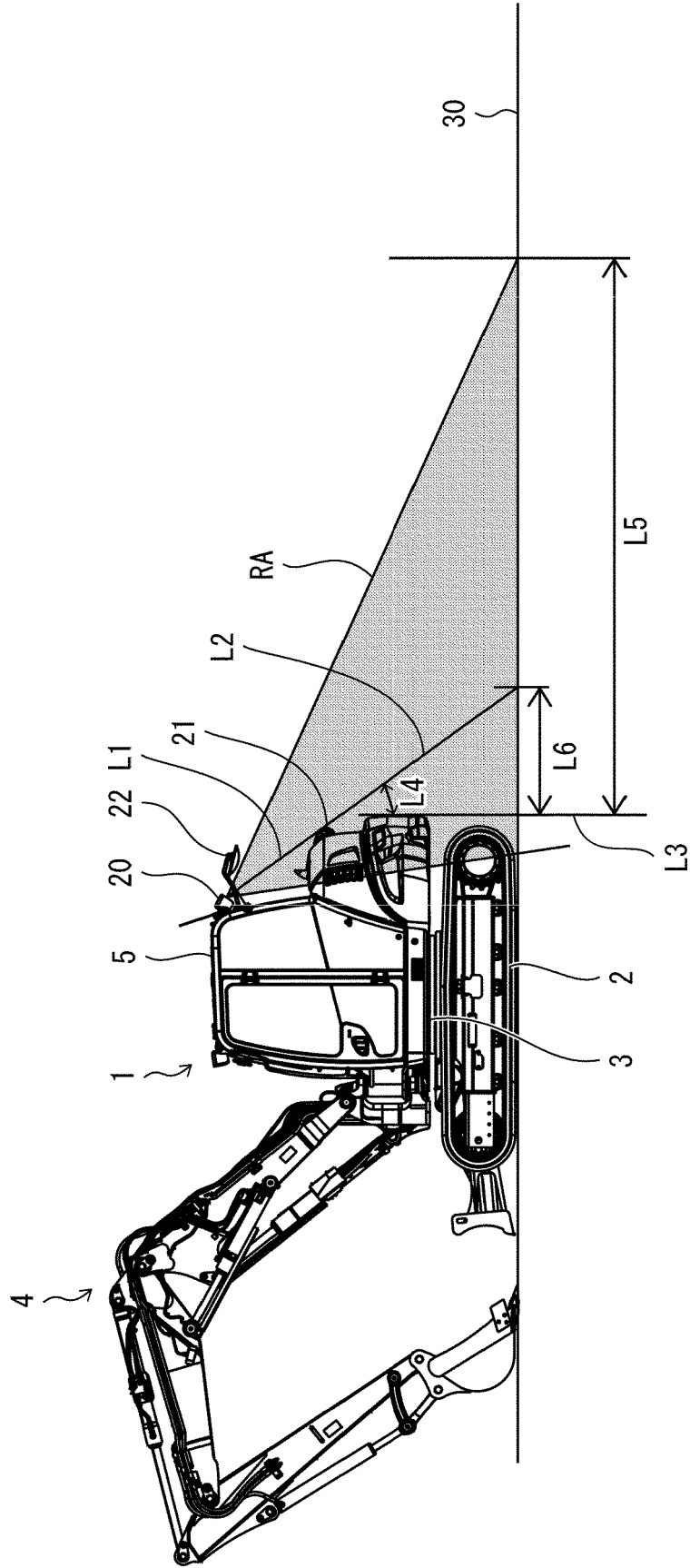
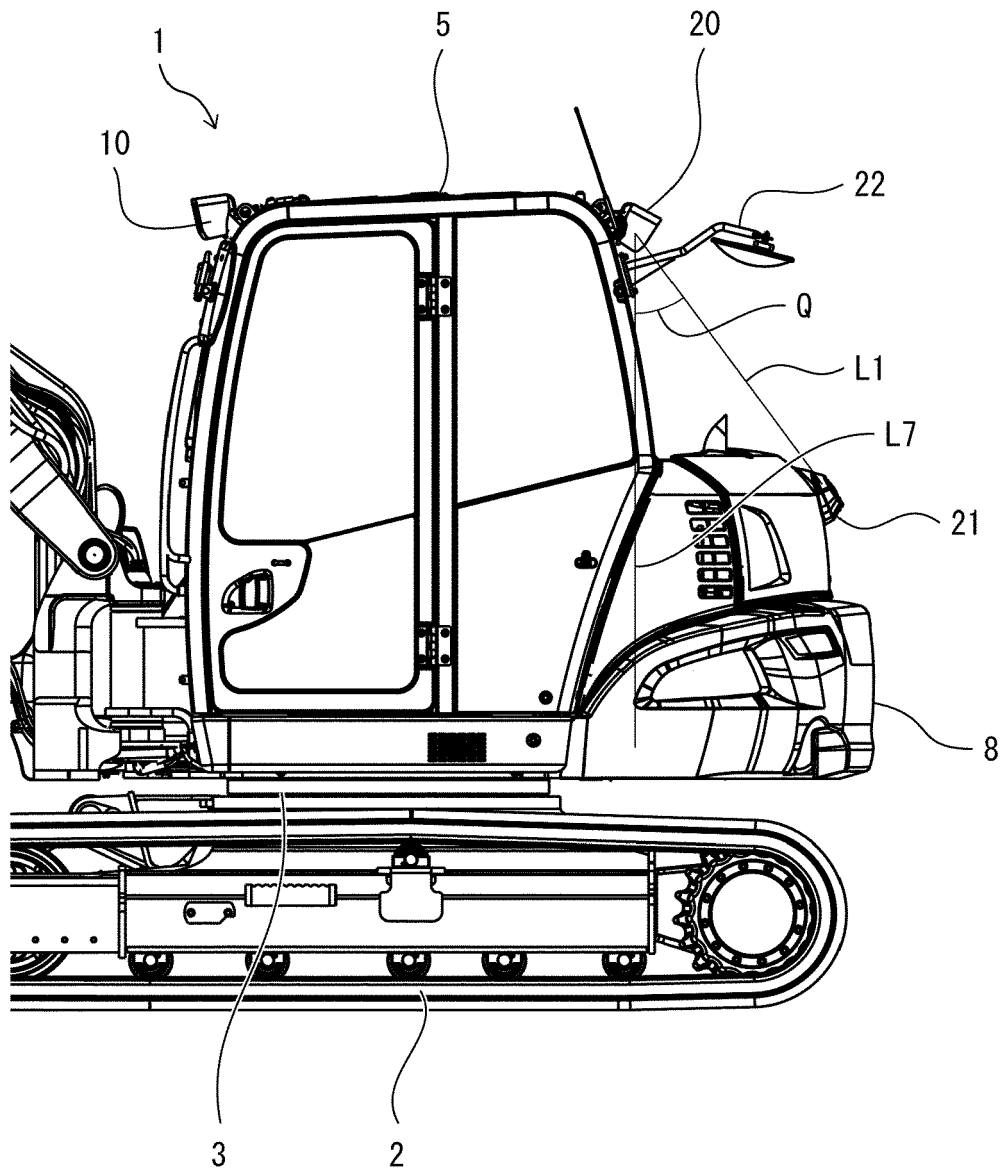


FIG. 7





EUROPEAN SEARCH REPORT

Application Number

EP 23 20 6556

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
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Y	Nordic Lights - Official: "SCORPIUS XTR & PICTOR - LED Excavator Lights NORDIC LIGHTS", / 14 September 2020 (2020-09-14), XP093140384, Retrieved from the Internet: URL:https://www.youtube.com/watch?v=nbs6VLJjdro [retrieved on 2024-03-12] * the whole document *	1-7	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 March 2024	Examiner Dreyer, Christoph
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	



EUROPEAN SEARCH REPORT

Application Number

EP 23 20 6556

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 March 2024	Examiner Dreyer, Christoph
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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