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(54) **WORKING MACHINE**

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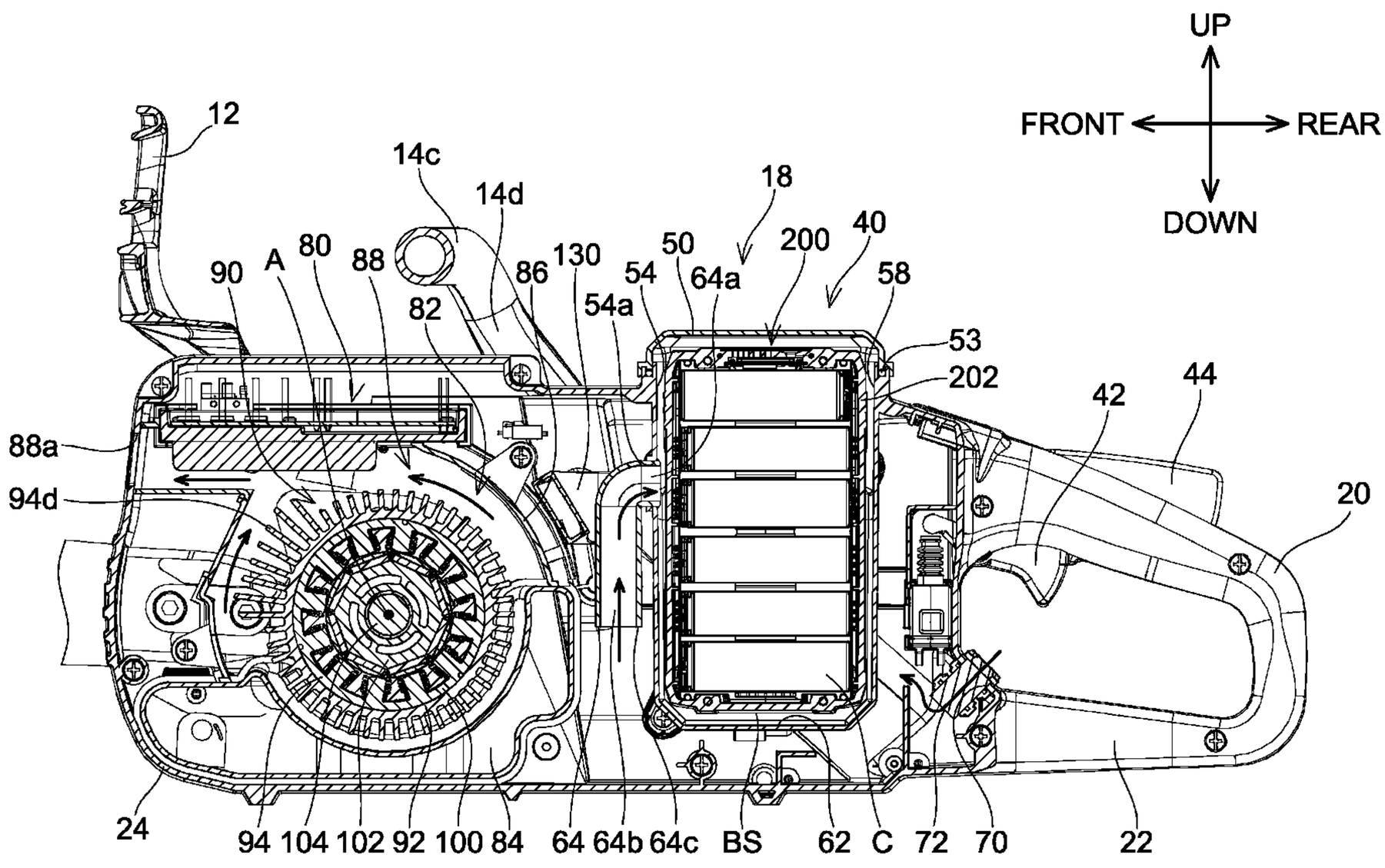
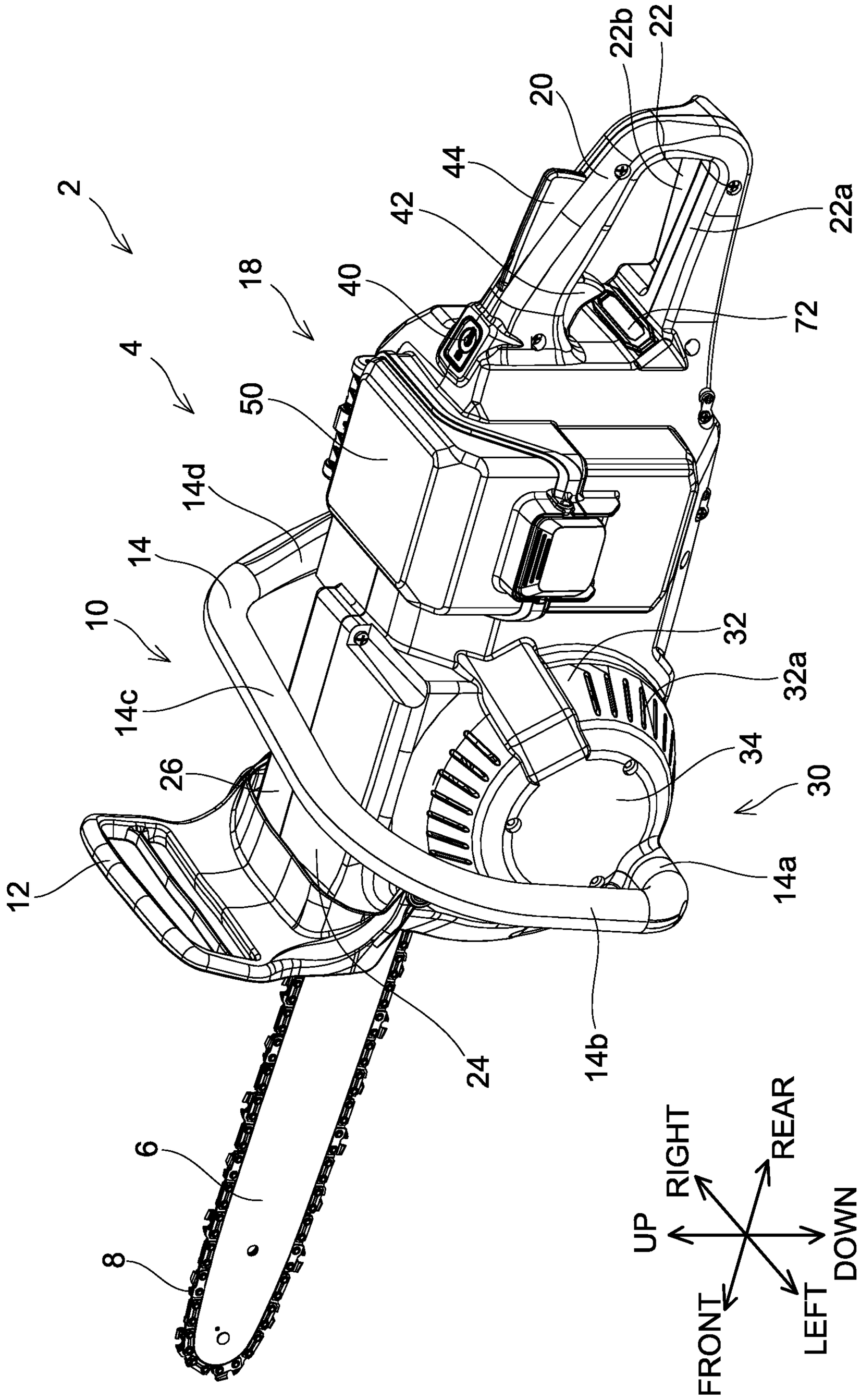
(57) **ABSTRACT**

A working machine may include a working part, a body including a motor accommodating part, a fan accommodated in the motor accommodating part and a motor accommodated in the motor accommodating part and configured to drive the working part and the fan. The fan may include a disk plate including a circular opening defined at a center of the disk plate, a plurality of vanes attached to the disk plate, and a cover part. The plurality of vanes may be covered by the disk plate and the cover part in an axial direction.

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4
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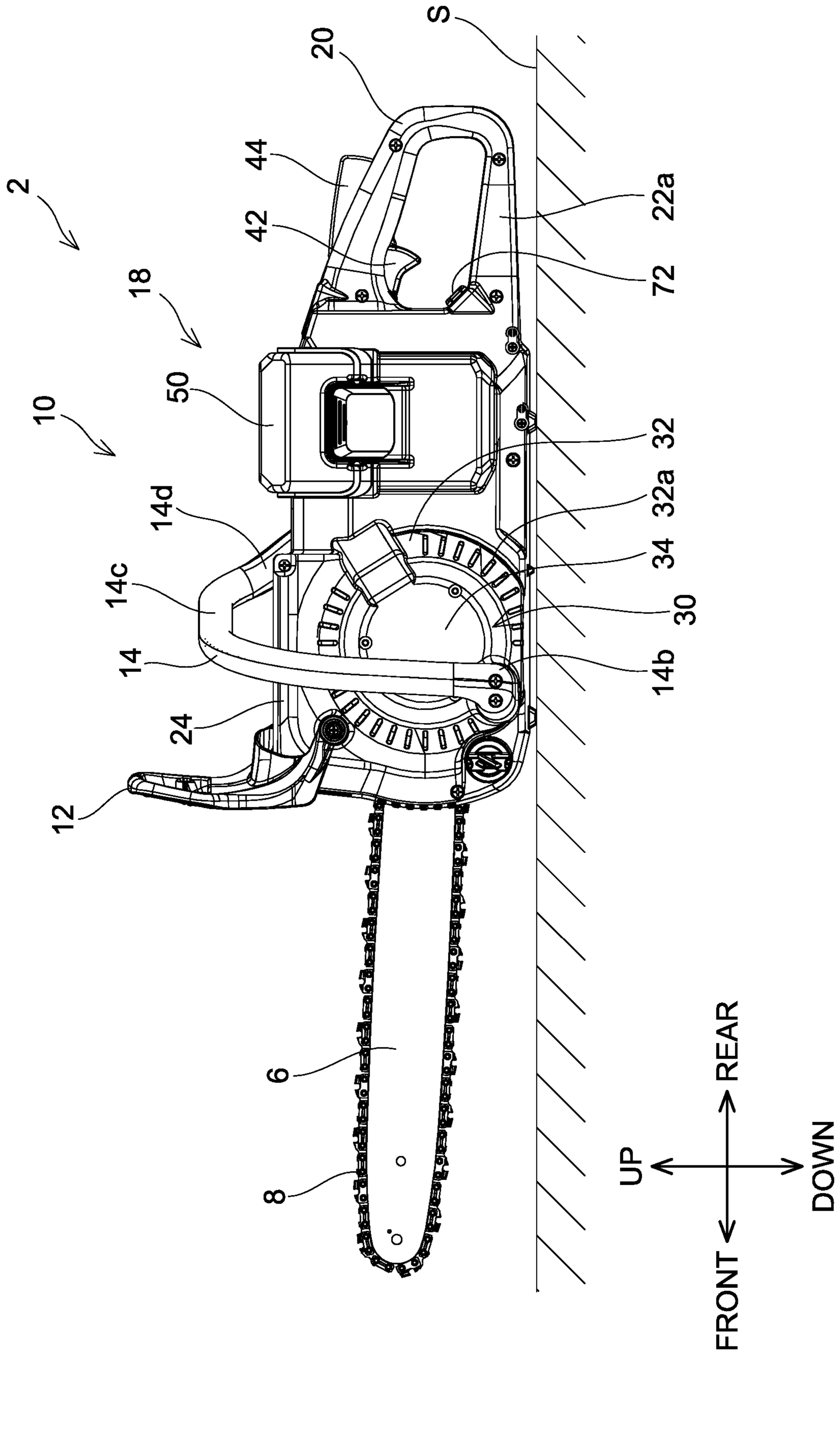
42
44
20
22b
22
22a
72
50
14d
14
10
14c
26
12
32
32a
34
30
14a
14b
24
6
8
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 1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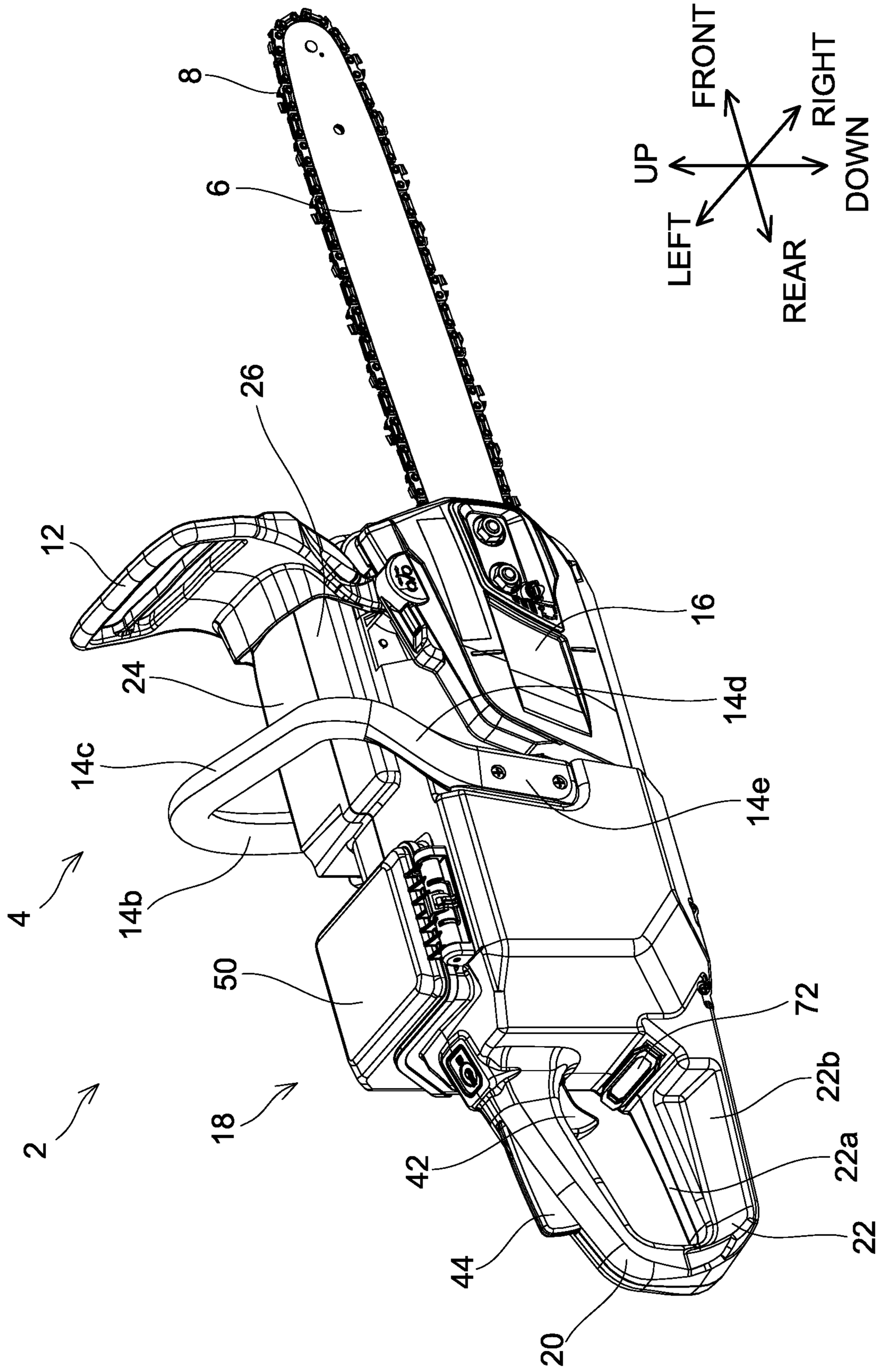
42
2
18
50
10
14d
14c
14
24
12
6
8
22a
72
32
32a
34
30
14b
UP
DOWN
FRONT
REAR

FIG. 2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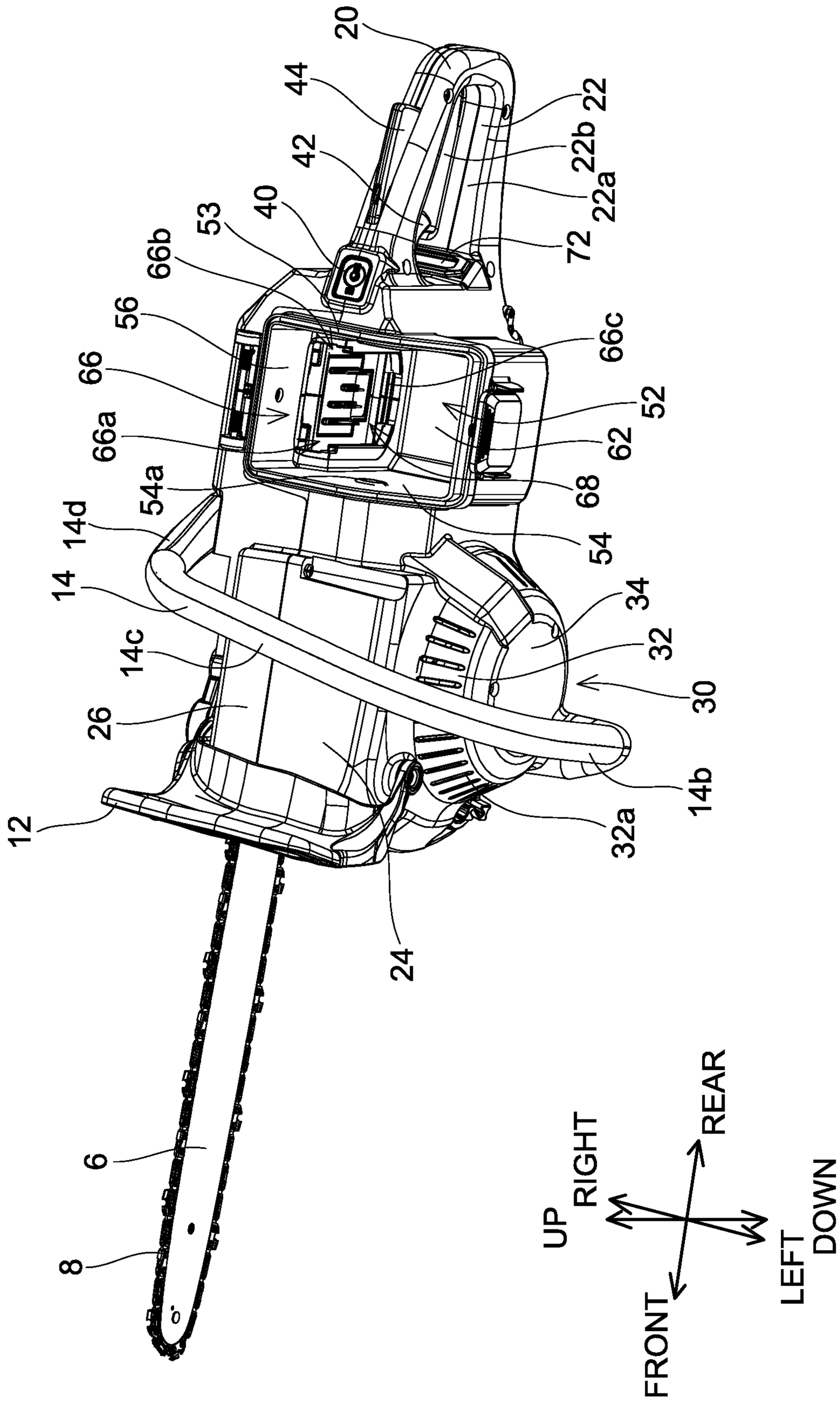
FRONT
RIGHT
LEFT
REAR
DOWN
8
6
26
12
24
16
14d
14c
14e
4
14b
50
72
22b
2
18
42
22a
44
22
20

FIG. 3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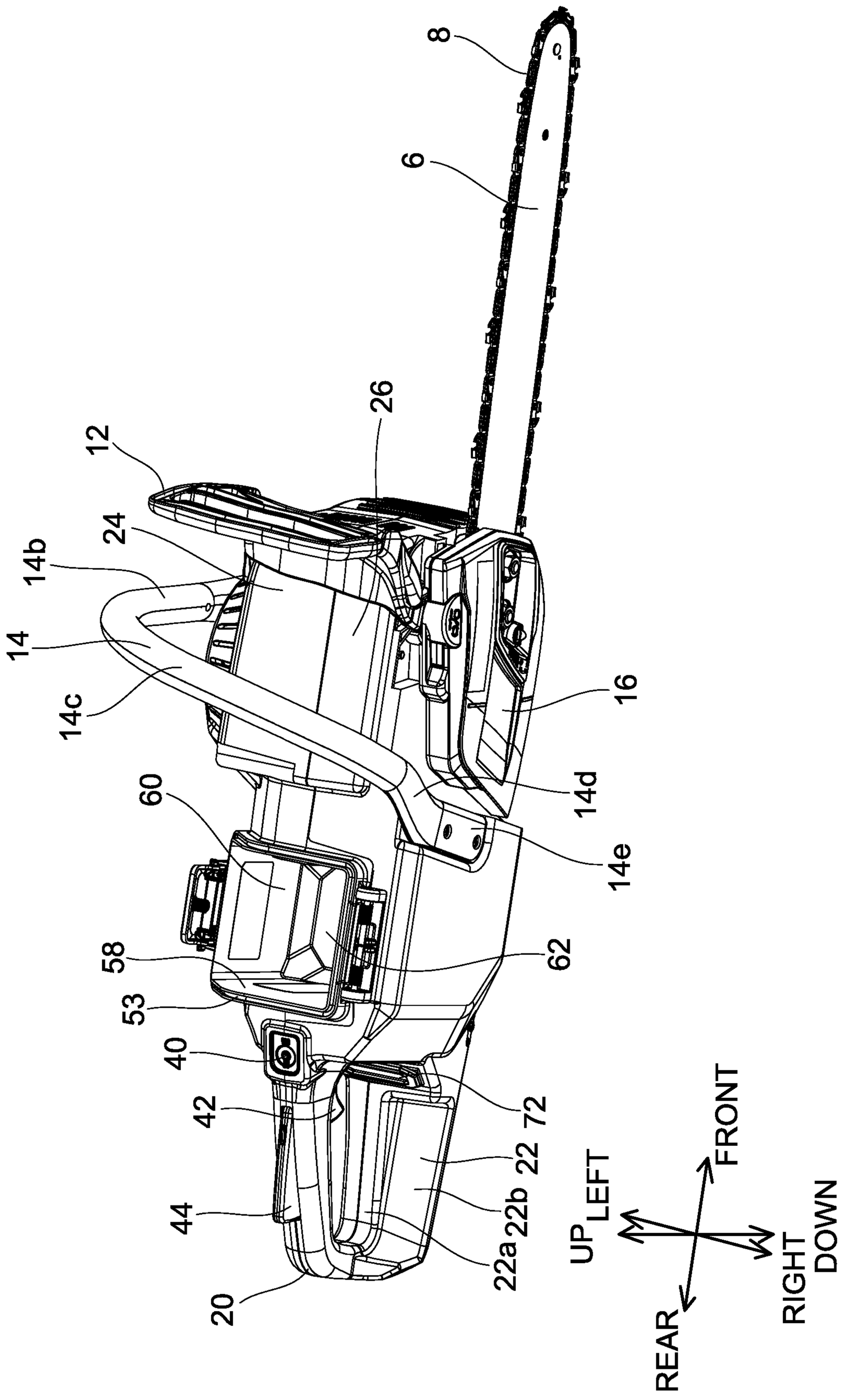
42
40
53
66b
56
66
66a
54a
14d
14
14c
26
12
24
6
8
22
22b
22a
72
66c
52
62
68
54
34
32
30
14b
32a
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 4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6
26
12
24
14b
14
14c
16
60
14d
14e
58
53
62
40
42
72
22
44
22b
22a
20
UP
LEFT
FRONT
REAR
RIGHT
DOWN

FIG. 5

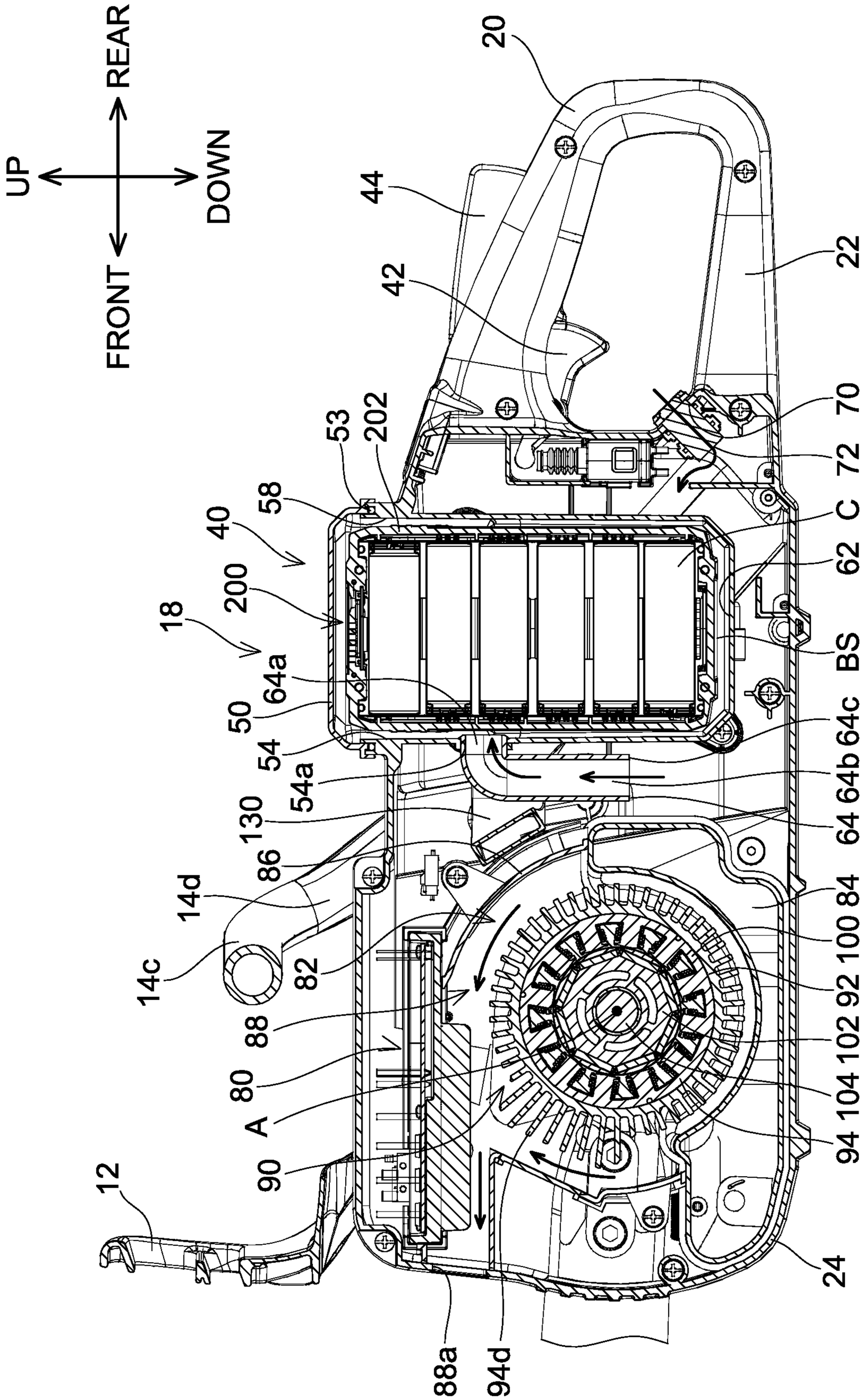
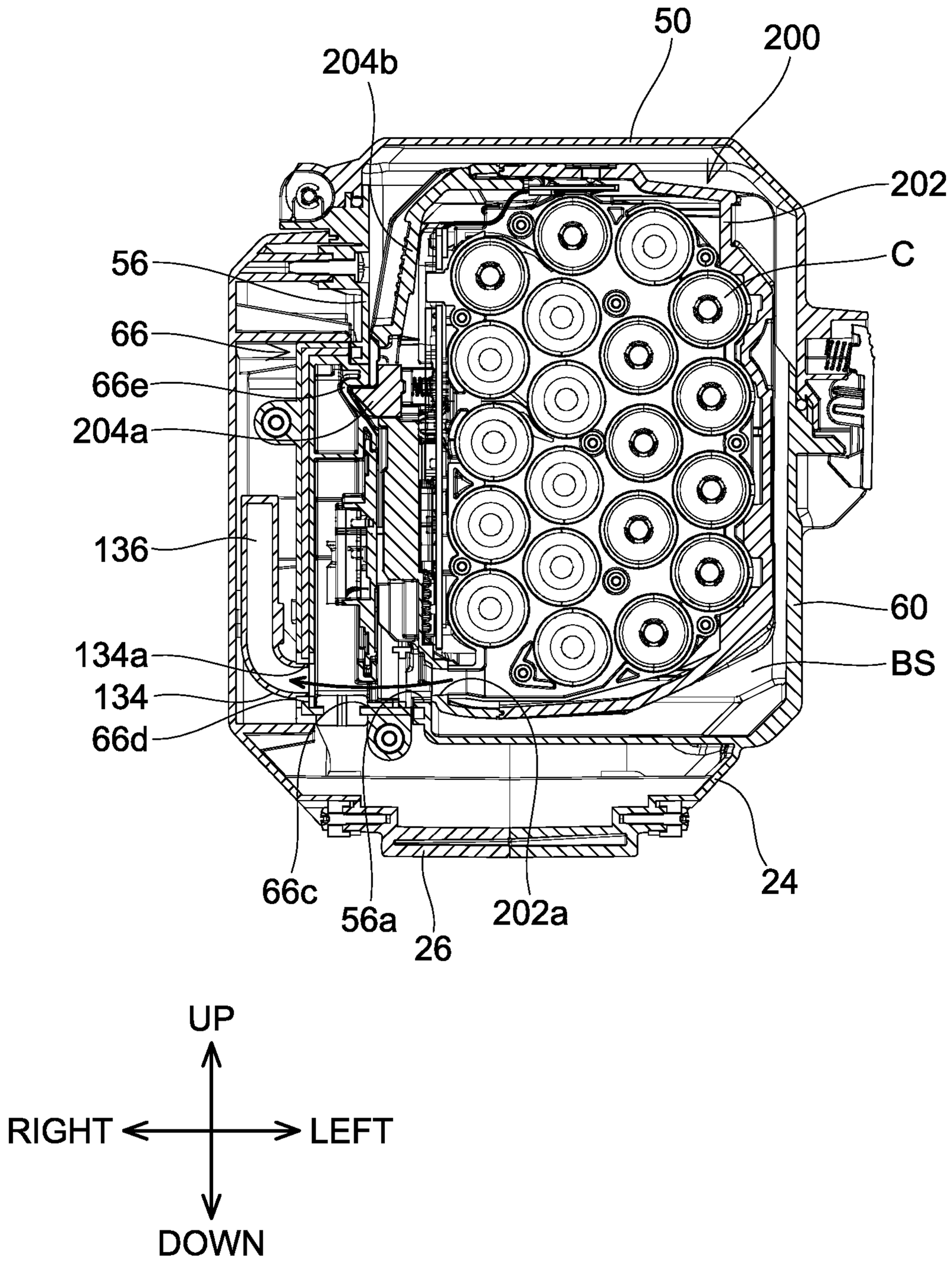

UP
REAR
DOWN
FRONT
20
44
42
22
53
202
58
40
200
18
64a
50
54
54a
130
86
14d
14c
82
88
80
A
90
12
88a
94d
70
72
C
62
BS
64c
64b
64
84
100
92
102
104
94
24

FIG. 6

FIG. 7


50
200
204b
202
C
56
66
66e
204a
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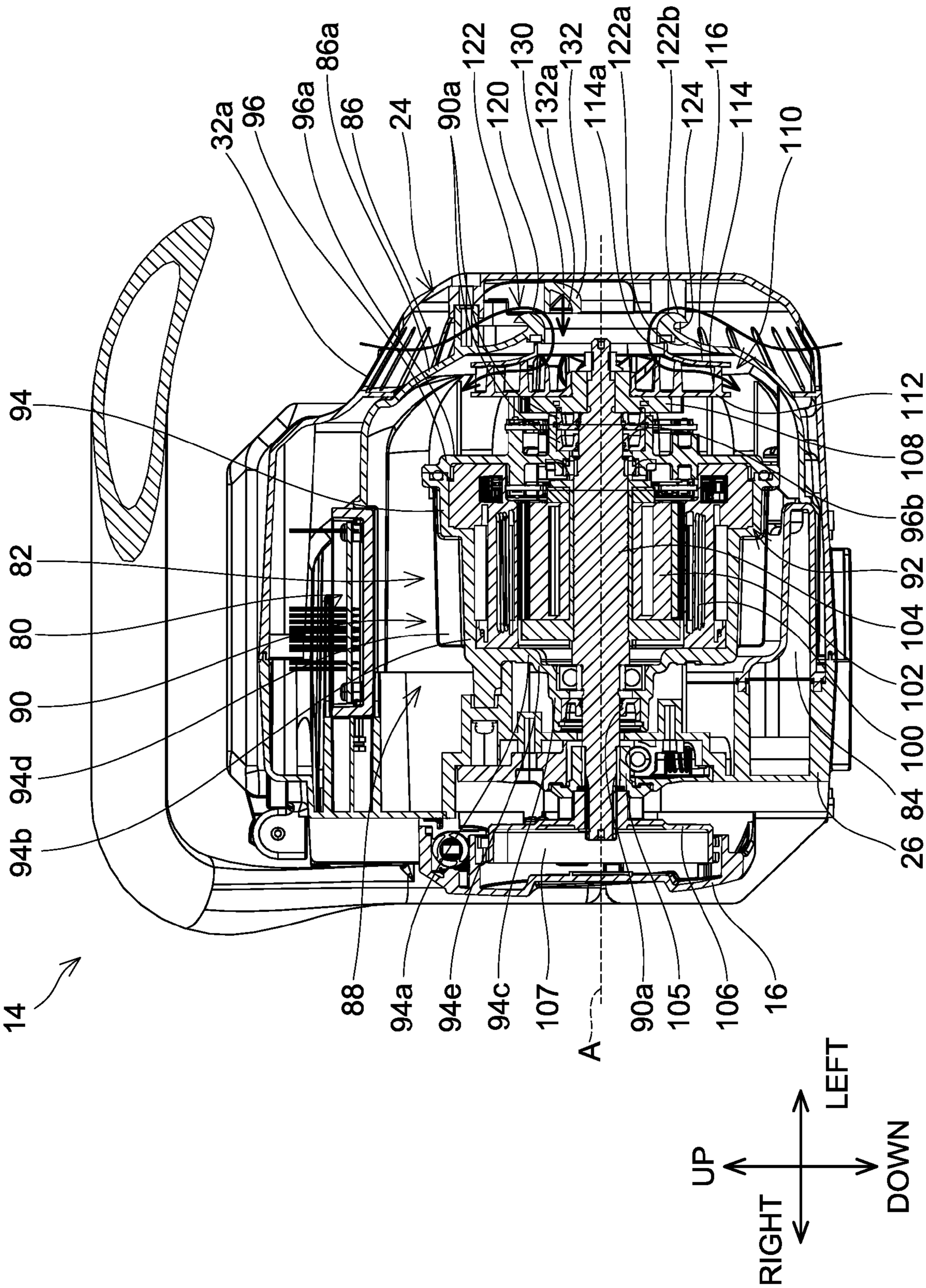
60
134a
BS
134
66d
24
66c
56a
26
202a
UP
RIGHT
LEFT
DOWN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96a
86a
86
24
90a
122
120
130
132a
132
114a
122a
122b
116
124
114
110
94
82
80
90
94d
94b
112
108
96b
92
104
102
100
84
26
14
88
94a
94e
94c
107
A
90a
105
106
16
UP
LEFT
RIGHT
DOWN

FIG. 8

FIG. 9

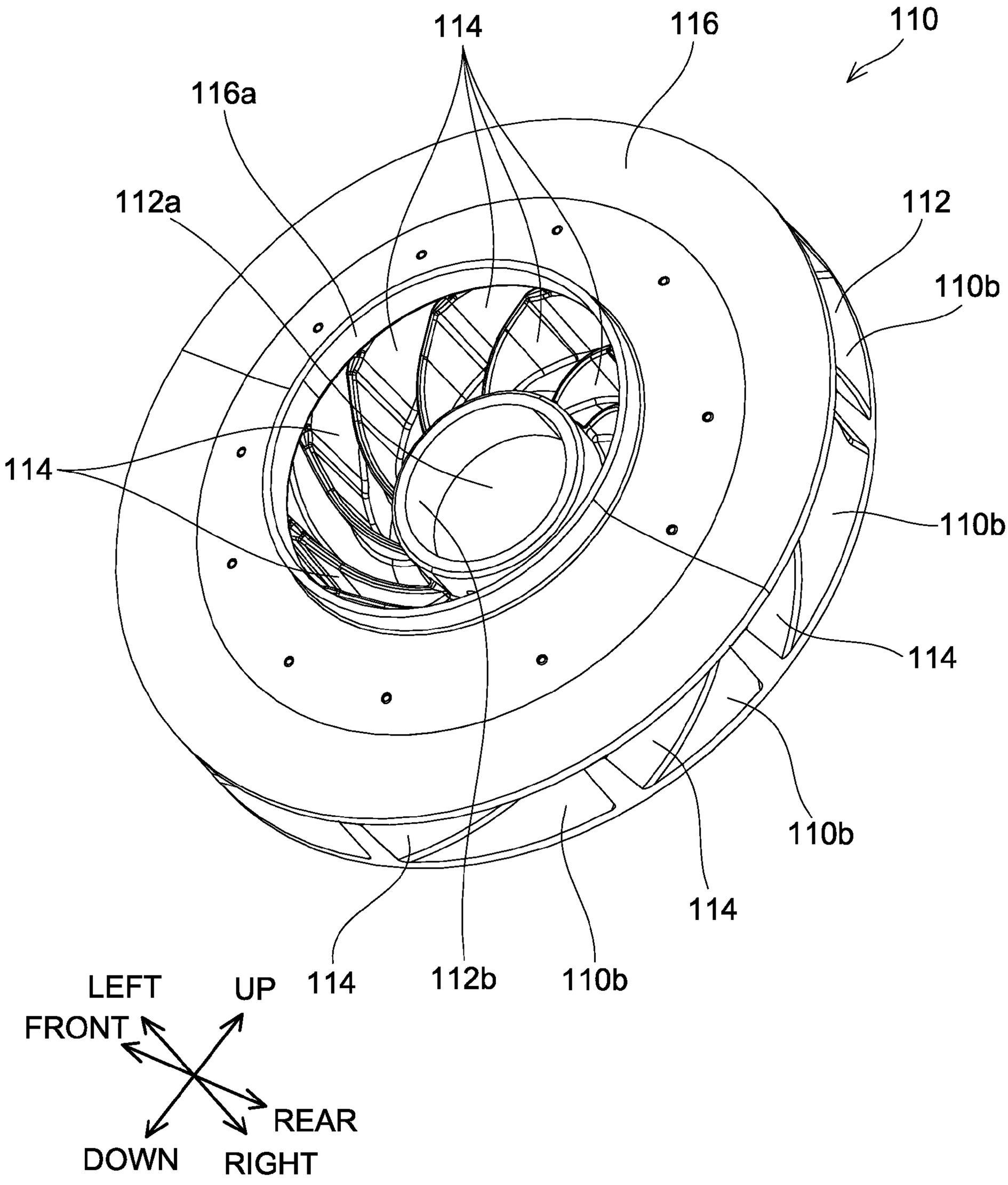

114
116
110
116a
112a
112
110b
114
110b
114
110b
114
112b
110b
LEFT
UP
FRONT
REAR
DOWN
RIGHT

FIG. 10

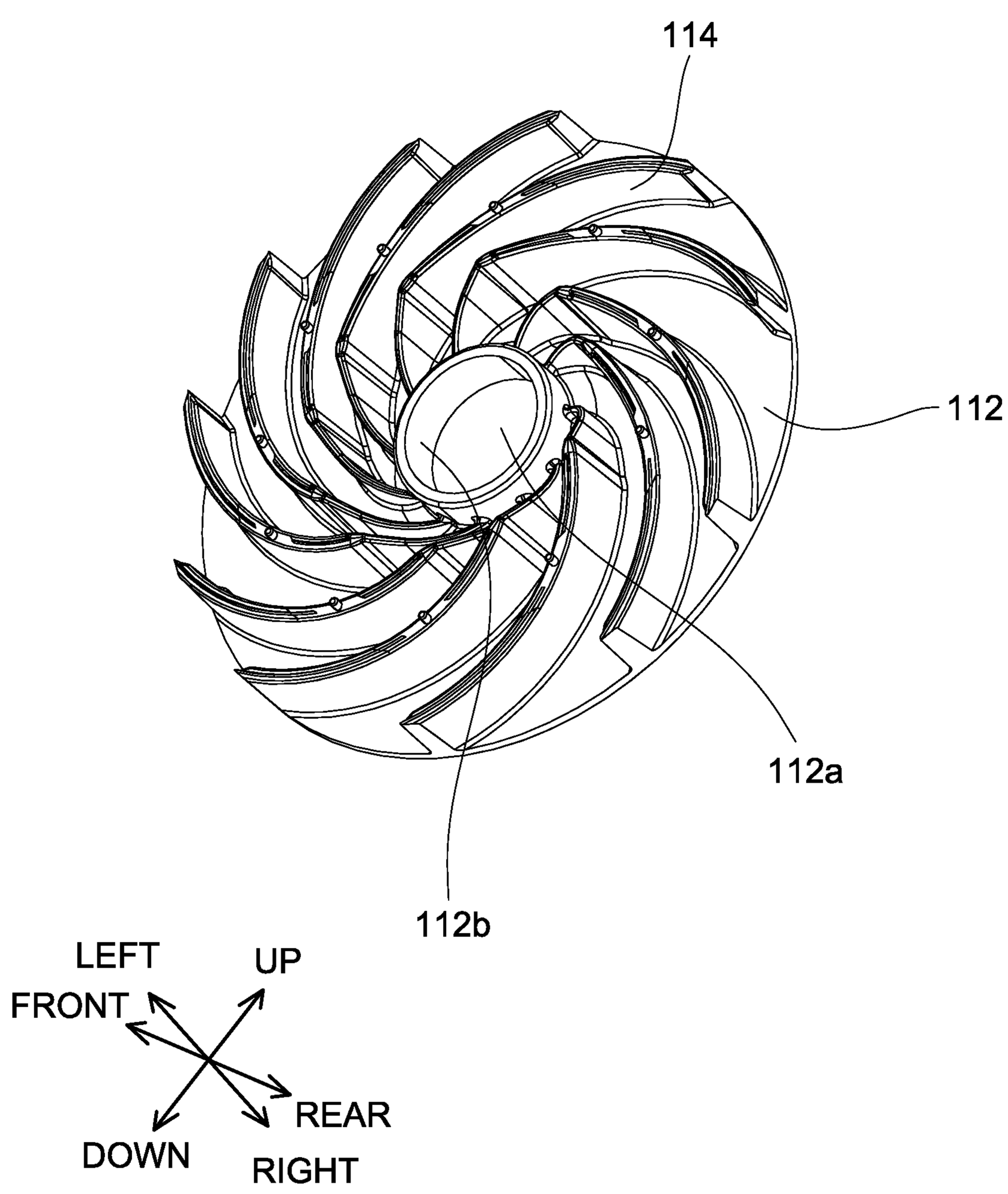


FIG. 11

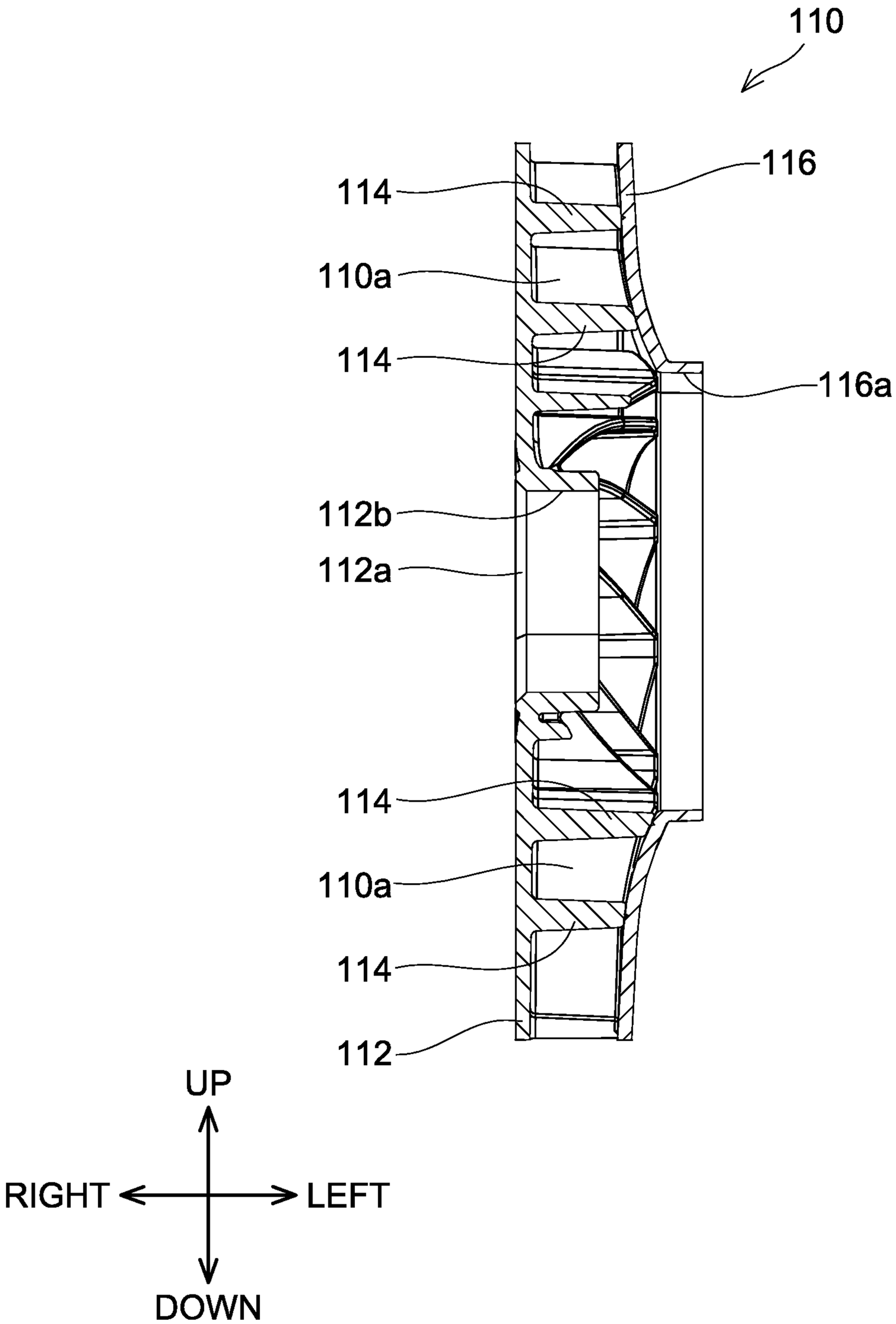

110
114
116
110a
114
116a
112b
112a
114
110a
114
112
UP
RIGHT
LEFT
DOWN

FIG. 12

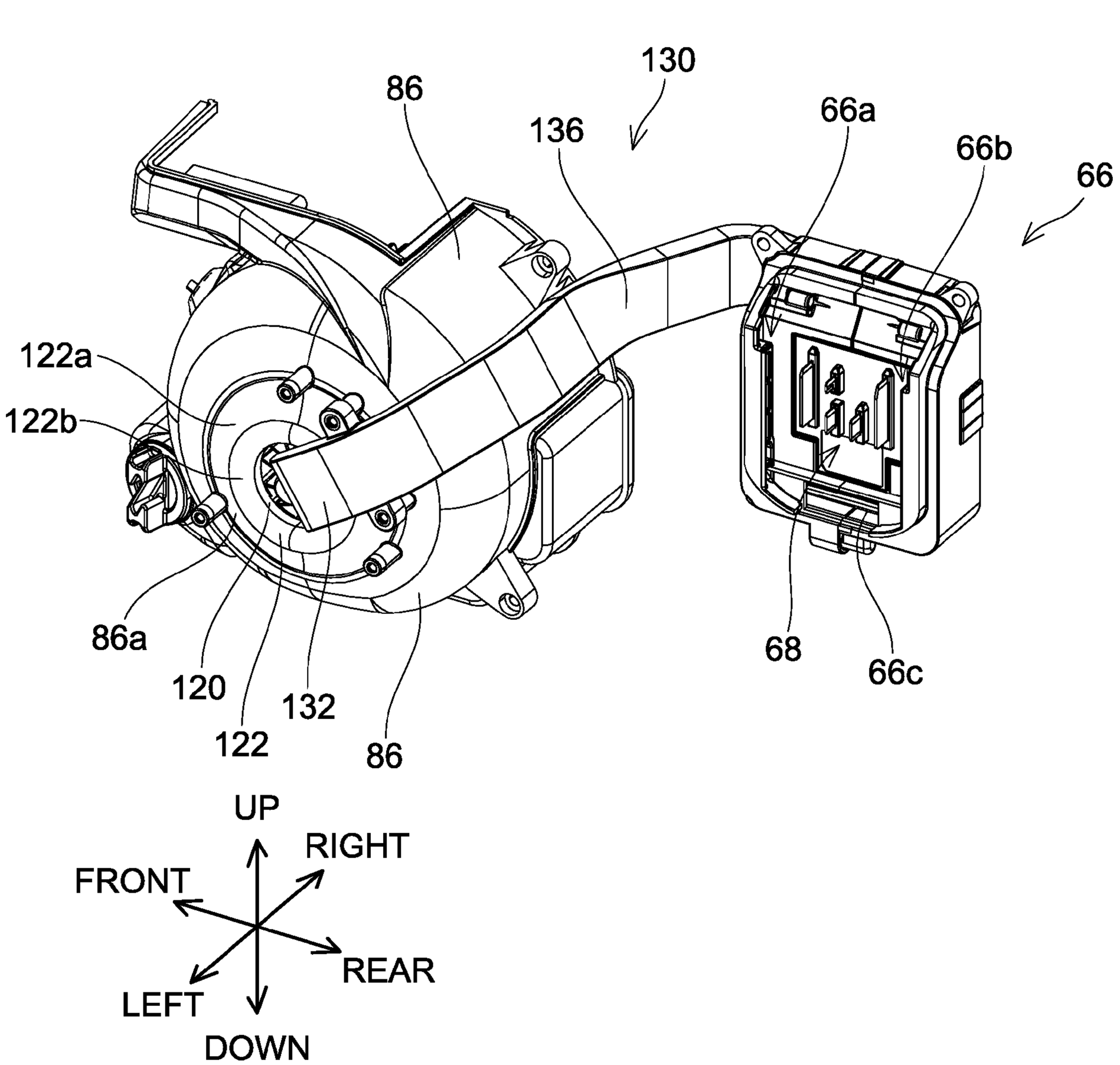

130
86
136
66a
66b
66
122a
122b
86a
120
132
122
86
68
66c
UP
RIGHT
FRONT
REAR
LEFT
DOWN

FIG. 13

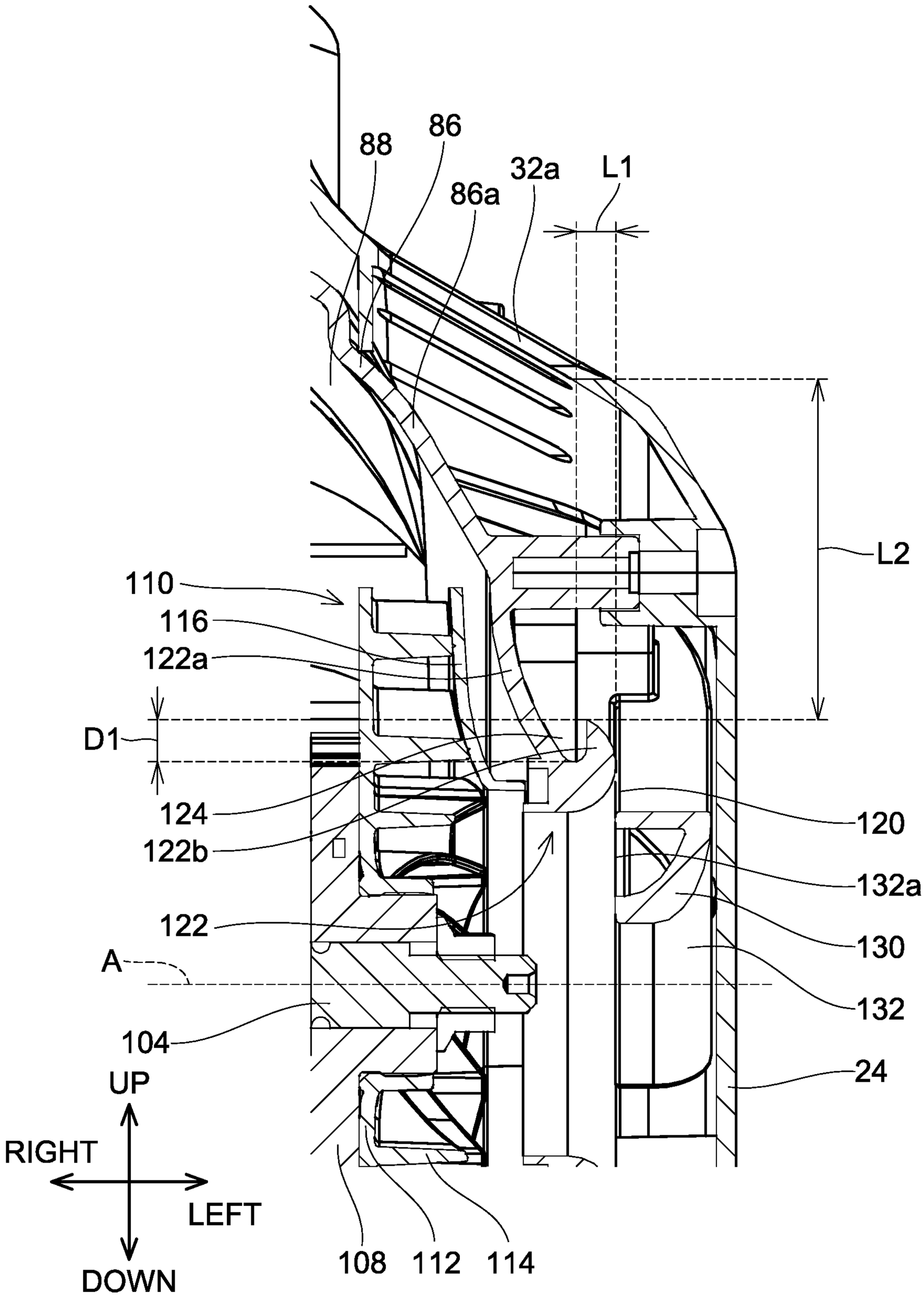

88
86
86a
32a
L1
L2
110
116
122a
D1
124
122b
122
A
104
120
132a
130
132
24
UP
RIGHT
LEFT
DOWN
108
112
114

FIG. 14

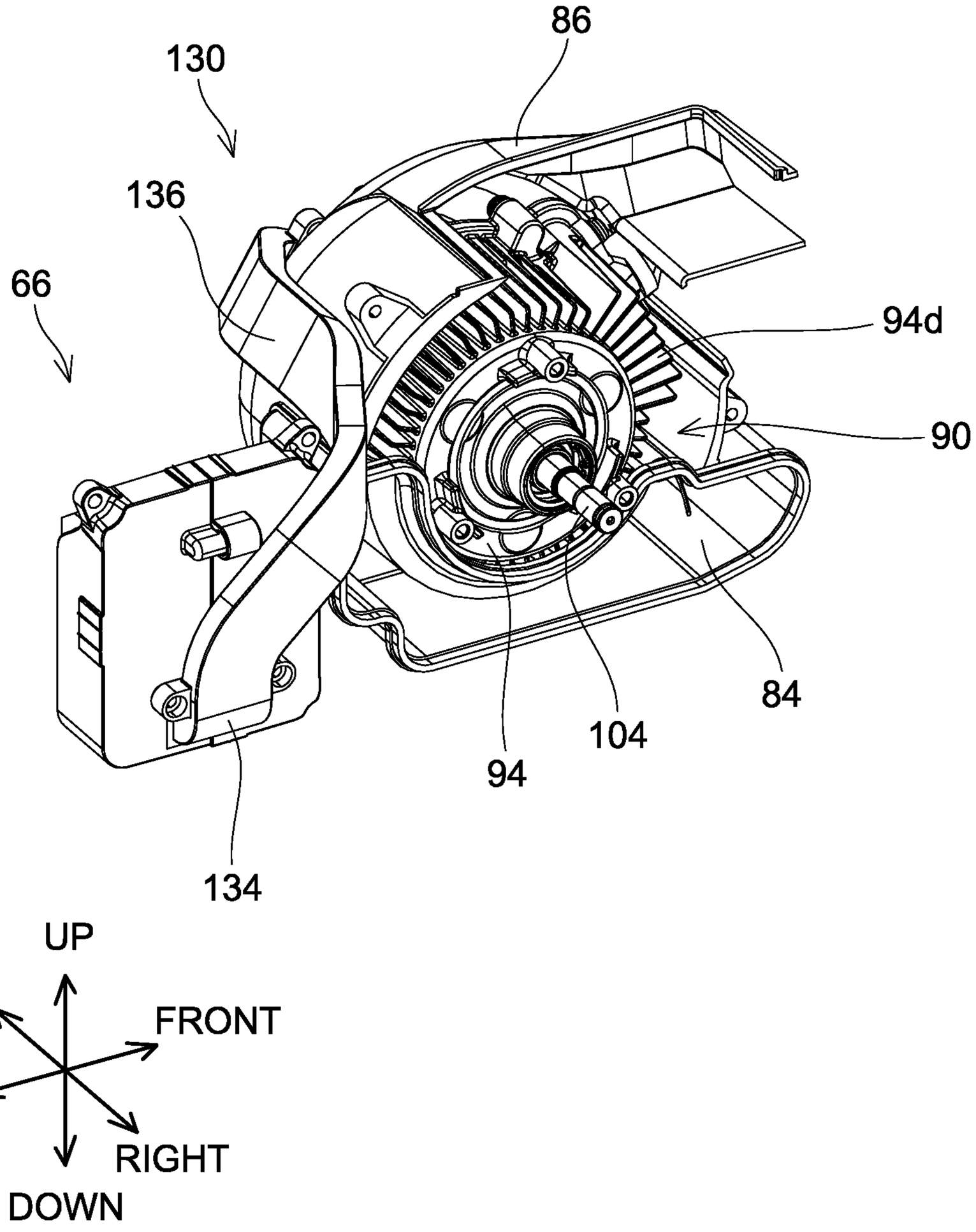


FIG. 15

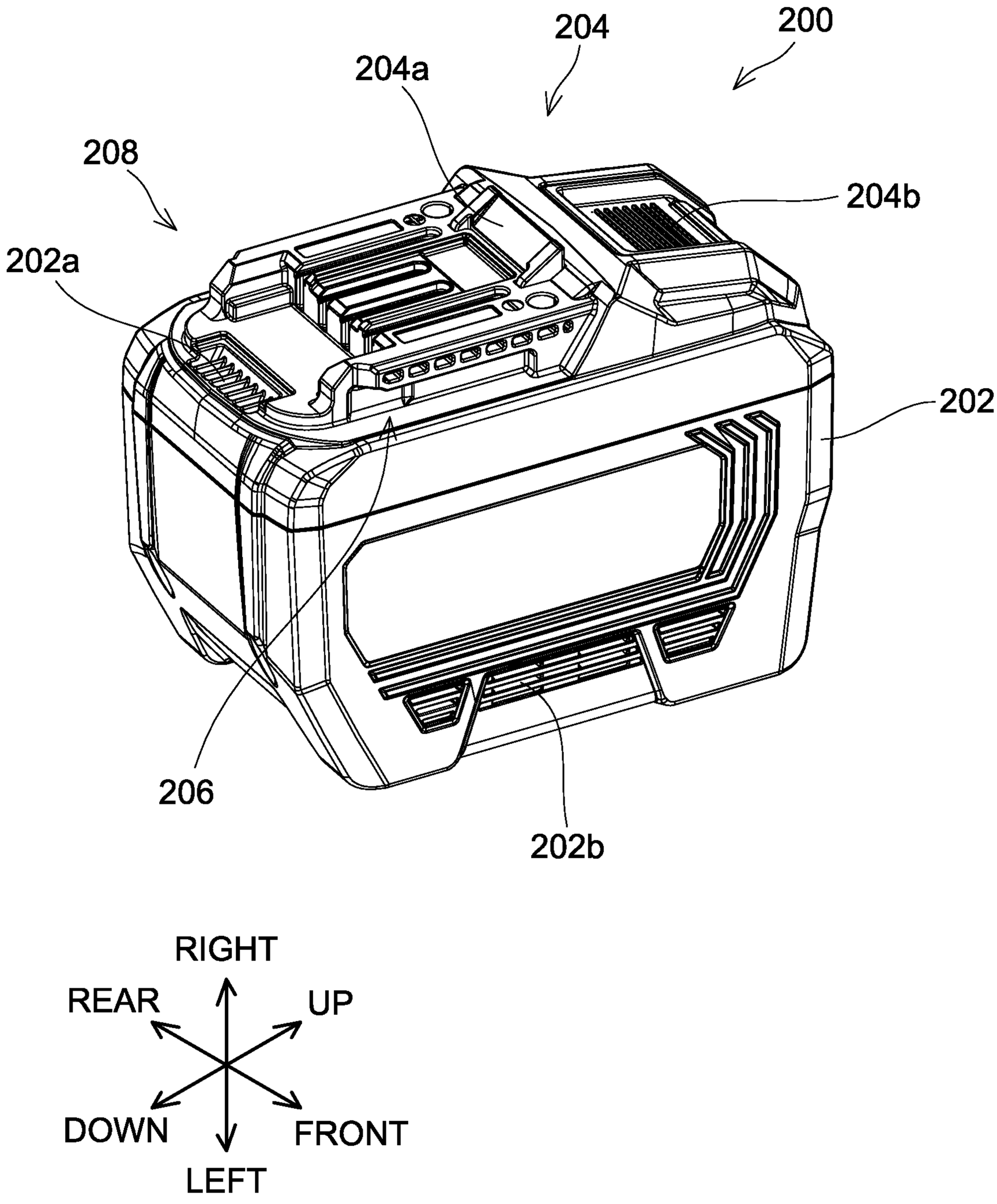

204
200
204a
208
204b
202a
202
206
202b
RIGHT
REAR
UP
DOWN
FRONT
LEFT

FIG. 16

(Second Embodiment)

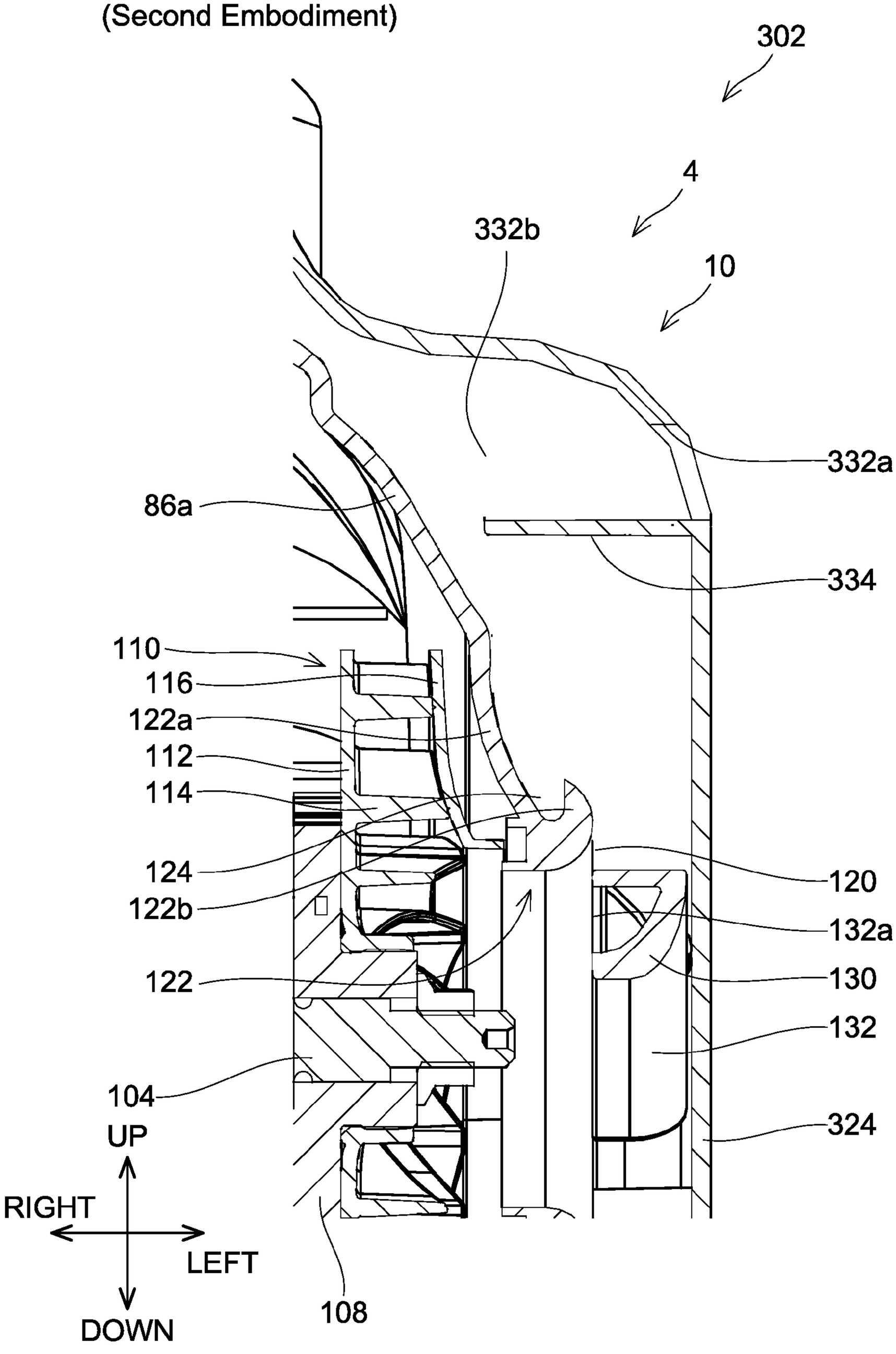


FIG. 17

(Third Embodiment)

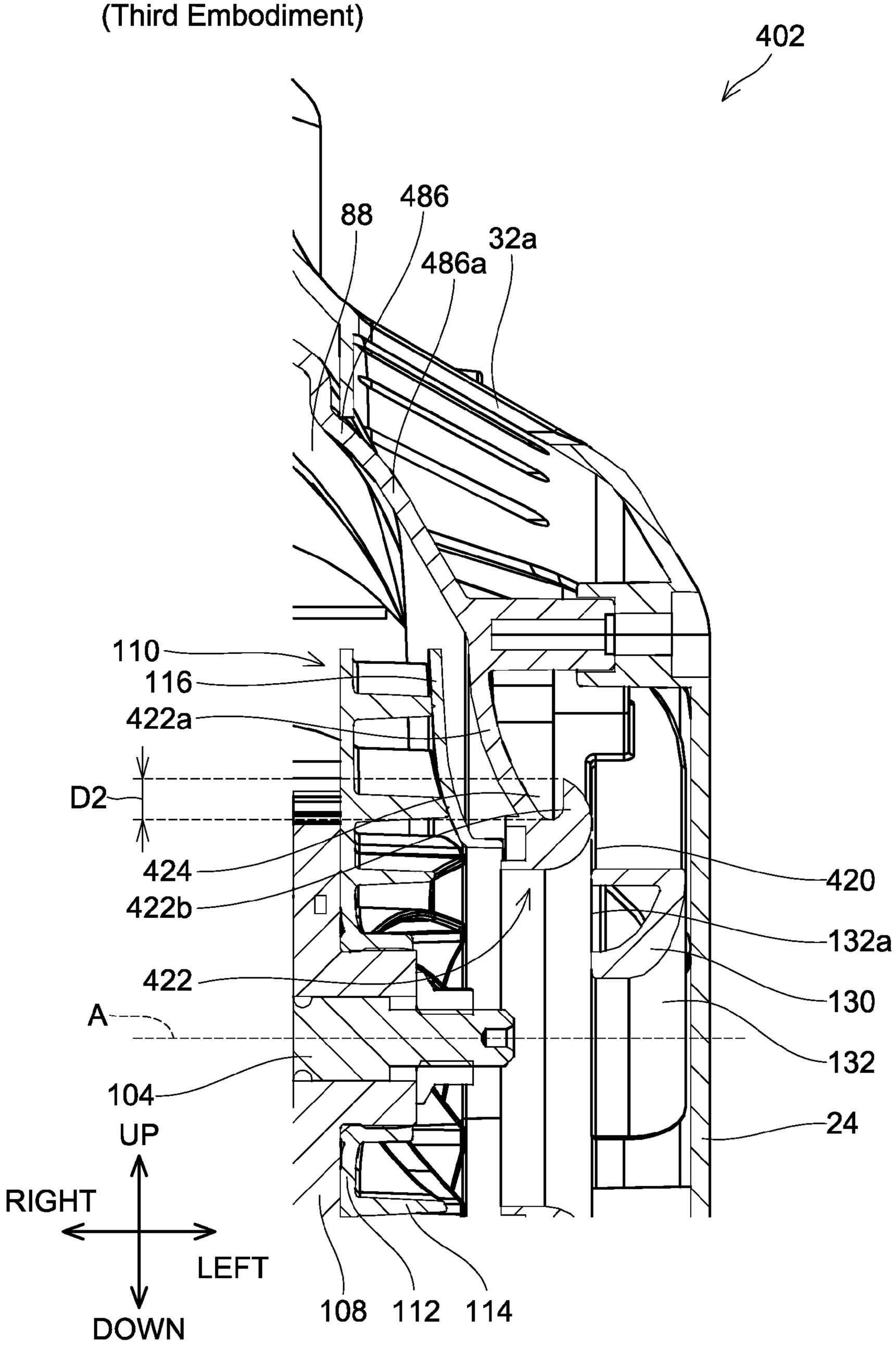
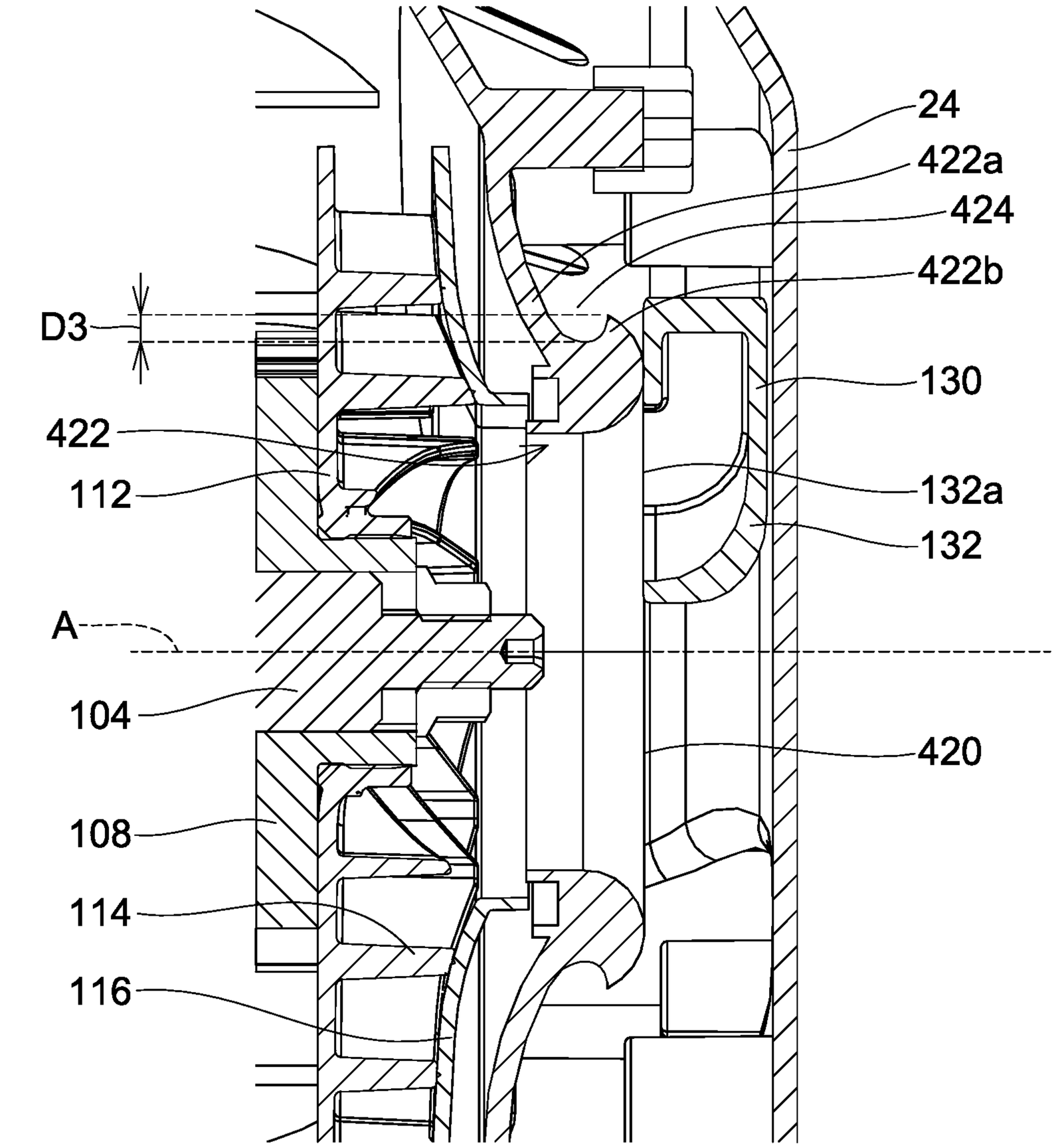
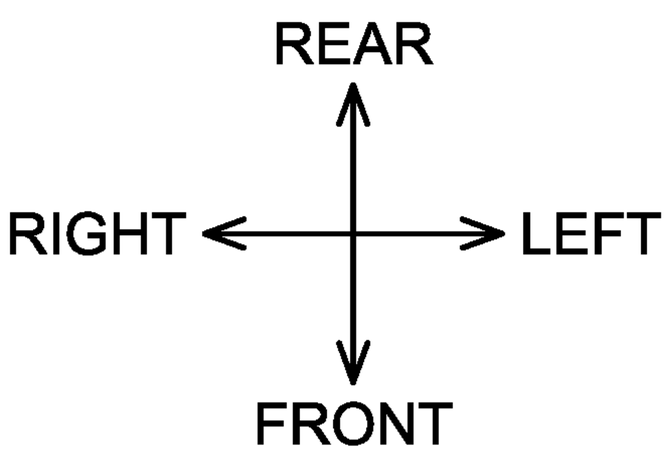


FIG. 18

(Third Embodiment)





WORKING MACHINE

REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Japanese Patent Application No. 2022-037159 filed on Mar. 10, 2022, the contents of which are hereby incorporated by reference into the present application.

BACKGROUND ART

[0002] U.S. Pat. Application Publication No. 2012/66916 describes a working machine which includes: a body including a motor accommodating chamber; a working part attached to the body; a fan accommodated in the motor accommodating chamber; and a motor accommodated in the motor accommodating chamber and configured to drive the working part and the fan. The fan includes a disk plate including a circular opening defined at a center of the disk plate; and a plurality of vanes attached to the disk plate.

DESCRIPTION

Summary

[0003] In the working machine described in US Patent Application Publication No. 2012/66916, the motor accommodated in the motor accommodating chamber may not be cooled sufficiently due to the amount of air suctioned in the motor accommodating chamber being small.

[0004] The present teachings provide an art configured to improve cooling performance of a motor in a working machine.

[0005] A working machine disclosed herein may comprise: a working part; a body including a motor accommodating part; a fan accommodated in the motor accommodating part; and a motor accommodated in the motor accommodating part and configured to drive the working part and the fan, wherein the fan comprises: a disk plate including a circular opening defined at a center of the disk plate; a plurality of vanes attached to the disk plate; and a cover part, and wherein the plurality of vanes is covered by the disk plate and the cover part in an axial direction.

[0006] According to the above configuration, the plurality of vanes in the fan is covered by the disk plate and the cover part in the axial direction. In this case, paths in the radial direction are defined by the plurality of vanes, the disk plate, and the cover part. According to such configuration, an amount of air suctioned into the motor accommodating part by the fan can be increased as compared to a fan in which one side in the axial direction of the plurality of vanes is not covered by the cover part. Accordingly, cooling performance for a motor accommodated in a motor accommodating part can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** illustrates a perspective view of a chainsaw **2** according to a first embodiment seen from rear left upper side.

[0008] FIG. **2** illustrates a left side view of the chainsaw **2** according to the first embodiment from left side.

[0009] FIG. **3** illustrates a perspective view of the chainsaw **2** according to the first embodiment from rear right upper side.

[0010] FIG. **4** illustrates a perspective view of the chainsaw **2** according to the first embodiment with a battery cover **50** and a battery pack **200** removed therefrom, seen from the rear left upper side.

[0011] FIG. **5** illustrates a perspective view of the chainsaw **2** according to the first embodiment with the battery cover **50** and the battery pack **200** removed therefrom, seen from front right upper side.

[0012] FIG. **6** illustrates a left cross-sectional view of the chainsaw **2** according to the first embodiment seen from the left side.

[0013] FIG. **7** illustrates a front cross-sectional view of the chainsaw **2** according to the first embodiment seen from a front side.

[0014] FIG. **8** illustrates a front cross-sectional view of the chainsaw **2** according to the first embodiment from the front.

[0015] FIG. **9** illustrates a perspective view of a fan **110** according to the first embodiment seen from front left upper side.

[0016] FIG. **10** illustrates a perspective view of the fan **110** according to the first embodiment with a cover part removed therefrom from the front left upper side.

[0017] FIG. **11** illustrates a front cross-sectional view of the fan **110** according to the first embodiment seen the front side.

[0018] FIG. **12** illustrates a perspective view of an inner housing **86**, the fan **110**, a duct **130**, and a receptacle unit **66** according to the first embodiment, seen from the rear left upper side.

[0019] FIG. **13** illustrates a front cross-sectional view of the chainsaw **2** according to the first embodiment, seen from the front side.

[0020] FIG. **14** illustrates a perspective view of the inner housing **86**, a motor unit **82**, the duct **130**, and the receptacle unit **66** according to the first embodiment, seen from the rear right upper side.

[0021] FIG. **15** illustrates a perspective view of the battery pack **200** according to the first embodiment, seen from front right lower side.

[0022] FIG. **16** illustrates a chainsaw **302** according to a second embodiment, seen from the front side.

[0023] FIG. **17** illustrates a front cross-sectional view of a chainsaw **402** according to a third embodiment seen from the front side.

[0024] FIG. **18** illustrates a top cross-sectional view of the chainsaw **402** according to the third embodiment seen from the front side.

DETAILED DESCRIPTION

[0025] Representative, non-limiting examples of the disclosure herein will now be described in further detail with reference to the attached drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention. Furthermore, each of the additional features and teachings disclosed below may be utilized separately or in conjunction with other features and teachings to provide improved working machines, as well as methods for using and manufacturing the same.

[0026] Moreover, combinations of features and steps disclosed in the following detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe repre-

sentative examples of the invention. Furthermore, various features of the below-described representative examples, as well as the various independent and dependent claims, may be combined in ways that are not specifically and explicitly enumerated in order to provide additional useful embodiments of the present teachings.

[0027] All features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter, independent of the compositions of the features in the embodiments and/or the claims. In addition, all value ranges or indications of groups of entities are intended to disclose every possible intermediate value or intermediate entity for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter.

[0028] In one or more embodiments, a working machine may comprise: a working part; a body including a motor accommodating part; a fan accommodated in the motor accommodating part; and a motor accommodated in the motor accommodating part and configured to drive the working part and the fan, wherein the fan comprises: a disk plate including a circular opening defined at a center of the disk plate; a plurality of vanes attached to the disk plate; and a cover part, and wherein the plurality of vanes is covered by the disk plate and the cover part in an axial direction.

[0029] In one or more embodiments, the cover part may be fixed to the plurality of vanes.

[0030] According to the above configuration, paths in the radial direction are securely defined by the plurality of vanes, the disk plate, and the cover part. Accordingly, the amount of air suctioned in the motor accommodating part can be increased, by which the cooling performance of the motor accommodated in the motor accommodating part can be improved.

[0031] In one or more embodiments, the working machine may further comprise a motor cover accommodating the motor. Fins protruding outward may be disposed on an outer peripheral surface of the motor cover.

[0032] According to the above configuration, the air suctioned into the motor accommodating part by the fan makes contact with the fins. When the air contacts the fins, the motor accommodated in the motor cover is cooled. Accordingly, cooling performance for the motor can be improved.

[0033] In one or more embodiments, the working machine may further comprise a motor cover configured to cover the motor in the motor accommodating part. The motor cover may comprise a waterproof structure that prevents entry of water.

[0034] When the motor cover has a waterproof structure, air does not flow into the motor cover even if the air is suctioned into the motor accommodating part by the fan. In this case, the motor accommodated in the motor cover is cooled by the air being brought in contact with the outer peripheral surface of the motor cover. That is, the outer peripheral surface of the motor cover needs to be exposed to a great amount of air as compared to the configuration where the air flows into the motor cover. According to the above configuration, a great amount of air is suctioned into the motor accommodating part by the fan. Accordingly, cooling performance for the motor can be improved while attachment of water on the motor is prevented.

[0035] In one or more embodiments, the body may comprise: a battery pack; a battery accommodating part configured to accommodate the battery pack; and a duct. The battery accommodating part may comprise a first air intake opening for intaking air from inside of the body into the battery accommodating part and a first air exhaust opening for exhausting air from the battery accommodating part to the inside of the body. The motor accommodating part may comprise: a wall positioned on a first side of the motor in the axial direction and defining the motor accommodating part; and a second air intake opening defined on the wall. One end of the duct may be connected to the battery accommodating part. Another end of the duct may face the second air intake opening on the first side of the second air intake opening.

[0036] According to the above configuration, when the fan is driven, air within the battery accommodating part is suctioned in to the duct. Inside of the battery accommodating part is put under negative pressure when the air within the battery accommodating part has been suctioned into the duct. In this case, the air inside the body starts to be suctioned into the battery accommodating part. Due to this, the battery pack within the battery accommodating part is cooled. Accordingly, the fan makes it possible for both the motor and the battery pack to be cooled.

[0037] In one or more embodiments, an opening defined on a surface of the other end of duct may have an opening area being one-third or more of an opening area of the second air intake opening. The surface of the other end of duct may face the second air intake opening.

[0038] According to the above configuration, the amount of air within the battery accommodating part which is suctioned into the duct can be increased. In this case, the amount of air which is suctioned into the battery accommodating part from the inside of the body can be increased as well. Accordingly, cooling performance for the battery can be improved.

[0039] In one or more embodiments, the body may comprise a third air intake opening for intaking air from outside of the body into the inside of the body. In a direction orthogonal to the axial direction, the battery accommodating part may be disposed between the motor accommodating part and the third air intake opening.

[0040] According to the above configuration, the air suctioned into the inside of the body from the third air intake opening can be utilized to cool the battery pack within the battery accommodating part. Accordingly, cooling performance for the battery pack can be improved as compared to a configuration where no third air intake opening is provided.

[0041] In one or more embodiments, the working machine may be a chainsaw.

[0042] A chainsaw has a relatively-high power output. Due to this, the motor easily generates heat. According to the above configuration, it is advantageous that the motor within the motor accommodating part can be suitably cooled.

(First Embodiment)

[0043] As shown in FIG. **1**, the chainsaw **2** comprises a body **4**, a guide bar **6**, and a saw chain **8**. The guide bar **6** is an elongated plate member attached to the body **4** so as to protrude frontward from the body **4**. The guide bar **6** is constituted of metal material such as iron. The saw chain **8** com-

prises a plurality of interlocked cutters and is attached along a circumference of the guide bar **6**. In the following description, when the chainsaw **2** is placed on a horizontal placement surface S such as ground as shown in FIG. **2**, a direction orthogonal to the placement surface S is an up-down direction of the chainsaw **2**; a direction which projects a longitudinal direction of the guide bar **6** on the placement surface S is a front-rear direction of the chainsaw **2**; and a direction orthogonal to the up-down direction and the front-rear direction is a left-right direction of the chainsaw **2**.

[0044] As shown in FIG. **1**, the body **4** comprises a body housing **10**, a front hand guard **12**, a front handle **14**, a sprocket cover **16** (see FIG. **3**), a battery accommodating part **18**, a rear handle **20**, and a rear hand guard **22**. The body housing **10** is composed of a left housing **24** and a right housing **26**. The body housing **10** has a substantially cuboid shape with its longitudinal direction being the front-rear direction of the body **4**.

[0045] A front air-intake part **30** protruding leftward is disposed on a left surface of the left housing **24**. The front air-intake part **30** includes a truncated cone portion **32** and a flat portion **34**. The flat portion **34** is disposed at a left end of the truncated cone portion **32**. The truncated cone portion **32** has its diameter increasing from left toward right. The truncated cone portion **32** comprises a plurality of outer air intake openings **32***a*. The plural outer air intake openings **32***a* are aligned along a circumferential direction of the truncated cone portion **32**. Each of the plural outer air intake openings **32***a* has an elongated hole shape, and has its longitudinal direction being parallel to a direction in which a generatrix of the truncated cone portion **32** extends.

[0046] The front handle **14** includes a left fixed portion **14***a* extending leftward from a front lower part of the left housing **24** (specifically, the front air-intake part **30**), a left grip portion **14***b* extending upward from a left end of the left fixed portion **14***a*, an upper grip portion **14***c* extending rightward from an upper end of the left grip portion **14***b*, a right grip portion **14***d* extending rear-downward from a right end of the upper grip portion **14***c*, and a right fixed portion **14***e* (see FIG. **3**) extending downward from a lower end of the right grip portion **14***d*. The left fixed portion **14***a* is fixed by screw(s) to the front lower part of the left housing **24**. As shown in FIG. **3**, the right fixed portion **14***e* is fixed by screw(s) to the right housing **26** at a position on a rear side of the sprocket cover **16**. The front hand guard **12** is pivotably supported to a front upper part of the body housing **10**. The front hand guard **12** is disposed on a front side of the front handle **14**. The front hand guard **12** is configured to protect a user's hand gripping the upper grip portion **14***c* of the front handle **14**.

[0047] The rear handle **20** extends rear-downward from an upper part of a rear surface of the body housing **10** and curves downward. The rear hand guard **22** extends rearward from a lower part of the rear surface of the body housing **10** to be coupled to a lower end of the rear handle **20**. The rear hand guard **22** comprises a first guard portion **22***a* located directly below the rear handle **20** and a second guard portion **22***b* extending rightward from the first guard portion **22***a*. The rear hand guard **22** is configured to protect a user's hand gripping the rear handle **20**.

[0048] A power button **40** for the user to switch the power of the chainsaw **2** on and off is disposed on an upper surface near a front end of the rear handle **20**. A trigger lever **42** for the user to control rotational operation of the saw chain **8** is disposed on a lower surface near the front end of the rear handle **20**. A lock lever **44** configured to switch between a state allowing user's operation on the trigger lever **42** and a state prohibiting the user's operation on the trigger lever **42** is disposed on the upper surface of the rear handle **20**. While the user is using the chainsaw **2**, the user holds the chainsaw **2** by gripping the rear handle **20** with his/her right hand and gripping the front handle **14** with his/her left hand. Once the user has pressed down the lock lever **44** of the rear handle **20** with his/her palm of the right hand from this state, the trigger lever **42** is in the state of being allowed for operation. The saw chain **8** starts to rotate by the user lifting up the trigger lever **42** with his/her index finger of the right hand in this state.

[0049] The battery accommodating part **18** is disposed between the front handle **14** and the rear handle **20**. The battery accommodating part **18** comprises an openable battery cover **50** and a battery interface (hereafter, may be termed "IF") **52** (see FIG. **4**). As shown in FIG. **4**, the battery IF **52** comprises an IF front surface **54**, an IF right surface **56**, an IF rear surface **58** (see FIG. **5**), an IF left surface **60** (see FIG. **5**), and an IF bottom surface **62**. The IF front surface **54** extends along the left-right direction and the front-rear direction and faces rearward. The IF right surface **56** extends along the front-rear direction and the up-down direction and faces leftward. The IF bottom surface **62** extends along the front-rear direction and the left-right direction, and faces upward. As shown in FIG. **5**, the IF rear surface **58** extends along the left-right direction and the up-down direction, and faces frontward. The IF left surface **60** extends along the front-rear direction and the up-down direction, and faces rightward.

[0050] As shown in FIG. **4**, the IF front surface **54** has an IF-side air intake opening **54***a* defined therein. As shown in FIG. **6**, an air intake tube **64** is coupled to the IF-side air intake opening **54***a*. The air intake tube **64** is constituted of rubber material, for example. Alternatively in a variant, the air intake tube **64** may be constituted of plastic, for example. The air intake tube **64** comprises a first air path **64***a* extending frontward from the IF-side air intake opening **54***a* and a second air path **64***b* extending from a front end of the first air path **64***a* to curve downward. An opening at an end **64***c* of the second air path **64***b* faces vertically downward. In the present embodiment, the air intake tube **64** is attached to the IF front surface **54** so that the opening at the end **64***c* faces vertically downward when the chainsaw **2** is in the state shown in FIG. **2**. In a variant, the air intake tube **64** may be rotatably attached to the IF-side air intake opening **54***a* so that the opening at the end **64***c* faces vertically downward not matter what state the chainsaw **2** is in.

[0051] As shown in FIG. **7**, the IF right surface **56** has a right opening **56***a* defined therein. The receptacle unit **66** is disposed in the right opening **56***a*. As shown in FIG. **4**, a first front rail **66***a* extending in the up-down direction is disposed at a front end of the receptacle unit **66**, and a first rear rail **66***b* extending in the up-down direction is disposed at a rear end of the receptacle unit **66**. The receptacle unit **66** comprises five machine-side terminals **68** held therein. The five machine-side terminals **68** are disposed between the first front rail **66***a* and the first rear rail **66***b*, and aligned in the front-rear direction. An inner air exhaust hole **66***c* is defined in a lower part of the receptacle unit **66**. As shown in FIG. **7**, an outer air exhaust hole **66***d* is defined in a lower part of a rear surface of the receptacle unit **66**. A battery accommo-

dating space BS is defined by the battery cover **50** and the battery IF **52**. As shown in FIG. **6**, a sealer **53** is disposed where the battery cover **50** and the battery IF **52** contact each other while the battery cover **50** is closed. Due to this, inside of the battery accommodating part **18** is sealed while the battery cover **50** is closed.

[0052] As shown in FIG. **6**, a rear air intake opening **70** is defined in a lower part of the rear surface of the body housing **10**. The rear air intake opening **70** has an elongated hole shape, and has its longitudinal direction being parallel to the left-right direction. A sponge **72** is mounted in the rear air intake opening **70**. The sponge **72** is configured to allow entry of air into the body housing **10** and also suppress entry of water and/or dust into the body housing **10**.

[0053] A control unit **80**, a motor unit **82**, an oil tank **84**, and an inner housing **86** are arranged in a front part inside the body housing **10**. The control unit **80**, the motor unit **82**, and the oil tank **84** are located to the front of the battery accommodating part **18**. The control unit **80** is arranged above the motor unit **82**. The oil tank **84** is configured to store lubricant for lubricating the saw chain **8**. A motor accommodating part **88** which accommodates the motor unit **82** is disposed in the front part inside the body housing **10**. The motor accommodating part **88** is defined by the left housing **24** (see FIG. **8**), the right housing **26**, the control unit **80**, the oil tank **84**, and the inner housing **86**. The motor accommodating part **88** has a front surface having a front air exhaust opening **88***a* defined therein. The motor unit **82** is fixed to the left housing **24** by screw(s).

[0054] The motor unit **82** comprises a motor cover **90** and a motor **92**. The motor cover **90** has a waterproof structure. As shown in FIG. **8**, the motor cover **90** comprises a cover body **94** and a lid **96**. The cover body **94** comprises a body-side disk portion **94***a*, a first cylinder portion **94***b* being cylindrical, and a second cylinder portion **94***c* being cylindrical. A center of the body-side disk portion **94***a* comprises a body-side opening **94***e* defined therein. The first cylinder portion **94***b* extends leftward from an outer end in a radial direction of the body-side disk portion **94***a*. The second cylinder portion **94***c* extends rightward from an outer circumferential end of the body-side opening **94***e* of the body-side disk portion **94***a*. The first cylinder portion **94***b* comprises a plurality of fins **94***d* extending radially outward. The lid **96** has a lid-side disk portion **96***a*. A center of the lid-side disk portion **96***a* comprises a lid-side circular opening **96***b* defined therein. The lid-side disk portion **96***a* covers an opening at a left-side end of the first cylinder portion **94***b*.

[0055] The motor **92** is waterproofed by the motor cover **90**. The motor **92** is an inner rotor type DC brushless motor. The motor **92** comprises a stator **100**, a rotor **102** disposed on the inner side relative to the stator **100**, and an output shaft **104** disposed so as to pass through centers of the stator **100** and the rotor **102** and fitted with the rotor **102**. The output shaft **104** extends along an axial direction A. The axial direction A is parallel to the left-right direction. A left end of the output shaft **104** is located to the left of a left end of the motor cover **90**, and a right end of the output shaft **104** is located to the right of a right side of the motor cover **90**. That is, the output shaft **104** penetrates the motor cover **90** in the left-right direction. In the motor cover **90**, a plurality of waterproof members **90***a* is disposed where the output shaft **104** penetrates the motor cover **90**.

[0056] A worm gear **105** and a sprocket **106** are fixed to the right end of the output shaft **104**. A left end of the sprocket **106** meshes with the worm gear **105**, and a brake drum **107** is disposed on a right end of the sprocket **106**. The saw chain **8** (see FIG. **1**) is wrapped around the sprocket **106** from the guide bar **6**. When the motor **92** is driven, the sprocket **106** revolves along with the output shaft **104**, by which the saw chain **8** revolves around the sprocket **106** and the guide bar **6**. When the user presses down the front hand guard **12** (see FIG. **1**) frontward with the motor **92** running, rotation of the output shaft **104** is braked via the brake drum **107**.

[0057] The fan **110** is mounted on a left end of the output shaft **104** via a bush **108**. As shown in FIG. **9**, the fan **110** is a so-called enclosed fan. The fan **110** comprises a fan disk plate **112**, a plurality of vanes **114**, and a cover part **116**. A central opening **112***a* is defined at a center of the fan disk plate **112**. The fan disk plate **112** has a cylindrical rib portion **112***b* extending frontward from an outer peripheral end of the central opening **112***a*. As shown in FIG. **10**, the fan disk plate **112** and the plurality of vanes **114** are integrally formed. The plurality of vanes **114** extends leftward from the fan disk plate **112**. Each of the vanes **114** has a shape in which, by seeing the fan **110** from the left side, a radially inner end of the vane **114** is located on a downstream side of a radially outer end of the vane **114** in a clockwise direction. As shown in FIG. **9**, the cover part **116** is heat-sealed to left ends of the vanes **114**. A cover-side air intake opening **116***a* is defined at a center of the cover part **116**. A diameter of the cover-side air intake opening **116***a* is greater than a diameter of the central opening **112***a*. As shown in FIG. **11**, a plurality of wind paths **110***a* is defined by a left surface of the fan disk plate **112**, a right surface of the cover part **116**, and two vanes **114** adjacent in a circumferential direction. As shown in FIG. **9**, a plurality of fan air exhaust openings **110***b* is defined on an outer circumferential surface of the fan **110** in the circumferential direction.

[0058] The inner housing **86** in FIG. **12** is fixed to the right housing **26** (see FIG. **1**) by screws. As shown in FIG. **8**, an inner air intake opening **120** and a waterproof part **122** are arranged on a left wall part **86***a* of the inner housing **86**. The waterproof part **122** comprises a diameter-reducing part **122***a* and a bell mouth part **122***b*. The diameter-reducing part **122***a* has its outer diameter and inner diameter reduced from right to left. The bell mouth part **122***b* is arranged at a left end of the diameter-reducing part **122***a*. The bell mouth part **122***b* has a shape which does not inhibit the leftward flow of air from the right side along an outer peripheral surface of the left wall part **86***a* and being suctioned into the motor accommodating part **88** through the inner air intake opening **120**. The inner air intake opening **120** is defined by the bell mouth part **122***b*. A waterproof groove **124** recessed from the outer peripheral surface of the left wall part **86***a* is defined in the bell mouth part **122***b*. Specifically, the waterproof groove **124** is recessed radially inward from the outer peripheral surface of the left wall part **86***a*. A depth D1 of the waterproof groove **124** is constant an entirety of a circumference of the bell mouth part **122***b*.

[0059] As shown in FIG. **13**, the inner air intake opening **120** is located to the left side of the outer air intake openings **32***a* by distance L1. The inner air intake opening **120** has a circular shape. The inner air intake opening **120** is disposed on the inner side of the outer air intake openings **32***a*. Here, "the inner air intake opening **120** is disposed on the inner side of the outer air intake openings **32***a*" means that air which flows into the chainsaw **2** from the outside passes

through the outer air intake openings **32***a* and the inner air intake opening **120** sequentially in this order. As shown in FIG. **8**, in the left-right direction, the inner air intake opening **120** is positioned farther away from the motor **92** than the outer air intake openings **32***a* is from the motor **92**. As shown in FIG. **13**, a distance L2 between a lower end of the outer air intake opening **32***a* that is located the highest and an upper end of the waterproof groove **124** is less than or equal to 10 cm.

[0060] As shown in FIG. **6**, the duct **130** is accommodated in the body housing **10**. As shown in FIG. **12**, the duct **130** comprises a fan-side end **132**, a receptacle-unit-side end **134** (see FIG. **14**), and a flow path portion **136** which connects the fan-side end **132** and the receptacle-unit-side end **134**. As shown in FIG. **8**, the fan-side end **132** is disposed between the left surface of the left housing **24** and the left wall part **86***a* of the inner housing **86**. A fan-side opening **132***a* is defined at the fan-side end **132** of the duct **130**. The fan-side opening **132***a* faces the inner air intake opening **120** of the inner housing **86**. An opening area of the fan-side opening **132***a* is one-third (⅓) times to one-half (½) times an opening area of the inner air intake opening **120**. As shown in FIG. **14**, the receptacle-unit-side end **134** of the duct **130** is attached to a lower part of a right surface of the receptacle unit **66**. As shown in FIG. **7**, a receptacle-unit-side opening **134***a* is defined on the receptacle-unit-side end **134**.

[0061] As shown in FIG. **15**, the battery pack **200** comprises a battery housing **202**. The battery housing **202** has a plurality of battery cells C (see FIG. **7**) accommodated therein. The battery housing **202** comprises a hook **204**, a second front rail **206** disposed at a front end of the battery housing **202**, and a second rear rail **208** disposed at a rear end of the battery housing **202**. The second front rail **206** and the second rear rail **208** respectively have shapes corresponding to the first front rail **66***a* and the first rear rail **66***b* (see FIG. **4**) of the chainsaw **2**. The hook **204** comprises an engaging portion **204***a* and a hook operation portion **204***b*. The hook **204** is biased outward of the battery housing **202** by a spring (not shown). When the battery pack **200** is to be attached to the battery IF **52** (see FIG. **4**) of the chainsaw **2**, the engaging portion **204***a* of the hook **204** enters an engaged portion **66***e* (see FIG. **7**) of the receptacle unit **66** of the chainsaw **2**, by which the battery pack **200** is fixed to the battery IF **52**. By the hook operation portion **204***b* being pressed in from this state, the engaging portion **204***a* is disengaged from the engaged portion **66***e*. In this state, the battery pack **200** can be slid relative to the battery IF **52**, and the battery pack **200** can be removed from the battery IF **52** (i.e., the chainsaw **2**).

[0062] A first battery vent hole **202***a* is defined on a lower part of a right surface of the battery housing **202**. As shown in FIG. **7**, the first battery vent hole **202***a* faces an inner air exhaust hole **66***c* of the receptacle unit **66**, with the battery pack **200** mounted in the chainsaw **2**. As shown in FIG. **15**, a second battery vent hole **202***b* is defined on a left part of a front surface of the battery housing **202**. The second battery vent hole **202***b* faces the IF-side air intake opening **54***a* (see FIG. **4**) on the IF front surface **54** of the battery IF **52**, with the battery pack **200** mounted in the chainsaw **2**.

[0063] How the air flows when the motor **92** of the chainsaw **2** is operating will be described. When the motor **92** in FIG. **8** is driven, the sprocket **106** and the fan **110** start rotating. In the present embodiment, the fan disk plate **112**, the vanes **114**, and the cover part **116** in the fan **110** rotate integrally. By the fan **110** being driven, air outside the body housing **10** passes through the outer air intake openings **32***a* of the left housing **24** and the inner air intake opening **120** of the inner housing **86** to be suctioned into the motor accommodating part **88**. As shown in FIG. **6**, the air having flowed in the motor accommodating part **88** passes around the motor cover **90**. Due to this, the motor **92** within the motor cover **90** is cooled. Further, the air flowing in the motor accommodating part **88** cools the control unit **80** which defines the motor accommodating part **88**. The air inside the motor accommodating part **88** is then discharged outside through the front air exhaust opening **88***a* on the front surface of the motor accommodating part **88**.

[0064] Also, by the fan **110** being driven, the air inside the battery accommodating part **18** is suctioned into the motor accommodating part **88** through the duct **130**. Specifically, as shown in FIG. **7**, the air inside the battery accommodating part **18** passes through the second battery vent hole **202***b* (see FIG. **15**) of the battery pack **200**, the first battery vent hole **202***a* of the battery pack **200**, the inner air exhaust hole **66***c* of the receptacle unit **66**, the outer air exhaust hole **66***d* of the receptacle unit **66**, and the receptacle-unit-side opening **134***a* of the duct **130** to be suctioned into the duct **130**. The plurality of battery cells C within the battery pack **200** is cooled by the air flowing through the battery pack **200**. As shown in FIG. **8**, the air having flowed into the duct **130** passes through the fan-side opening **132***a* and the inner air intake opening **120** of the inner housing **86** to be suctioned into the motor accommodating part **88**. How the air flows thereafter is the same as how the air having flowed inward from the outer air intake openings **32***a* of the left housing **24** flows.

[0065] As described above, the inside of the battery accommodating part **18** is tightly-sealed in the state where the battery cover **50** is closed. Due to this, when the operation of the motor **92** continues, that creates negative pressure inside the battery accommodating part **18**. In this case, as shown in FIG. **6**, the air inside the body housing **10** starts to be suctioned into the battery accommodating part **18**. Specifically, the air inside the body housing **10** passes through the air intake tube **64** and the IF-side air intake opening **54***a* of the IF front surface **54** to be suctioned into the battery accommodating part **18**.

[0066] When the operation of the motor **92** further continues, the inside of the body housing **10** is put under negative pressure as well. In this case, the air outside the body housing **10** starts to be suctioned into the body housing **10** through the rear air intake opening **70** defined on the lower part of the rear surface of the body housing **10**. The air having flowed in the body housing **10** through the rear air intake opening **70** flows frontward and passes through the air intake tube **64** and the IF-side air intake opening **54***a* of the IF front surface **54** to flow into the battery accommodating part **18**. As such, while the motor **92** is operating, the motor **92**, the control unit **80**, and the plurality of battery cells C within the battery pack **200** are cooled.

[0067] In one or more embodiments, as shown in FIGS. **1** and **8**, the chainsaw **2** (example of "working machine") comprises: the saw chain **8** (example of "working part"); the body **4** including the motor accommodating part **88**; the fan **110** accommodated in the motor accommodating part **88**; and the motor **92** accommodated in the motor accommodating part **88** and configured to drive the saw

chain **8** and the fan **110**. The fan **110** comprises: the fan disk plate **112** (example of "disk plate") including the central opening **112***a* defined at a center of the fan disk plate **112**; the plurality of vanes **114** attached to the fan disk plate **112**; and the cover part **116**, in which the plurality of vanes **114** is covered by the fan disk plate **112** and the cover part **116** in the axial direction A. According to the above configuration, the plurality of vanes **114** in the fan **110** is covered by the fan disk plate **112** and the cover part **116** in the axial direction A. In this case, the wind paths **110***a* in the radial direction are defined by the plurality of vanes **114**, the fan disk plate **112**, and the cover part **116**. According to such configuration, an amount of air suctioned into the motor accommodating part **88** by the fan **110** can be increased as compared to a fan in which one side in the axial direction of the plurality of vanes **114** is not covered by the cover part **116**. Accordingly, cooling performance for the motor **92** accommodated in the motor accommodating part **88** can be improved. The chainsaw **2** has a relatively-high power output. Due to this, the motor **92** easily generates heat. According to the above configuration, it is advantageous that the motor **92** within the motor accommodating part **88** can be appropriately cooled.

[0068] In one or more embodiments, as shown in FIG. **9**, the cover part **116** is fixed (heat-sealed) to the plurality of vanes **114**. According to the above configuration, the wind paths **110***a* in the radial direction are securely defined by the plurality of vanes **114**, the fan disk plate **112**, and the cover part **116**. Accordingly, the amount of air suctioned in the motor accommodating part **88** can be increased, by which the cooling performance for the motor **92** accommodated in the motor accommodating part **88** can be improved.

[0069] In one or more embodiments, as shown in FIG. **8**, the chainsaw **2** further comprises the motor cover **90** accommodating the motor **92**, in which the fins **94***d* protruding outward are disposed on the outer peripheral surface of the motor cover **90**. According to the above configuration, the air suctioned into the motor accommodating part **88** by the fan **110** makes contact with the fins **94***d*. When the air contacts the fins **94***d*, the motor **92** accommodated in the motor cover **90** is cooled. Accordingly, cooling performance for the motor **92** can be improved.

[0070] In one or more embodiments, as shown in FIG. **8**, the chainsaw **2** further comprises the motor cover **90** configured to cover the motor **92** in the motor accommodating part **88**, in which the motor cover **90** comprises a waterproof structure that prevents entry of water. When the motor cover **90** has a waterproof structure, air does not flow into the motor cover **90** even if the air is suctioned into the motor accommodating part **88** by the fan **110**. In this case, the motor **92** accommodated in the motor cover **90** is cooled by the air being brought in contact with the outer peripheral surface of the motor cover **90**. That is, the outer peripheral surface of the motor cover **90** needs to be exposed to a great amount of air as compared to the configuration where the air flows into the motor cover **90**. According to the above configuration, a great amount of air is suctioned into the motor accommodating part **88** by the fan **110**. Accordingly, cooling performance for the motor **92** can be improved while water is prevented from being attached on the motor **92**.

[0071] In one or more embodiments, as shown in FIGS. **6**, **7**, **11**, and **12**, the body **4** comprises: the battery pack **200**; the battery accommodating part **18** configured to accommodate the battery pack **200**; and the duct **130**. The battery accommodating part **18** comprises the IF-side air intake opening **54***a* (example of "first air intake opening") for intaking air from inside of the body **4** into the battery accommodating part **18** and the inner air exhaust hole **66***c* (example of "first air exhaust opening") for exhausting air from the battery accommodating part **18** to the inside of the body **4**. The motor accommodating part **88** comprises: the left wall part **86***a* (example of "wall") positioned on the left side (example of "first side") than the motor **92** in the axial direction A and defining the motor accommodating part **88**; and the inner air intake opening **120** (example of "second air intake opening") defined on the left wall part **86***a*. The receptacle-unit-side end **134** (example of "one end") of the duct **130** is connected to the battery accommodating part **18**, and the fan-side end **132** (example of "another end") of the duct **130** faces the inner air intake opening **120** on the left side of the inner air intake opening **120**. According to the above configuration, when the fan **110** is driven, air within the battery accommodating part **18** is suctioned in to the duct **130**. Inside of the battery accommodating part **18** is put under negative pressure when the air within the battery accommodating part **18** has been suctioned into the duct **130**. In this case, the air inside the body **4** starts to be suctioned into the battery accommodating part **18**. Due to this, the battery pack **200** within the battery accommodating part **18** is cooled. Accordingly, the fan **110** makes it possible for both the motor **92** and the battery pack **200** to be cooled.

[0072] In one or more embodiments, the fan-side opening **132***a* defined on the fan-side end **132** of duct **130** has the opening area being one-third or more of the opening area of the inner air intake opening **120**. According to the above configuration, the amount of air within the battery accommodating part **18** which is suctioned into the duct **130** can be increased. In this case, the amount of air which is suctioned into the battery accommodating part **18** from the inside of the body **4** can be increased as well. Accordingly, cooling performance for the battery pack **200** can be improved.

[0073] In one or more embodiments, as shown in FIG. **7**, the body **4** comprises the rear air intake opening **70** (example of "third air intake opening") for intaking air from outside of the body **4** into the inside of the body **4**. In the front-rear direction (example of "direction orthogonal to the axial direction A"), the battery accommodating part **18** is disposed between the motor accommodating part **88** and the rear air intake opening **70**. According to the above configuration, the air suctioned into the inside of the body **4** from the rear air intake opening **70** can be utilized to cool the battery pack **200** within the battery accommodating part **18**. Accordingly, cooling performance for the battery pack **200** can be improved as compared to a configuration where no rear air intake opening **70** is provided.

(Second Embodiment)

[0074] As shown in FIG. **16**, a chainsaw **302** according to the second embodiment will be described. The chainsaw **302** of the second embodiment has a left housing **324** with a different structure from the left housing **24** (see FIG. **8**) according to the first embodiment. Hereafter, descriptions for like configurations between the embodiments may be omitted as the same reference numerals will be given to the like configurations.

[0075] The left housing **324** comprises a plurality of the outer air intake openings **332***a*, a plurality of the left air

intake openings **332***b* disposed on the right side of the outer air intake openings **332***a*, and the right extension part **334** that connects the outer air intake openings **332***a* and the left air intake openings **332***b*. In the present embodiment, the plurality of outer air intake openings **332***a* and the plurality of left air intake openings **332***b* are aligned in the front-rear direction. The plurality of outer air intake openings **332***a* and the plurality of left air intake openings **332***b* are disposed higher than the inner air intake opening **120**.

(Third Embodiment)

[0076] A chainsaw **402** according to a third embodiment will be described with reference to FIGS. **17**, **18**. The chainsaw **402** of the third embodiment has a left wall part **486***a* of an inner housing **486** with a different structure from the left wall part **86***a* (see FIGS. **8**, **13**) of the inner housing **86** according to the first embodiment.

[0077] As shown in FIG. **17**, an inner air intake opening **420** and a waterproof part **422** are disposed on the left wall part **486***a* of the inner housing **486**. The waterproof part **422** comprises a diameter-reducing part **422***a* and a bell mouth part **422***b* extending radially outward from a left end of the diameter-reducing part **422***a*. The diameter-reducing part **422***a* has an inner diameter and an outer diameter which reduce from right to left. The bell mouth part **422***b* is disposed at the left end of the diameter-reducing part **422***a*. The inner air intake opening **420** is defined by the bell mouth part **422***b*. A waterproof groove **424** recessed from an outer peripheral surface of the left wall part **486***a* is disposed in the bell mouth part **422***b*. In details, the waterproof groove **424** is recessed radially inward from the outer circumferential surface of the left wall part **486***a*. A depth of the waterproof groove **424** is a maximum depth D2 at upper and lower portions of the waterproof groove **424**. Further, as shown in FIG. **18**, the depth of the waterproof groove **424** is a minimum depth D3 at left and right portions of the waterproof groove **424**. The depth D3 is smaller than the depth D2. In the present embodiment, the depth of the waterproof groove **424** varies along its circumferential direction. In other words, the depth of the waterproof groove **424** is not constant along its entire circumference.

[0078] (First Variant) "Working machine" may not be limited to the chainsaw **2**, and also may be a pole saw, a blower, a grass trimmer, a hedge trimmer, a pressure washer, a sprayer, a lawn mower, a scarifier, a cultivator, for example.

[0079] (Second Variant) The fan **110** may comprise a cover part composed by the left wall part **86***a* of the inner housing **86**, instead of the cover part **116**. In the present variant, a distance between the plurality of vanes **114** and the left wall part **86***a* is substantially zero. In the present variant, when the motor **92** is driven, the fan disk plate **112** and the vanes **114** rotate, but the cover part constituted of the left wall part **86***a* of the inner housing **86** does not rotate. According to such configuration also, an air flow path in the radial direction is defined by the fan disk plate **112**, the vanes **114**, and the cover part. Due to this, the amount of air suctioned into the motor accommodating part **88** by the fan can be increased. Also, in another variant, the fan **110** may comprise the cover part constituted of the body housing **10**, instead of the cover part **116**.

[0080] (Third Variant) The fan **110** may be disposed on the left side (that is, downstream) of the motor **92**.

[0081] (Fourth Variant) The motor **92** may not be accommodated in the motor cover **90**.

[0082] (Fifth Variant) The motor cover **90** may not have a waterproof structure. In the present variant, degree of waterproofing can be improved as compared to a configuration where the motor **92** is not covered by the motor cover **90**.

[0083] (Sixth Variant) The battery accommodating part **18** may not comprise the IF-side air intake opening **54***a*. In the present variant, cooling performance for the motor **92** can be improved as compared to the configuration where both the motor **92** and the battery pack **200** are cooled by the fan **110**.

[0084] (Seventh Variant) An opening area of the fan-side opening **132***a* may be less than one-third of an opening area of the inner air intake opening **120**. Further, the fan-side opening **132***a* may not face the inner air intake opening **120** of the inner housing **86**.

[0085] (Eighth Variant) The body **4** may not comprise the rear air intake opening **70**.

[0086] (Ninth Variant) The motor **92** may be a brushed DC motor, or any other type of motor such as AC motor.

What is claimed is:

1. A working machine comprising:
a working part;
a body including a motor accommodating part;
a fan accommodated in the motor accommodating part; and
a motor accommodated in the motor accommodating part and configured to drive the working part and the fan,
wherein the fan comprises:
a disk plate including a circular opening defined at a center of the disk plate;
a plurality of vanes attached to the disk plate; and
a cover part, and
wherein the plurality of vanes is covered by the disk plate and the cover part in an axial direction.

2. The working machine according to claim **1**, wherein
the cover part is fixed to the plurality of vanes.

3. The working machine according to claim **1**, further comprising
a motor cover accommodating the motor,
wherein fins protruding outward are disposed on an outer peripheral surface of the motor cover.

4. The working machine according to claim **1**, further comprising
a motor cover configured to cover the motor in the motor accommodating part,
wherein the motor cover comprises a waterproof structure that prevents entry of water.

5. The working machine according to claim **1**, wherein
the body comprises:
a battery pack;
a battery accommodating part configured to accommodate the battery pack; and
a duct,
wherein the battery accommodating part comprises a first air intake opening for intaking air from inside of the body into the battery accommodating part and a first air exhaust opening for exhausting air from the battery accommodating part to the inside of the body,
the motor accommodating part comprises:
a wall positioned on a first side of the motor in the axial direction and defining the motor accommodating part; and
a second air intake opening defined on the wall,

wherein one end of the duct is connected to the battery accommodating part, and

another end of the duct faces the second air intake opening on the first side of the second air intake opening.

6. The working machine according to claim **5**, wherein

an opening defined on a surface of the other end of duct has an opening area being one-third or more of an opening area of the second air intake opening, wherein the surface of the other end of duct faces the second air intake opening.

7. The working machine according to claim **5**, wherein

the body comprises a third air intake opening for intaking air from outside of the body into the inside of the body,

wherein in a direction orthogonal to the axial direction, the battery accommodating part is disposed between the motor accommodating part and the third air intake opening.

8. The working machine according to claim **1**, wherein

the working machine is a chainsaw.

9. A working machine comprising:

a working part;

a body including a motor accommodating part;

a fan accommodated in the motor accommodating part; and

a motor accommodated in the motor accommodating part and configured to drive the working part and the fan,

wherein the fan comprises:

a disk plate including a circular opening defined at a center of the disk plate;

a plurality of vanes attached to the disk plate; and

a cover part, and

wherein the plurality of vanes is covered by the disk plate and the cover part in an axial direction,

wherein the cover part is fixed to the plurality of vanes,

the working machine further comprises:

a motor cover accommodating the motor,

wherein fins protruding outward are disposed on an outer peripheral surface of the motor cover,

wherein the motor cover is configured to cover the motor in the motor accommodating part,

the motor cover comprises a waterproof structure that prevents entry of water,

wherein the body comprises:

a battery pack;

a battery accommodating part configured to accommodate the battery pack; and

a duct,

wherein the battery accommodating part comprises a first air intake opening for intaking air from inside of the body into the battery accommodating part and a first air exhaust opening for exhausting air from the battery accommodating part to the inside of the body,

the motor accommodating part comprises:

a wall positioned on a first side of the motor in the axial direction and defining the motor accommodating part; and

a second air intake opening disposed on the wall,

wherein one end of the duct is connected to the battery accommodating part, and

another end of the duct faces the second air intake opening on the first side of the second air intake opening,

wherein an opening defined on a surface of the other end of duct has an opening area being one-third or more of an opening area of the second air intake opening, wherein the surface of the other end of duct faces the second air intake opening,

wherein the body comprises a third air intake opening for intaking air from outside of the body to the inside of the body,

wherein in a direction orthogonal to the axial direction, the battery accommodating part is disposed between the motor accommodating part and the third air intake opening, and

wherein the working machine is a chainsaw.

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