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(54) **MIXER**

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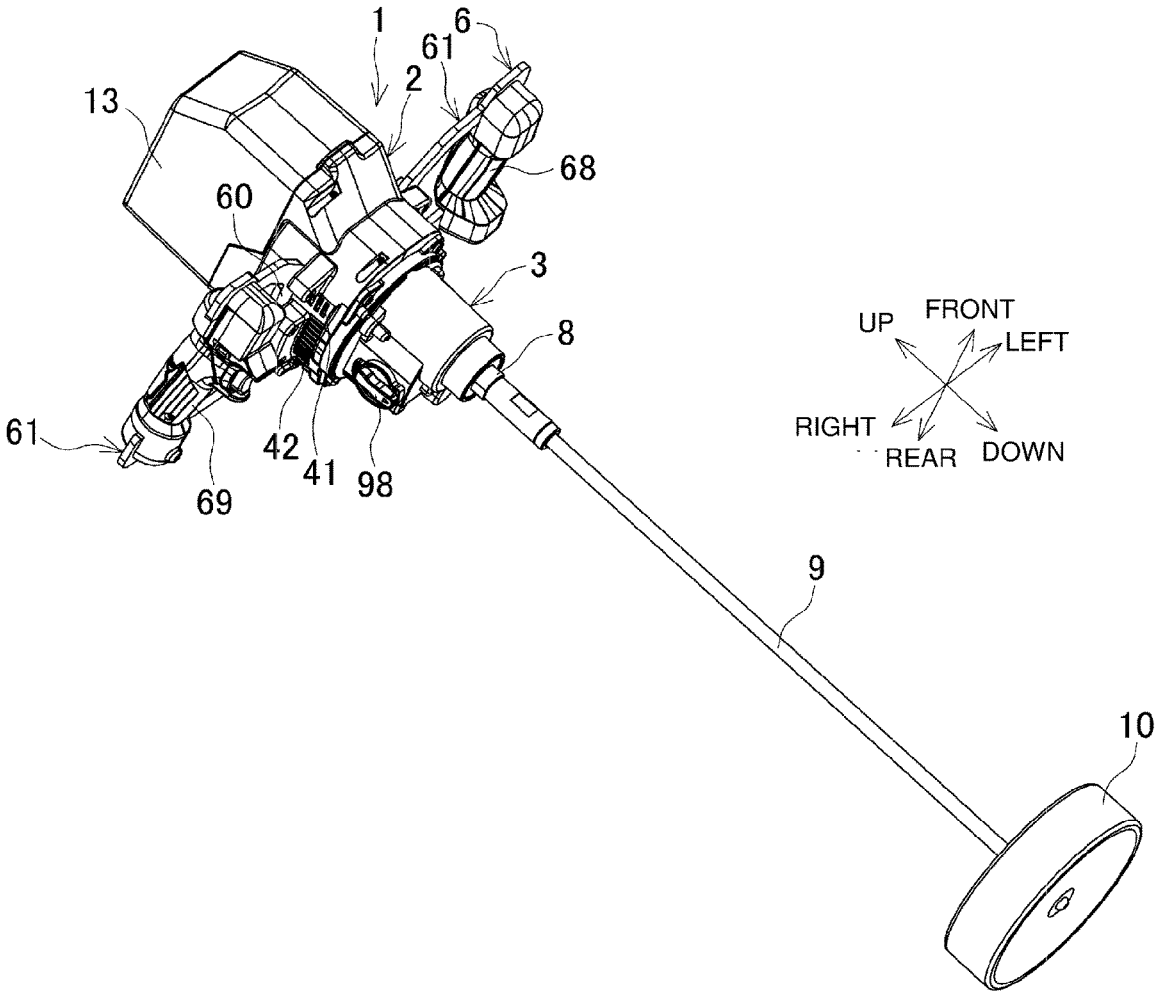
(57) **ABSTRACT**

For vertical downsizing, a mixer includes a motor including a stator and a rotor, a motor housing accommodating the motor, a reducer driven by the rotor, a reducer housing below the motor housing and accommodating the reducer, a shaft holder protruding downward from the reducer housing to hold a mixer shaft, and a controller that controls the motor. The controller is vertically on the same level as the motor.



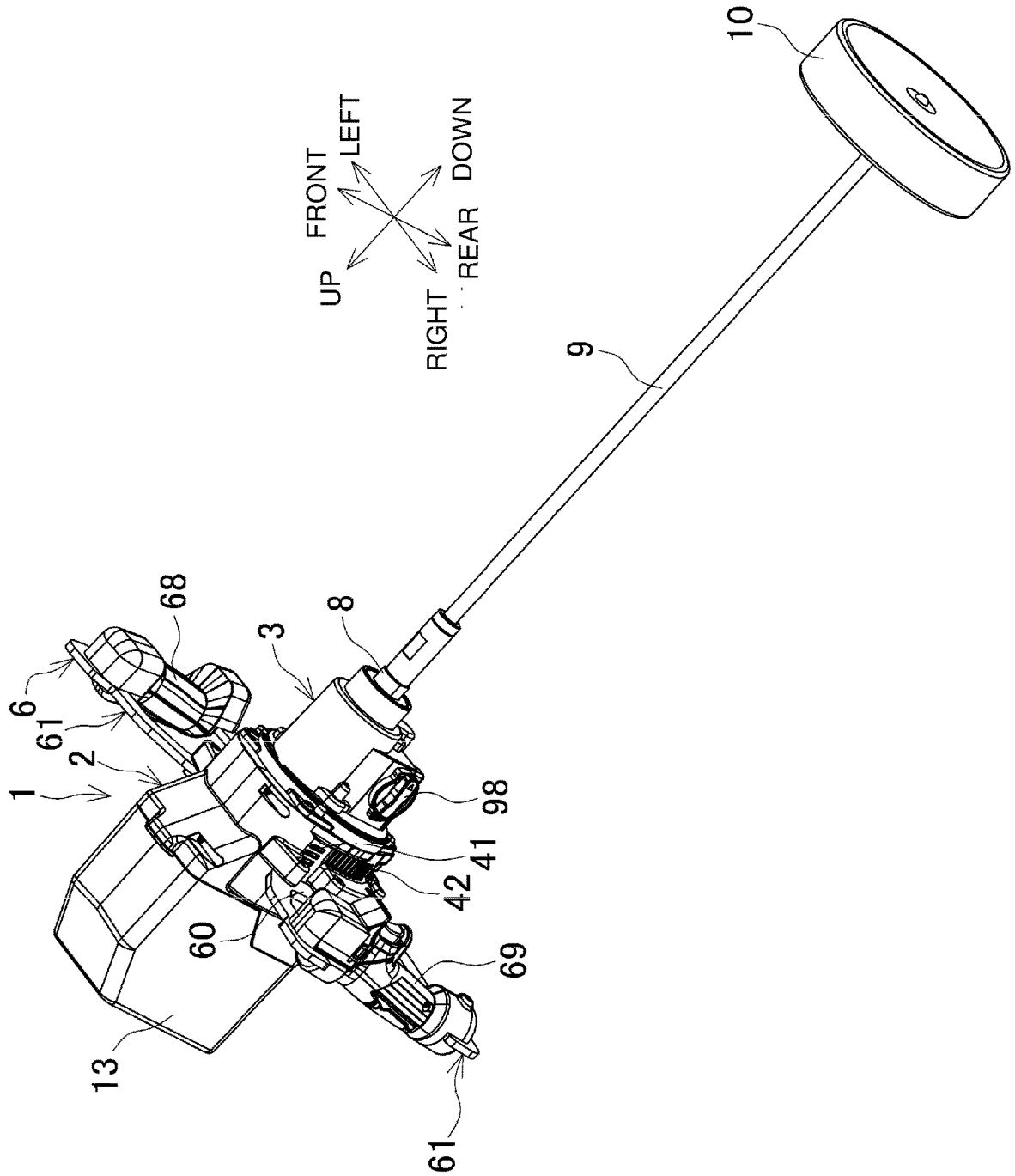

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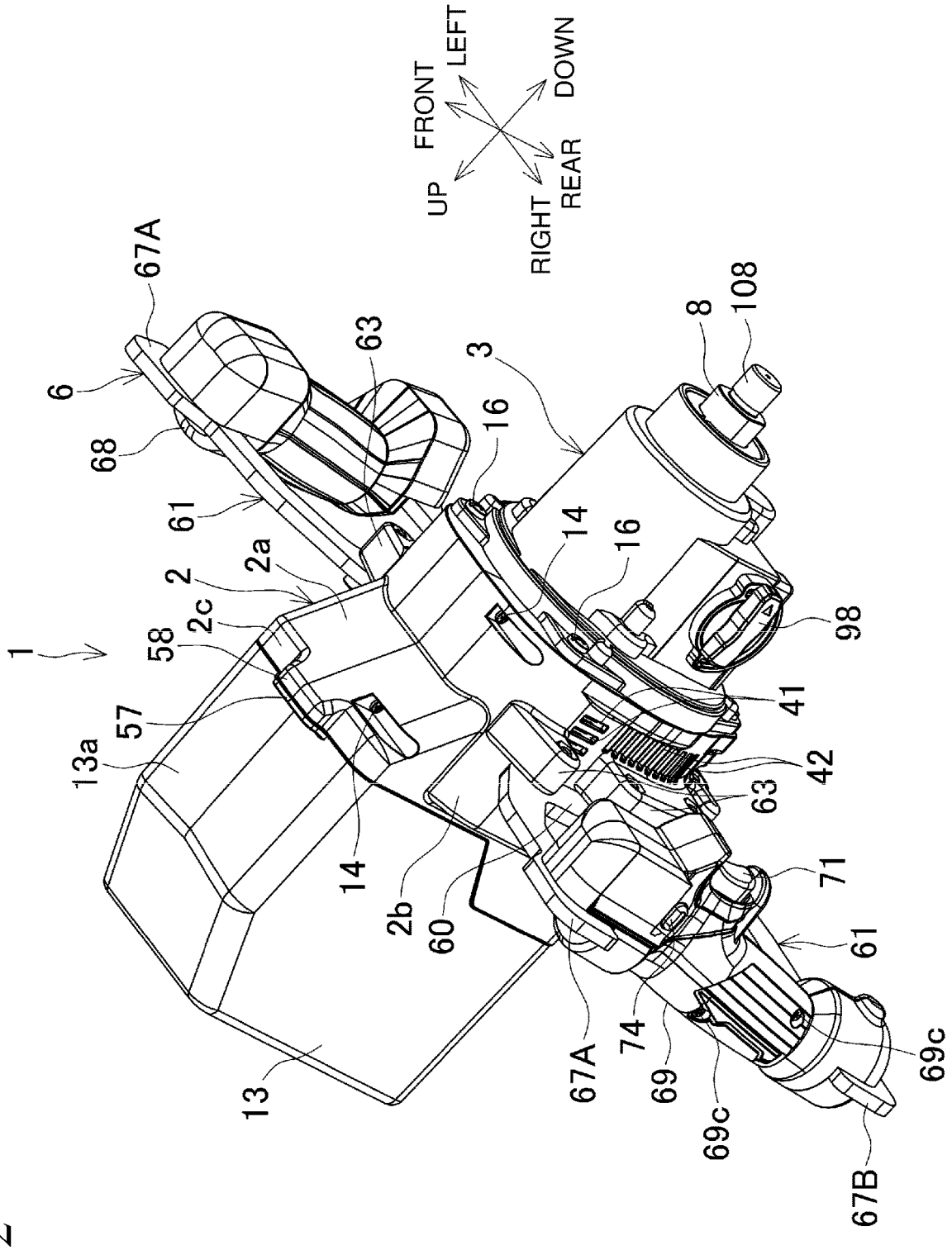
FIG. 1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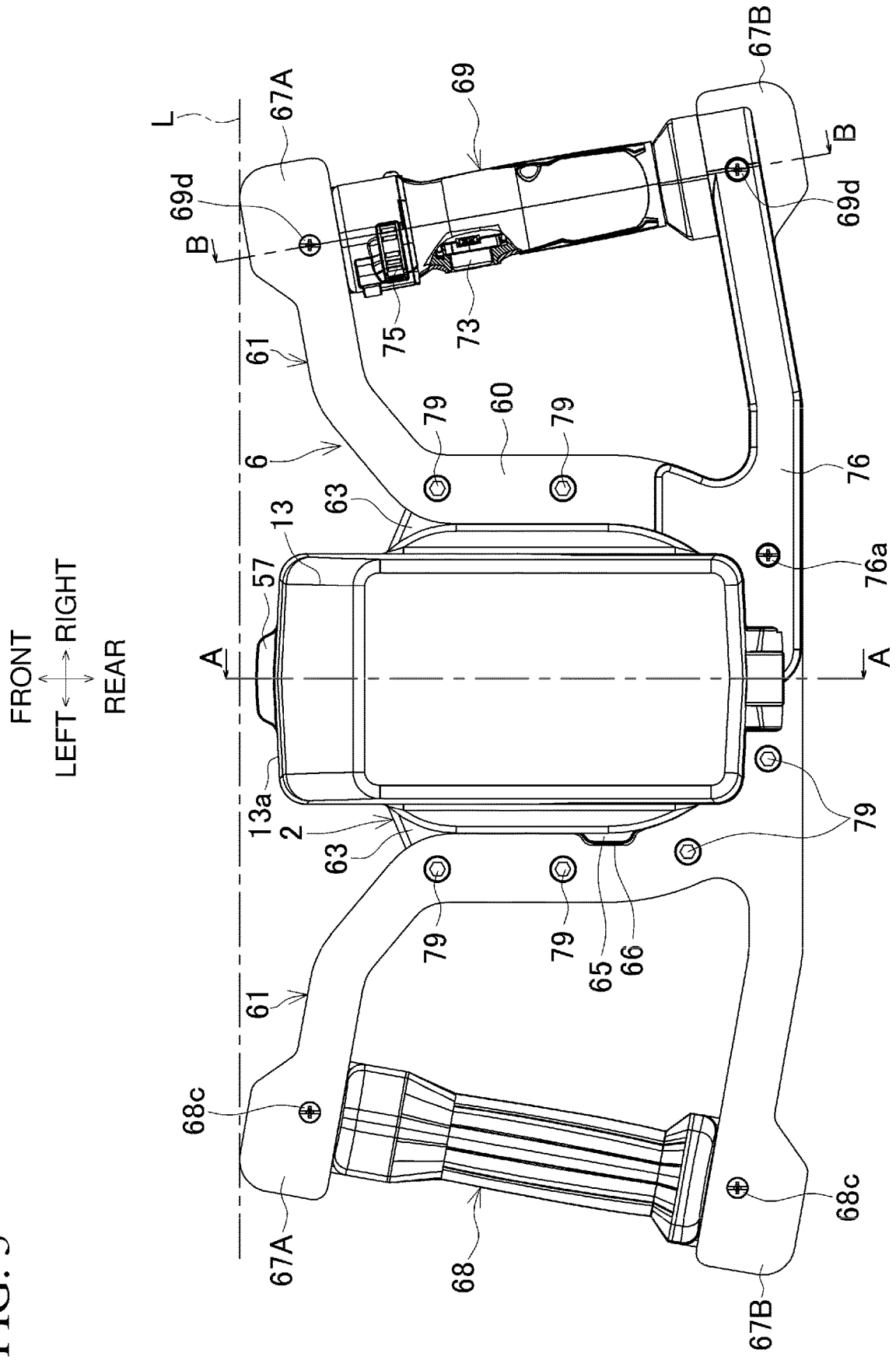
108

FIG. 2

FIG. 3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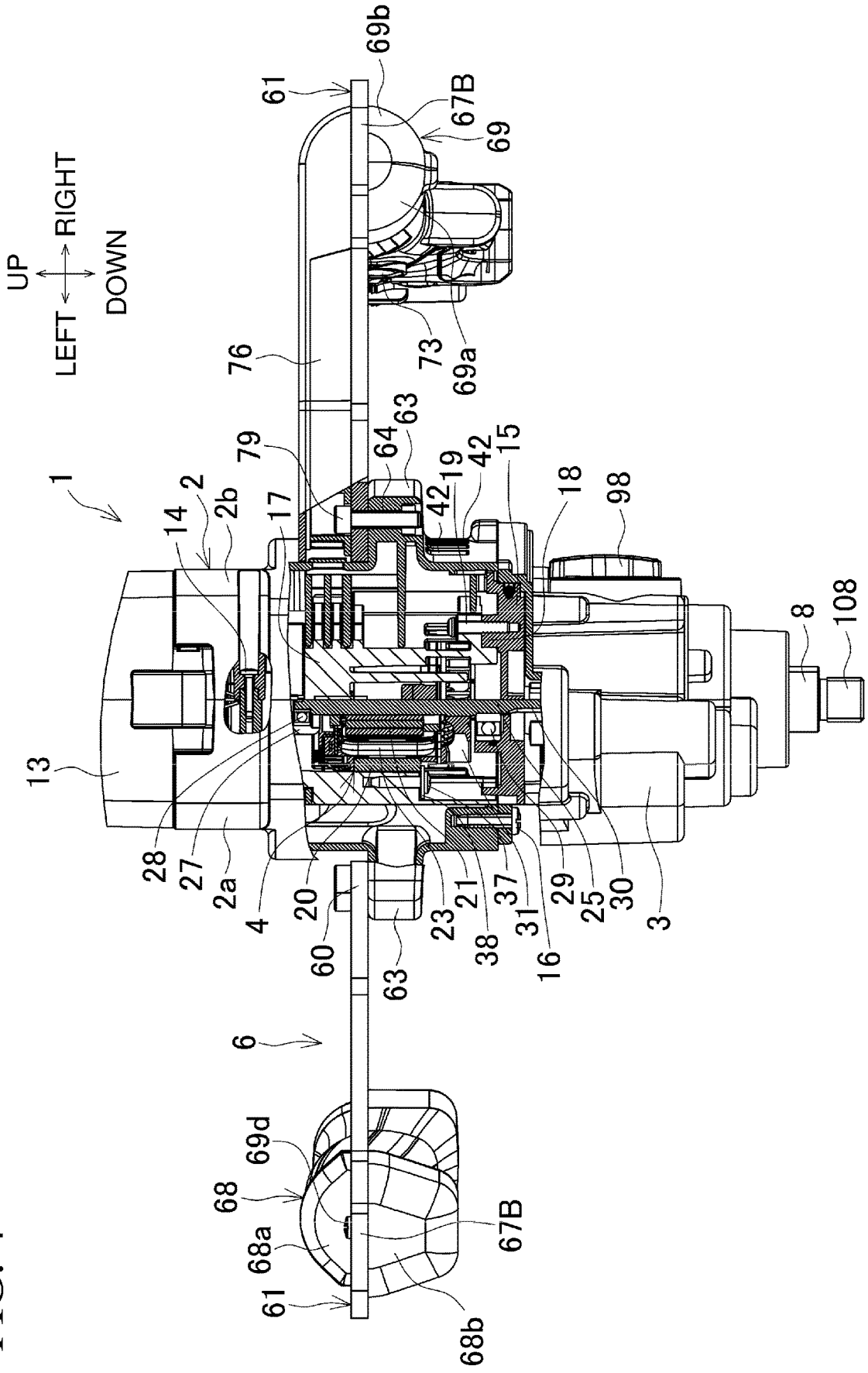
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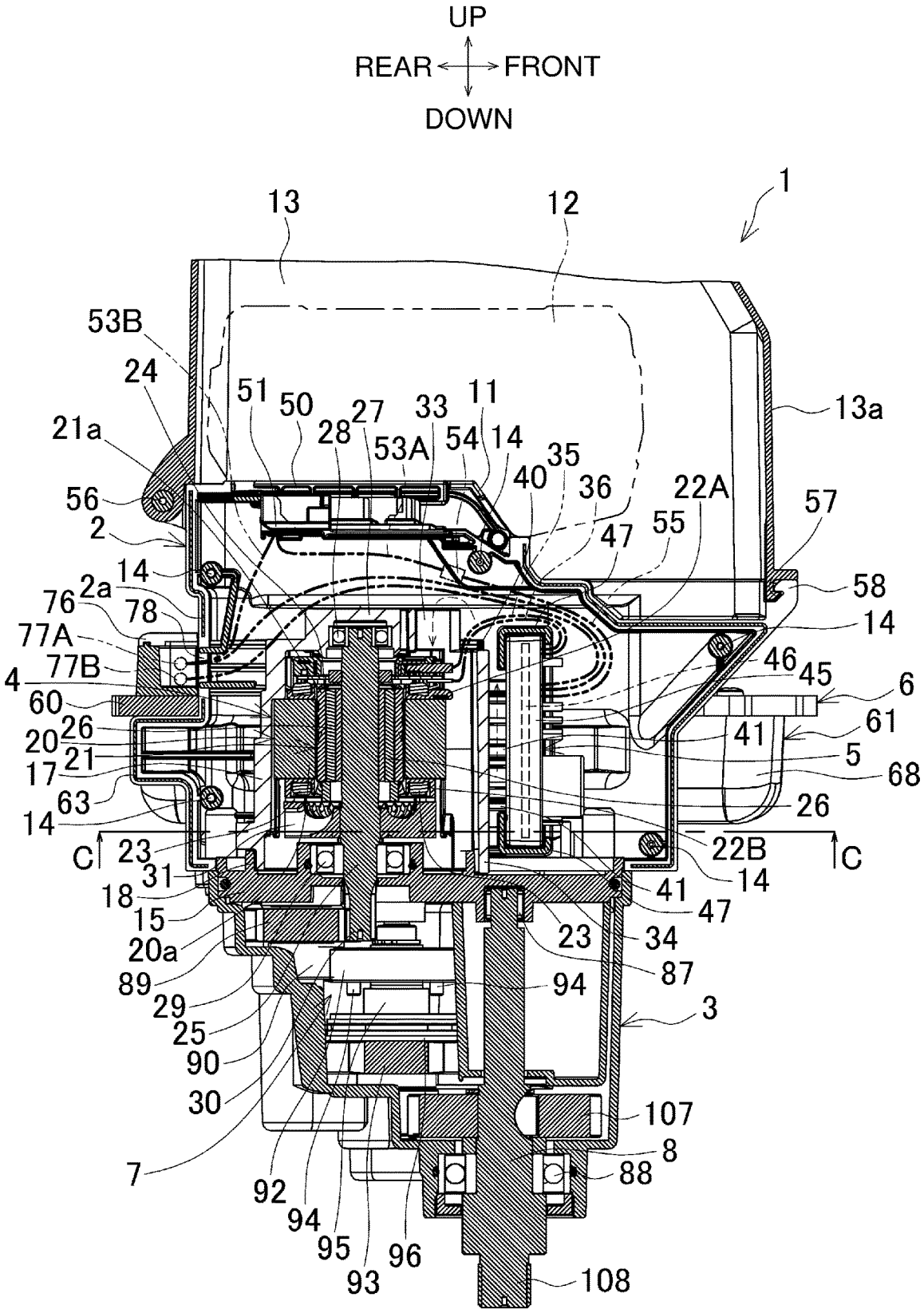
FIG. 4

FIG. 5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22A
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57
2
47
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2a
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77A
77B
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61
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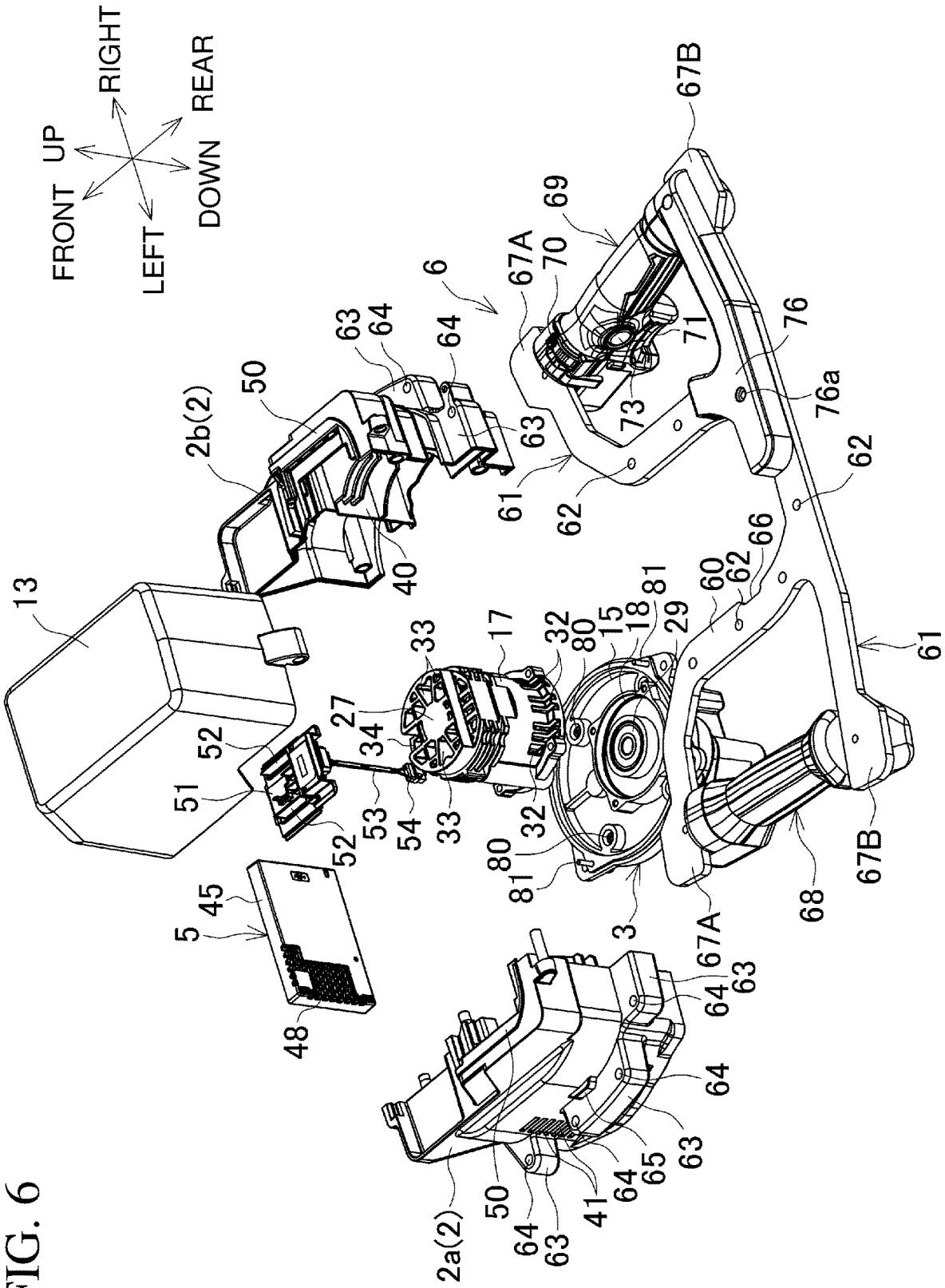
FIG. 6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45
48
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67A
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2a(2)
68
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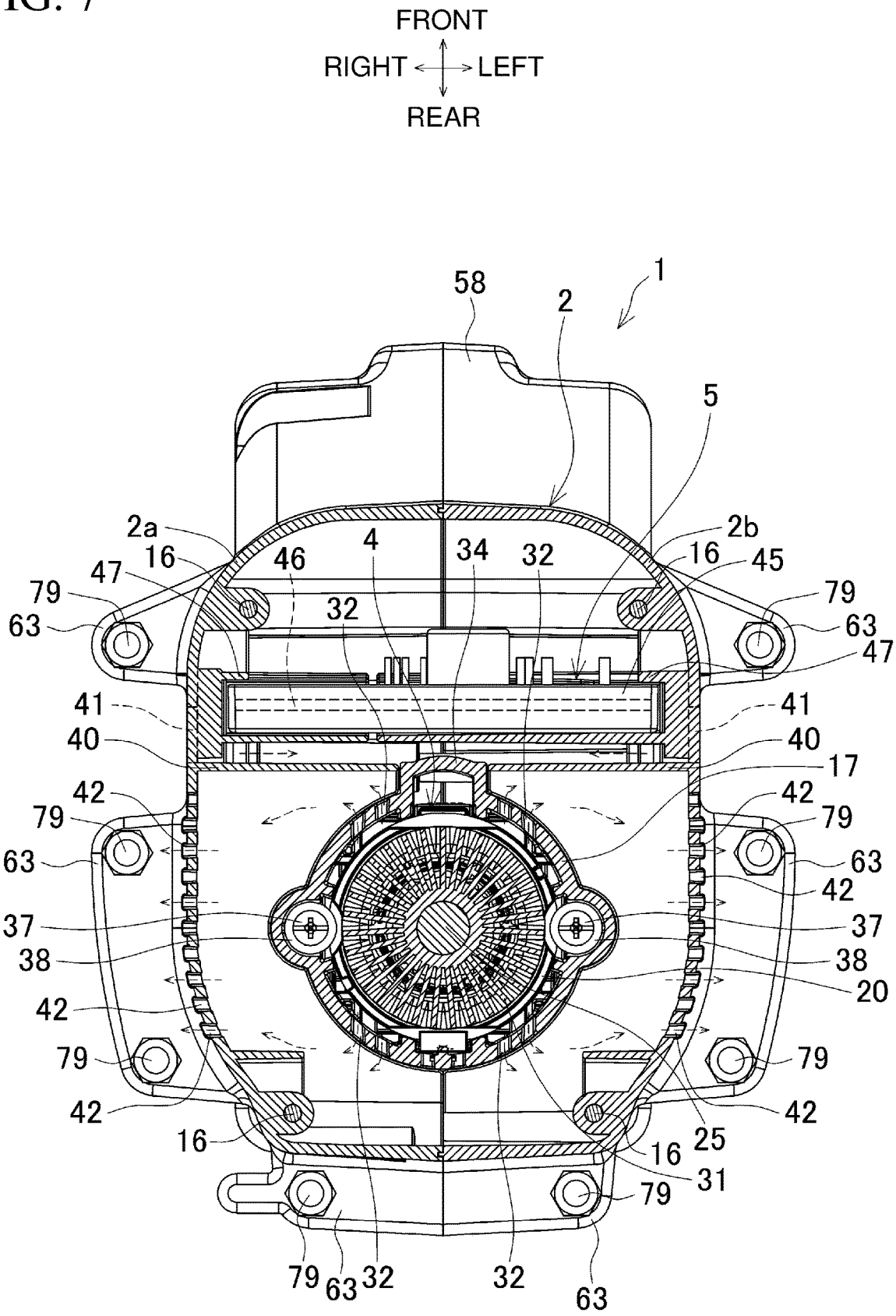
FIG. 7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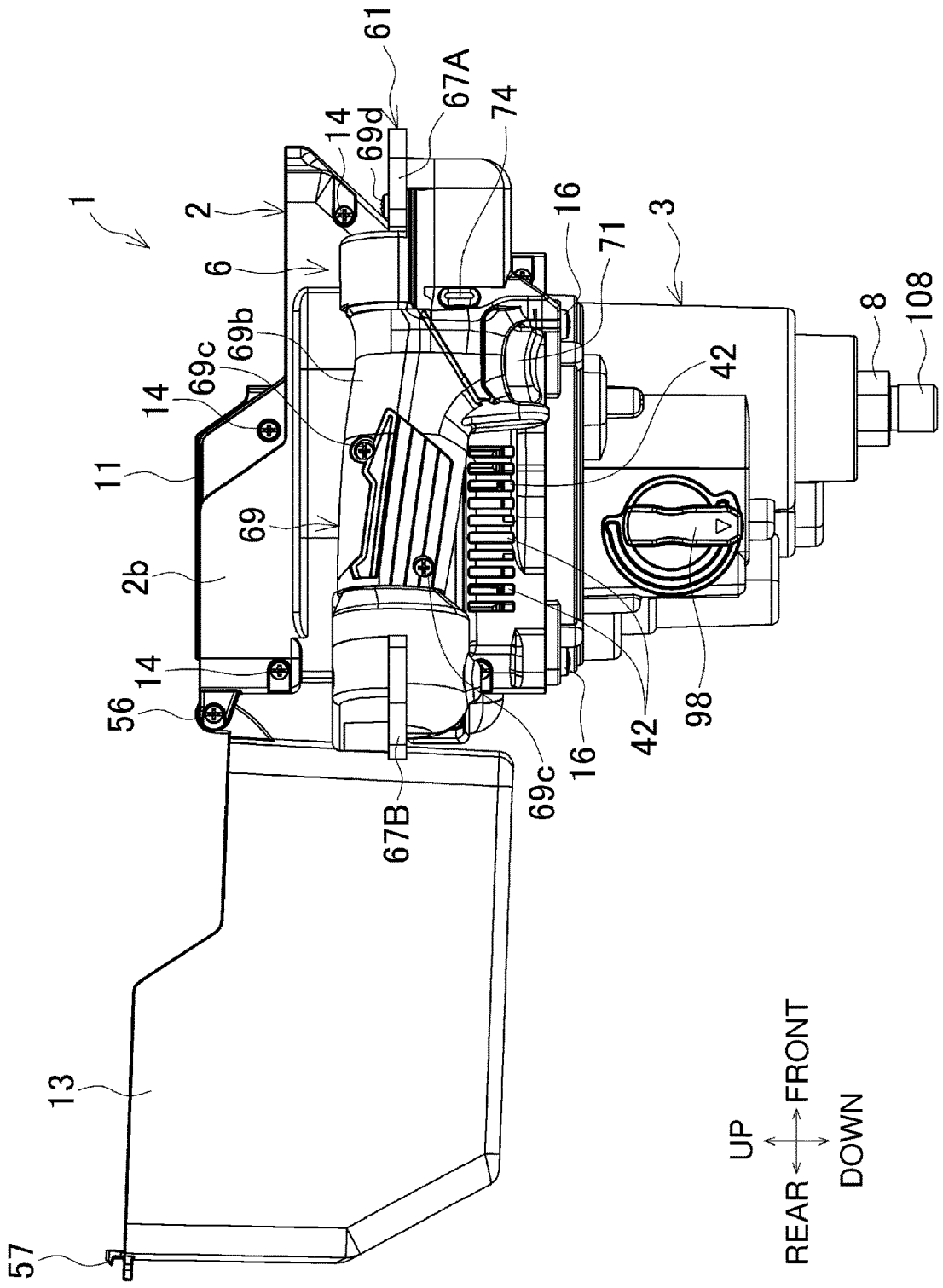
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FIG. 8

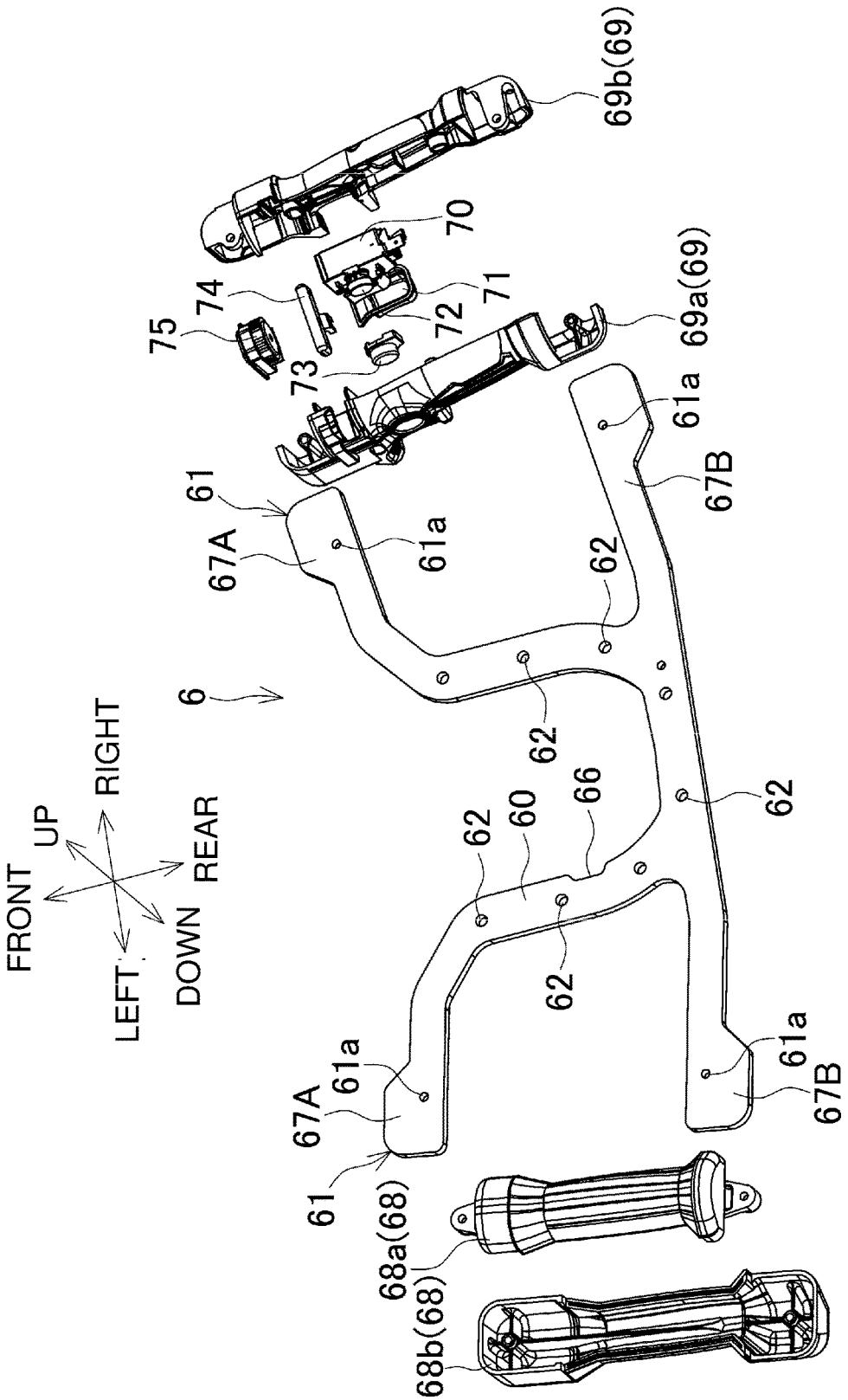
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FIG. 9

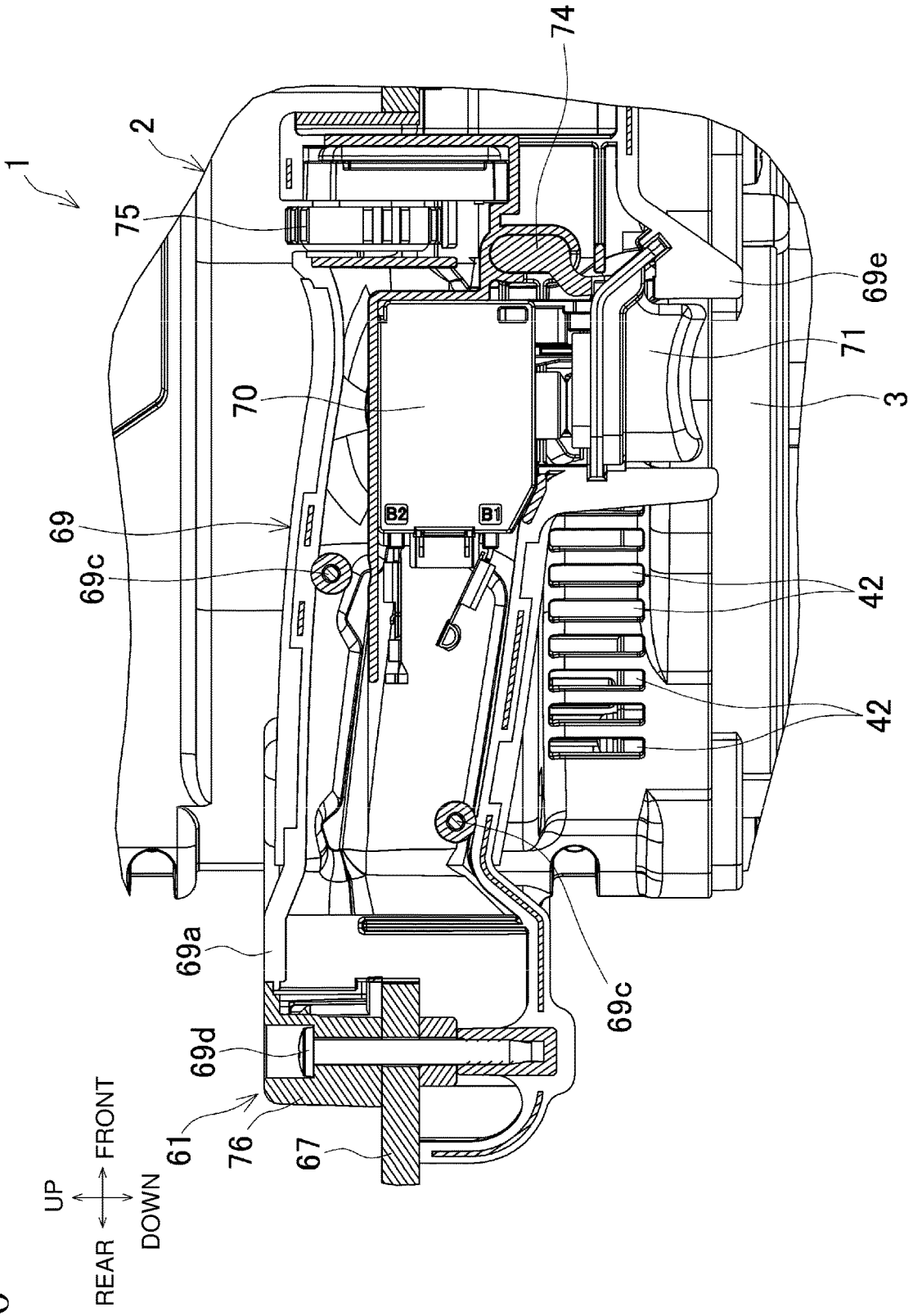
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FIG. 10

FIG. 11

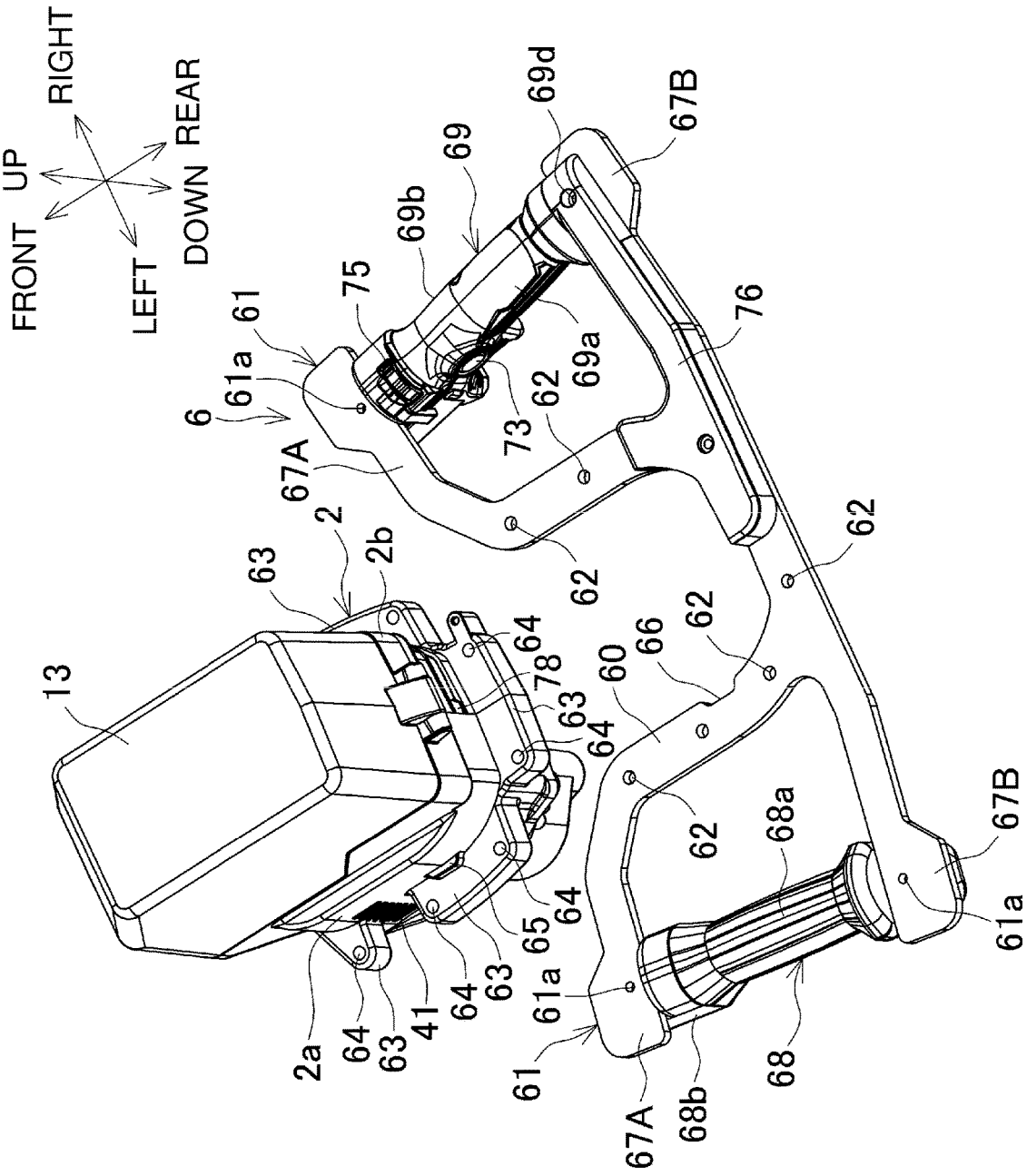
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FIG. 12

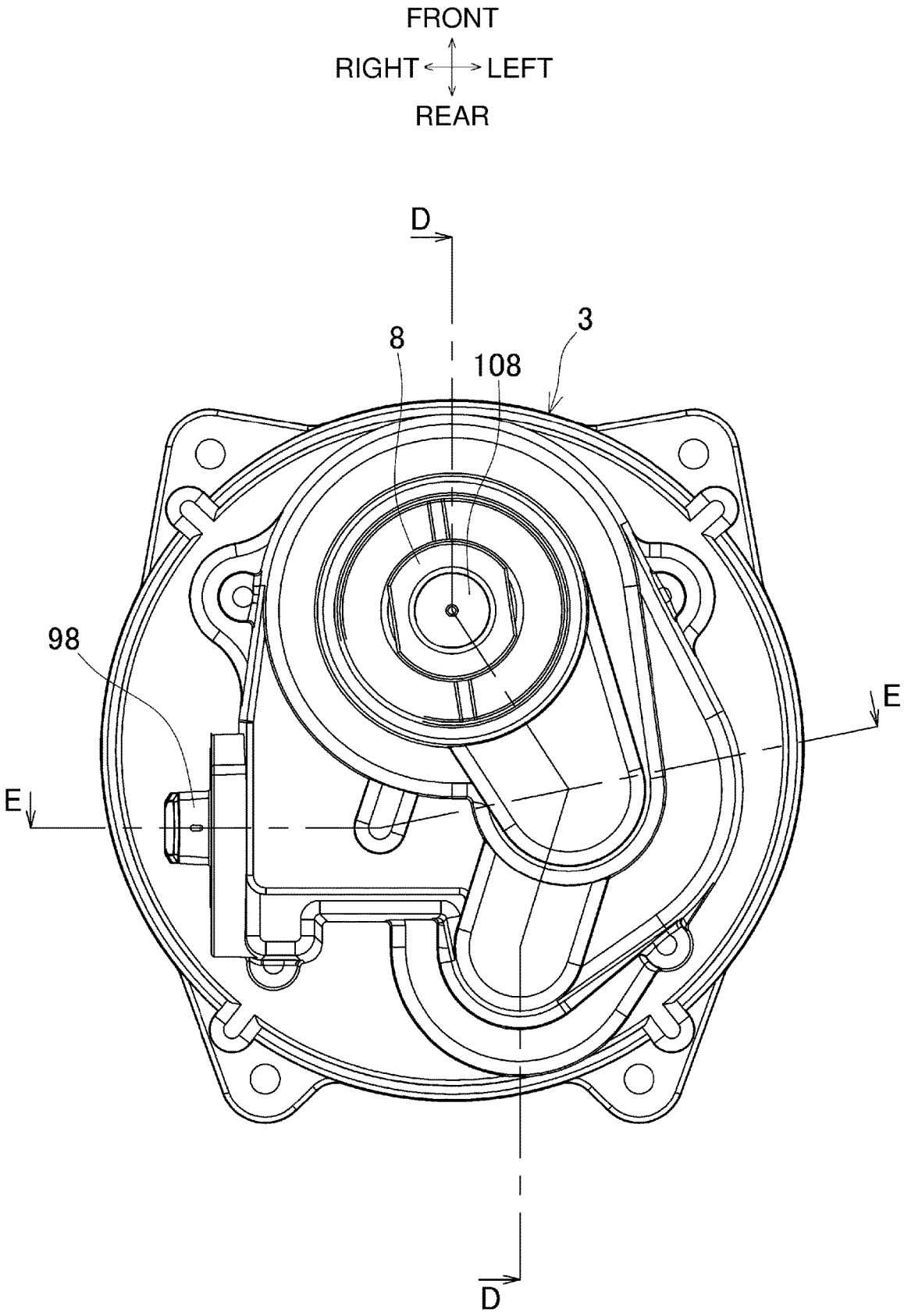

FIG. 13

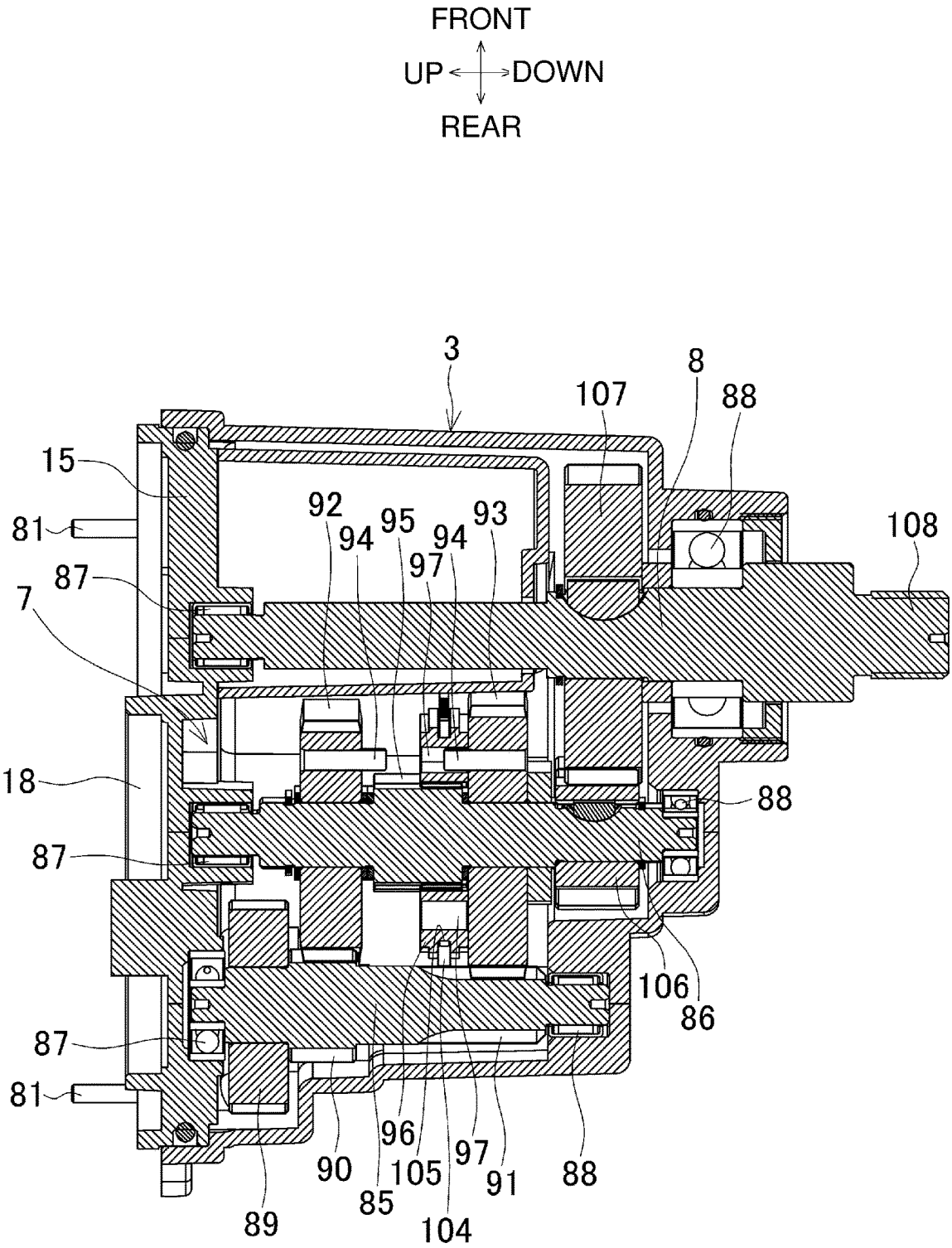
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FIG. 14

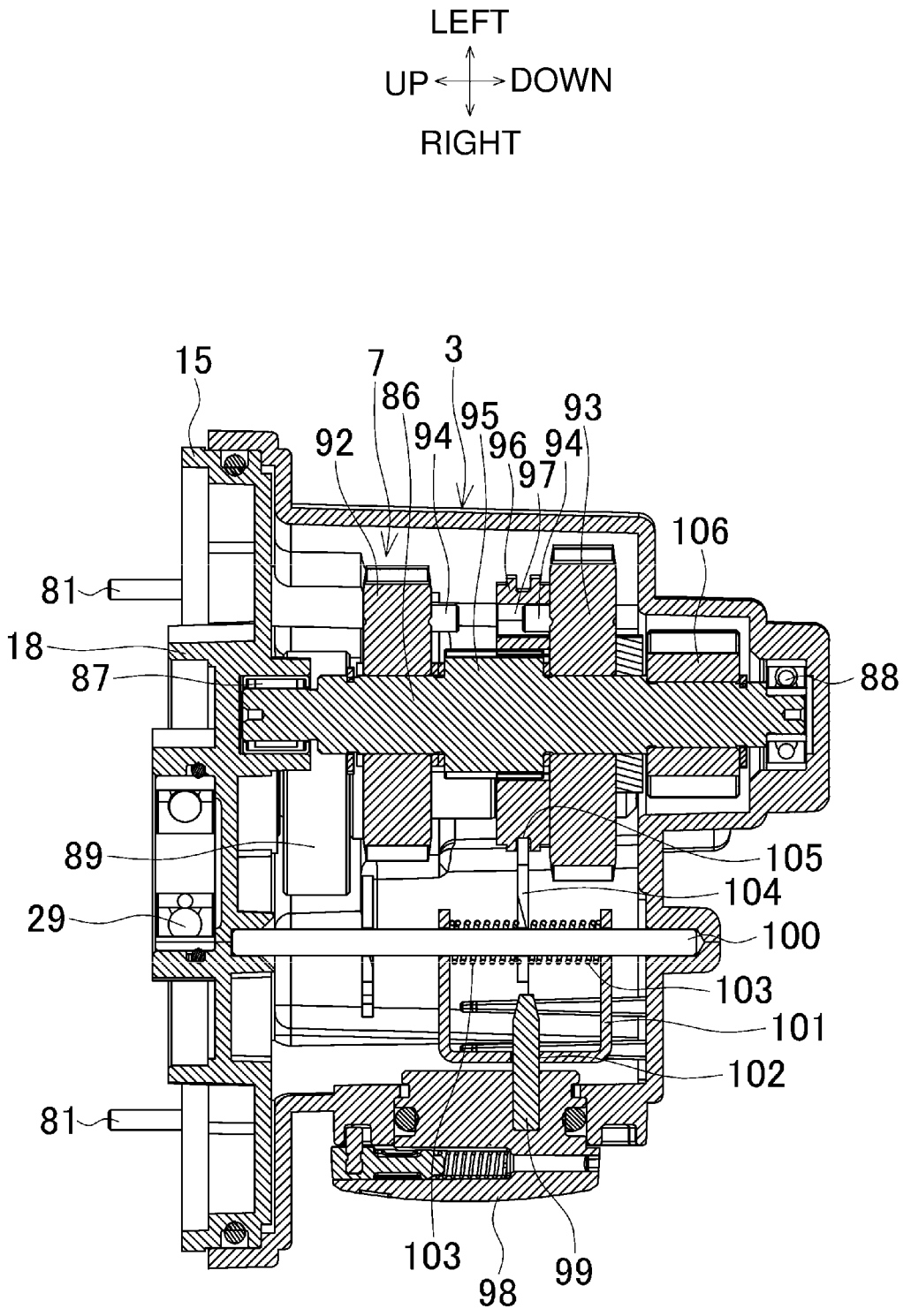
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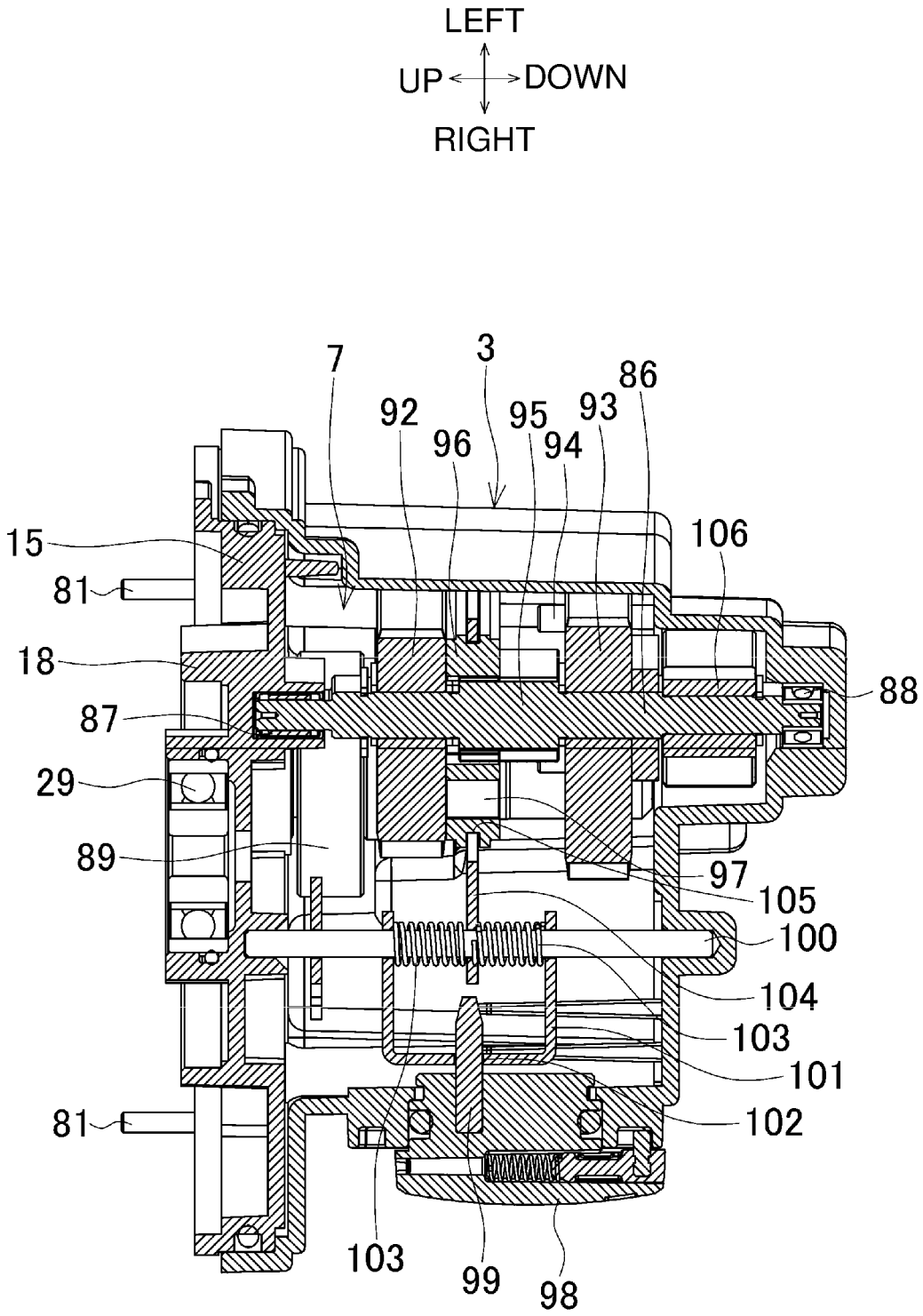
FIG. 15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MIXER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to Japanese Patent Application No. 2020-101835, filed on Jun. 11, 2020, the entire contents of which are hereby incorporated by reference.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a mixer for mixing fluid materials such as paint and mortar.

2. Description of the Background

[0003] A known mixer includes one or more blades rotating together with a mixer shaft to mix, for example, paint (refer to, for example, German Utility Model No. 202010014783, hereafter Patent Literature 1).

BRIEF SUMMARY

[0004] Patent Literature 1 describes a mixer but does not describe control of a motor. A mixer additionally including a controller for controlling a motor can be easier to use. However, the positioning of the controller determines the dimensions of the mixer. The total vertical length of the mixer particularly affects operability.

[0005] Further, the mixer described in Patent Literature 1 includes the motor with its rotational shaft extending vertically in a motor housing, and has an inlet and an outlet located vertically apart from each other in the motor housing to let air in and out for cooling the motor. The mixer may have a longer total vertical length including the motor housing, or in other words, in the lengthwise direction of the mixer shaft, and may have lower operability.

[0006] One or more aspects of the present disclosure are directed to a mixer that can be downsized vertically.

[0007] A first aspect of the present disclosure provides a mixer for holding a mixer shaft, the mixer including:

[0008] a motor including a stator and a rotor;

[0009] a motor housing accommodating the motor;

[0010] a reducer driven by the rotor;

[0011] a reducer housing below the motor housing and accommodating the reducer;

[0012] a shaft holder protruding downward from the reducer housing to hold the mixer shaft; and

[0013] a controller configured to control the motor, the controller being vertically on the same level as at least a part of the motor.

[0014] A second aspect of the present disclosure provides a mixer for holding a mixer shaft, the mixer including:

[0015] a motor including a stator and a rotor;

[0016] a motor housing accommodating the motor;

[0017] a reducer driven by the rotor;

[0018] a reducer housing below the motor housing and accommodating the reducer;

[0019] a shaft holder protruding downward from the reducer housing to hold the mixer shaft; and

[0020] a controller configured to control the motor, the controller extending vertically in the motor housing.

[0021] A third aspect of the present disclosure provides a mixer for holding a mixer shaft, the mixer including:

[0022] a motor including a stator and a rotor;

[0023] a fan rotatable together with the rotor;

[0024] a motor housing accommodating the motor, the motor housing including

[0025] an inlet to draw in air in response to rotation of the fan, and

[0026] an outlet to discharge air in response to rotation of the fan, the outlet being vertically on the same level as at least a part of the inlet;

[0027] a reducer driven by the rotor;

[0028] a reducer housing below the motor housing and accommodating the reducer; and

[0029] a shaft holder protruding downward from the reducer housing to hold the mixer shaft.

[0030] The mixer according to the above aspects of the present disclosure can be downsized vertically.

BRIEF DESCRIPTION OF DRAWINGS

[0031] FIG. **1** is an overall perspective view of a mixer including a mixer shaft and a blade.

[0032] FIG. **2** is a perspective view of a body of the mixer.

[0033] FIG. **3** is a plan view of the body of the mixer.

[0034] FIG. **4** is a rear view of the body of the mixer, partially showing in cross section.

[0035] FIG. **5** is a cross-sectional view taken along line A-A in FIG. **3**.

[0036] FIG. **6** is an exploded perspective view of the body.

[0037] FIG. **7** is a cross-sectional view taken along line C-C in FIG. **5** without showing a handle.

[0038] FIG. **8** is a side view of the body with a battery cover open.

[0039] FIG. **9** is an exploded perspective view of the handle.

[0040] FIG. **10** is an enlarged sectional view taken along line B-B in FIG. **3**.

[0041] FIG. **11** is a perspective view of the handle being attached to a motor housing.

[0042] FIG. **12** is a bottom view of a reducer housing.

[0043] FIG. **13** is a cross-sectional view of the mixer body taken along line D-D in FIG. **12** in a low speed mode.

[0044] FIG. **14** is a cross-sectional view of the mixer body taken along line E-E in FIG. **12** in the low speed mode.

[0045] FIG. **15** is a cross-sectional view of the mixer body in a high-speed mode.

DETAILED DESCRIPTION

[0046] Embodiments of the present disclosure will now be described with reference to the drawings.

[0047] FIG. **1** is an overall perspective view of a rechargeable mixer **1** as an example of a mixer. FIG. **2** is a perspective view of a body of the mixer **1**. FIG. **3** is a plan view of the body of the mixer **1**. FIG. **4** is a rear view of the body of the mixer **1**, partially showing in cross section. FIG. **5** is a cross-sectional view taken along line A-A in FIG. **3**.

[0048] The mixer **1** includes the body including a motor housing **2** and a reducer housing **3**. The motor housing **2** accommodates a motor **4** and a controller **5**. A handle **6** is attached to the motor housing **2**. The reducer housing **3** accommodates a reducer **7**. The reducer **7** includes a spindle **8** to be an output shaft. The spindle **8** protrudes downward from the reducer housing **3**. A mixer shaft **9** is coaxially connectable to the spindle **8**. A blade **10** is attached to a lower end of the mixer shaft **9**.

[0049] A battery mount **11** is located on an upper portion of the motor housing **2**. A battery pack **12** is slidable onto the battery mount **11** from the front. A battery cover **13** is attached to the upper portion of the motor housing **2**. The battery cover **13** covers the battery pack **12** and the battery mount **11** from above.

[0050] The motor housing **2** includes a pair of left and right half housings **2***a* and **2***b*. The half housings **2***a* and **2***b* are joined together with multiple screws **14** that are screwed from the right.

[0051] The motor housing **2** receives a disk-shaped bracket plate **15** on its lower end. The bracket plate **15** is fastened to the motor housing **2** together with the reducer housing **3** with multiple screws **16** from below.

[0052] As shown in FIG. **6**, the bracket plate **15** receives, on its upper side, a bottomed cylindrical inner housing **17** that is open downward. The inner housing **17** is an integral resin-molded part. The inner housing **17** accommodates the motor **4**. The inner housing **17** is mounted on a mount **18** on the upper surface of the bracket plate **15** with four screws **19** (FIG. **4**) screwed from above.

[0053] The motor **4** is a brushless motor. The motor **4** is an inner-rotor motor including an outer stator **20** and a rotor **21** inside the stator **20**. The stator **20** is held in the inner housing **17** with its axis extending vertically. As shown in FIGS. **4** and **7**, the stator **20** in the inner housing **17** is fixed in the axial direction with screws **37** screwed from below with washers **38** in between. The stator **20** has an upper portion fixed to the inner housing **17** in the rotation direction.

[0054] The stator **20** includes a stator core **20***a*, an upper insulator **22**A, a lower insulator **22**B, and multiple coils **23**. The upper insulator **22**A and the lower insulator **22**B are fixed to the stator core **20***a*. The multiple coils **23** are wound around the upper insulator **22**A and the lower insulator **22**B. The upper and lower insulators **22**A and **22**B insulate each coil **23** from the stator core **20***a*. The coils **23** form a three-phase connection on the upper insulator **22**A. A sensor circuit board **24** is attached to the upper insulator **22**A. The sensor circuit board **24** includes a rotation detecting element (not shown). The rotation detecting element detects the positions of permanent magnets **26** included in the rotor **21**.

[0055] The rotor **21** includes a rotational shaft **25**, a rotor core **21***a*, and the permanent magnets **26**. The rotational shaft **25** extends vertically through the stator **20**. The rotor core **21***a* is fixed around the rotational shaft **25**. The rotor core **21***a* has multiple holes extending in the axial direction each receiving the permanent magnet **26** in a fixed manner.

[0056] A bearing holder **27** is located on the upper end of the inner housing **17**. The rotational shaft **25** has an upper end supported on a bearing **28** in a rotatable manner. The bearing **28** is held in the bearing holder **27**. The rotational shaft **25** has a lower portion supported on a bearing **29** in a rotatable manner. The bearing **29** is held in the mount **18**. The rotational shaft **25** has a lower end extending through the bracket plate **15** and protruding into the reducer housing **3**. The rotational shaft **25** has the lower end with a pinion (gear) **30**.

[0057] A fan **31** is located between the bearing **29** and the rotor core **21***a* on a lower portion of the rotational shaft **25**. As shown in FIGS. **6** and **7**, the inner housing **17** has, in its front and rear radially outward from the fan **31**, multiple internal outlets **32**. The internal outlets **32** extend radially through the inner housing **17**. The internal outlets **32** are located at lower portions of the inner housing **17**. The inner housing **17** has, on its upper portions and around the bearing holder **27**, multiple internal inlets **33**. The internal inlets **33** extend vertically through the inner housing **17**.

[0058] As shown in FIGS. **5** to **7**, a ridge **34** is located at the lateral center of the front surface of the inner housing **17**. The ridge **34** extends vertically. The ridge **34** has an open upper end lower than the upper surface of the inner housing **17**. As indicated with a two-dot chain line in FIG. **5**, a three-phase power supply line **35** is directed outside the inner housing **17** through the ridge **34** in an upper portion of the inner housing **17**. As indicated with a two-dot chain line, a signal line **36** connected to the sensor circuit board **24** for the rotation detecting element is also directed outside the inner housing **17** through the ridge **34** in an upper portion of the inner housing **17**.

[0059] The motor housing **2** has a pair of right and left ribs **40** aligned with the ridge **34**. The ribs **40** protrude inward from the inner surfaces of the half housings **2***a* and **2***b* toward the ridge **34**. The ribs **40** are higher than the ridge **34** and lower than the inner housing **17**. The ribs **40** each have an edge in contact with either the right side surface or the left side surface of the ridge **34**. The ribs **40** separate the interior of the motor housing **2** except the inner housing **17** and the area above the motor **4** into front and rear areas.

[0060] The half housings **2***a* and **2***b* each have multiple external inlets **41** in their side surfaces and frontward from the ribs **40**. The external inlets **41** are slits extending in the circumferential direction of the motor housing **2**. As shown in FIGS. **2** and **6**, the multiple external inlets **41** are apart from one another vertically at predetermined intervals. The half housings **2***a* and **2***b* each have multiple external outlets **42** in their side surfaces and rearward from the ribs **40**. The external outlets **42** are slits extending vertically. The multiple external outlets **42** are apart from one another in the circumferential direction of the motor housing **2** at predetermined intervals. As shown in FIG. **2**, the lowest two of the external inlets **41** apart vertically overlap the external outlets **42** apart in the circumferential direction of the motor housing **2**. In other words, at least one of the external inlets **41** is on the vertically same level as the external outlets **42**.

[0061] The controller **5** is located in front of the ribs **40** in the motor housing **2**. The controller **5** extends vertically and laterally. The vertical length of the controller **5** is smaller than the vertical length of the rotational shaft **25**. The controller **5** is thus vertically within the vertical dimension of the rotational shaft **25**. In other words, the controller **5** is on the vertically same level as the motor **4**.

[0062] The controller **5** includes a case **45** that accommodates a control circuit board **46**. The case **45** is formed from aluminum, which provides high heat dissipation. The control circuit board **46** includes, for example, a microcomputer and multiple switching elements. The control circuit board **46** is accommodated in the case **45** with its mounting surface facing outward (frontward). As shown in FIGS. **5** and **7**, the case **45** has its right and left edges held by support ribs **47**. The support ribs **47** each protrude from the inner surface of either the half housing **2***a* or the half housing **2***b*. The right and left external inlets **41** are located outward from the right and left of the controller **5**. A heat dissipator **48** having multiple recesses and protrusions (FIG. **6**) is located on the rear surface of the case **45**. The heat dissipator **48** is exposed from the support ribs **47** vertically (FIG. **5**).

[0063] The battery mount **11** is located above the inner housing **17** and on the upper surface of the motor housing **2**.

The battery mount **11** includes a pair of right and left guide rails **50**. The guide rails **50** each extend in the front-rear direction. The guide rails **50** receive, from the front, the battery pack **12** with its connection side facing downward. A terminal block **51** is located between the guide rails **50**. Terminal strips **52** are located on the upper surface of the terminal block **51**. The terminal strips **52** are electrically connectable to the attached battery pack **12**. Lead wires **53**A and **53**B are directed outside from the lower surface of the terminal block **51**.

[0064] The power supply line **35** and the signal line **36** from the motor **4** extend above the controller **5**, are directed to the front of the controller **5**, and then are connected to the front surface of the control circuit board **46**. The lead wire **53**A directed from the terminal block **51** is connected to the controller **5**. The lead wire **53**A is directed to above the inner housing **17** and the controller **5**, and is then connected to a lead wire **55** directed from the front surface of the control circuit board **46** with a connector **54**. The lead wire **53**B directed from the terminal block **51** is connected to a switch **70** in the handle **6**. The lead wire **53**B above the inner housing **17** is directed rearward, then directed outside through a wiring hole **78** in the rear surface of the motor housing **2**, and connected to a lead wire **77**A from the switch **70**.

[0065] The battery cover **13** is a box having an open lower end and is rectangular in a plan view. The battery cover **13** has a lower rear end pivotably connected to an upper rear end of the motor housing **2** with a screw **56** extending laterally.

[0066] The battery cover **13** is pivotable about the screw **56** between a closed position and an open position. FIG. **5** shows the battery cover **13** at the closed position covering the battery pack **12** and the battery mount **11**. FIG. **8** shows the battery cover **13** at the open position uncovering the battery pack **12** and the battery mount **11**.

[0067] An engagement part **57** protrudes at the lower front end of the battery cover **13**. A counter engagement part **58** is located at the upper front end of the motor housing **2**. When the battery cover **13** is at the closed position, the engagement part **57** engages with the counter engagement part **58**. The battery cover **13** at the closed position has a flat foremost surface **13***a* defined horizontally and vertically. The motor housing **2** excluding the counter engagement part **58** also has a flat foremost surface **2***c* defined horizontally and vertically. The foremost surface **2***c* of the motor housing **2** and the foremost surface **13***a* of the battery cover **13** are flush with each other vertically. As shown in FIG. **3**, the battery cover **13** at the closed position has its right and left rear ends extending slightly outward from the motor housing **2** and partially overlapping the handle **6** vertically.

[0068] The handle **6** includes an attaching portion **60**, a left grip **68**, a right grip **69**, and joints **61**. The joints **61** connect the attaching portion **60** with the left and right grips **68** and **69**. The attaching portion **60** is attached to the motor housing **2**. The joints **61** are connected to the right and left of the attaching portion **60**.

[0069] The attaching portion **60** is U-shaped in a plan view and is a vertically thin metal sheet. The joints **61** are metal sheets integral with the attaching portion **60**. As shown in FIG. **9**, the attaching portion **60** has multiple upper attachment holes **62** along its U-shaped portion. As shown in FIG. **6**, the left and right half housings **2***a* and **2***b* each include three support protrusions **63** to support the attaching portion **60** from below. Each support protrusion **63** has one or more lower attachment holes **64**. The lower attachment holes **64** correspond to the respective upper attachment holes **62** in the attaching portion **60**. The half housing **2***a* includes a projection **65** above the middle support protrusion **63**. The attaching portion **60** has a cutout **66** on its left inner edge. The projection **65** and the cutout **66** fit together to determine the lateral orientation of the handle **6**.

[0070] Each joint **61** includes a pair of a front arm **67**A and a rear arm **67**B. Each front arm **67**A is integral with and extends laterally outward from the front end of the attaching portion **60**. Each rear arm **67**B is integral with and extends laterally outward from the rear end of the attaching portion **60**. The left front arm **67**A is referred to as a front arm **67**LA, and the left rear arm **67**B as a rear arm **67**LB. The right front arm **67**A is referred to as a front arm **67**RA, and the right rear arm **67**B as a rear arm **67**RB.

[0071] The left grip **68** extends between the left edges of the left front and rear arms **67**LA and **67**LB. The right grip **69** extends between the right edges of the right front and rear arms **67**RA and **67**RB. As shown in FIG. **9**, the left grip **68** is dividable into an upper half part **68***a* and a lower half part **68***b* by a plane extending in the front-rear direction. The front and rear ends of the half parts **68***a* and **68***b* are fastened together in through-holes **61***a* in the left edges of the front and rear arms **67**LA and **67**LB with screws **68***c*. The left grip **68** is hollow and is shaped to be gripped by an operator.

[0072] The right grip **69** is dividable into a left half part **69***a* and a right half part **69***b* by a plane extending in the front-rear direction. As shown in FIGS. **8** and **10**, the half parts **69***a* and **69***b* are joined together with screws **69***c* extending laterally. The front and rear ends of the right grip **69** are fastened in through-holes **61***a* in the right edges of the front and rear arms **67**RA and **67**RB with screws **69***d*.

[0073] As shown in FIGS. **9** and **10**, the left and right half parts **69***a* and **69***b* in the right grip **69** incorporate multiple components including the switch **70**, a trigger **71**, a lock button **72**, a button cover **73**, a lock lever **74**, and an adjustment dial **75**.

[0074] The switch **70** is located inside the half parts **69***a* and **69***b* with the trigger **71** protruding downward. The trigger **71** is exposed from an opening periphery **69***e* on the lower surface of the right grip **69**. The opening periphery **69***e* is located downward from the lower surface of the trigger **71**.

[0075] The lock button **72** is located on the left side surface of the switch **70**. The lock button **72** locks the trigger **71** being pressed. The button cover **73** for the lock button **72** protrudes from the right grip **69**. The lock button **72** is exposed from the left side surface of the right grip **69** to be operable by an operator.

[0076] The lock lever **74** is located in front of the switch **70**. The lock lever **74** is slidable between a position at which the trigger **71** is prevented from being pressed and a position at which the trigger **71** is allowed to be pressed. The lock lever **74** is exposed from the right side surface of the right grip **69** to be operable by an operator.

[0077] The adjustment dial **75** is located in front of the lock lever **74**. The adjustment dial **75** is rotated to adjust the rotational speed of the motor **4**. The adjustment dial **75** is exposed from the right grip **69** to be operable by an operator.

[0078] A lead wire cover **76** is fastened to the upper surfaces of the rear arm **67**RB in the right joint **61** and the attaching portion **60** with a screw **76***a*. As shown in FIG. **5**,

the lead wires **77**A and **77**B are directed into the lead wire cover **76**. The lead wire **77**A is connected to the switch **70** in the right grip **69**. The lead wire **77**B is connected to a substrate for the adjustment dial **75**. The lead wires **77**A and **77**B are first directed from the front to the rear in the right grip **69** and then directed outside the right grip **69**. The lead wires **77**A and **77**B then extend through a vertical space between the lead wire cover **76** and the rear arm **67**RB to be directed from the right to the left. The lead wires **77**A and **77**B are then directed into the motor housing **2** through the wiring hole **78** in the rear surface of the motor housing **2**. As indicated with a two-dot chain line in FIG. **5**, the lead wire **77**A for the switch **70** extends above the inner housing **17** and is connected to the front surface of the control circuit board **46** and to the lead wire **53**B for the terminal block **51**. As indicated with a two-dot chain line in FIG. **5**, the lead wire **77**B for the adjustment dial **75** extends above the inner housing **17** and is directed to the front surface of the control circuit board **46**.

[0079] As shown in FIG. **11**, the attaching portion **60** in the handle **6** is mounted on the support protrusions **63** from the upper rear of the motor housing **2** with the opening of the U-shaped attaching portion **60** facing frontward. The cutout **66** is fitted to the projection **65**. Subsequently, bolts **79** are placed through the respective upper attachment holes **62** and then through the respective lower attachment holes **64** from above, and are tightened with nuts. The handle **6** is thus fixed to the motor housing **2** as shown in FIG. **3**. With the handle **6** fixed, the motor housing **2** and the battery cover **13** have their front surfaces rearward from a dot-and-dash straight line L extending laterally that connects the front edges of the left and right joints **61**. The attaching portion **60** has its rear edge rearward from the rear surfaces of the motor housing **2** and the battery cover **13**. The motor housing **2** and the battery cover **13** can be easily attached to the attaching portion **60** without being inserted through the attaching portion **60**.

[0080] As shown in FIGS. **4**, **7**, and **8**, the reducer housing **3** is fixed to the lower surface of the motor housing **2** with the four screws **16** from below. As shown in FIG. **6**, the reducer housing **3** is fixed to the bracket plate **15** with four screws **80** from above. As shown in FIG. **6**, the reducer housing **3** includes, on its upper surface, four pins **81** protruding upward. The pins **81** pass through the bracket plate **15** and are placed into the lower surface of the motor housing **2**.

[0081] As shown in FIGS. **12** and **13**, the reducer **7** includes a first shaft **85**, a second shaft **86**, and the spindle **8**. The first shaft **85**, the second shaft **86**, and the spindle **8** extend vertically. The first shaft **85** is at the rearmost position. The spindle **8** is at the foremost position. The second shaft **86** is between the first shaft **85** and the spindle **8**. The first and second shafts **85** and **86** and the spindle **8** have their upper ends supported by bearings **87**. The bearings **87** are held on the bracket plate **15**. The first and second shafts **85** and **86** and the spindle **8** have their lower ends supported by bearings **88**. The bearings **88** are held on the reducer housing **3**.

[0082] The first shaft **85** includes an input gear **89** on its upper portion. The input gear **89** meshes with the pinion **30** on the rotational shaft **25**. The first shaft **85** receives a first driving gear unit **90** and a second driving gear unit **91** with different diameters and different numbers of teeth on its upper and lower portions below the input gear **89**.

[0083] The second shaft **86** includes a first follower gear **92** and a second follower gear **93**. The first follower gear **92** and the second follower gear **93** are separately rotatable. The first follower gear **92** is above the second follower gear **93**. The first follower gear **92** meshes with the first driving gear unit **90** on the first shaft **85**. The second follower gear **93** with a larger diameter than the first follower gear **92** meshes with the second driving gear unit **91** on the first shaft **85**. Multiple connecting pins **94** are located on the first follower gear **92** and the second follower gear **93**. Each connecting pin **94** on either the first follower gear **92** or the second follower gear **93** protrudes toward a surface of another connecting pin **94** facing the connecting pin **94**.

[0084] The second shaft **86** has a splined part **95** between the first follower gear **92** and the second follower gear **93**. A speed switch ring **96** is located on the splined part **95** in a manner rotatable together with the splined part **95** and movable in the axial direction. The speed switch ring **96** has multiple through-holes **97**. Each through-hole **97** can receive the connecting pin **94** from above and below. The connecting pins **94** on the first follower gear **92** are placed in the through-holes **97** at upper positions of the speed switch ring **96**. This enables a high-speed mode in which the rotation of the first follower gear **92** is transmitted to the second shaft **86** via the speed switch ring **96**. The connecting pins **94** on the second follower gear **93** are placed in the through-holes **97** at lower positions of the speed switch ring **96**. This enables a low-speed mode in which the rotation of the second follower gear **93** is transmitted to the second shaft **86** via the speed switch ring **96**.

[0085] As shown in FIG. **14**, a switch lever **98** on the right side surface of the reducer housing **3** can change the vertical position of the speed switch ring **96**. The switch lever **98** on the reducer housing **3** is rotatable. The switch lever **98** has an eccentric pin **99** at a position decentered from its rotation center. The eccentric pin **99** protrudes into the reducer housing **3**. A guide pin **100** extends vertically across the reducer housing **3** between the switch lever **98** and the second shaft **86**. The guide pin **100** extends through the upper and lower ends of a change plate **101**, which is U-shaped in a side view. The change plate **101** is vertically slidable along the guide pin **100**. The change plate **101** has a slit **102** with a length allowing the eccentric pin **99** to move laterally as the switch lever **98** rotates. The eccentric pin **99** extends through the slit **102**. When the switch lever **98** is rotated, the change plate **101** moves vertically as the eccentric pin **99** moves.

[0086] A pair of coil springs **103** are externally mounted on the guide pin **100** inside the change plate **101**. A change ring **104** is held between the coil springs **103**. The guide pin **100** extends through the change ring **104**. The change ring **104** engages with a ring groove **105** on the outer periphery of the speed switch ring **96**. When the change plate **101** moves vertically, the change ring **104** held between the coil springs **103** moves vertically accordingly to cause the speed switch ring **96** to move vertically. Thus, the mode is switchable between the high-speed mode and the low-speed mode by rotating the switch lever **98** and thus changing the vertical position of the speed switch ring **96**. FIGS. **13** and **14** show the low-speed mode in which the speed switch ring **96** is moved downward to connect to the second follower gear **93**. FIG. **15** shows the high-speed mode in which the speed switch ring **96** is moved upward to connect to the first follower gear **92**.

[0087] The second shaft **86** receives an intermediate gear **106** on its lower portion in a manner rotatable together with the second shaft **86**. The spindle **8** receives an output gear **107** on its lower portion in a manner rotatable together with the spindle **8**. The output gear **107** meshes with the intermediate gear **106**.

[0088] The rotation of the rotational shaft **25** of the motor **4** is reduced while being transmitted to the first shaft **85** via the input gear **89** in the reducer **7**. The rotation of the first shaft **85** is reduced in the high-speed mode through the first driving gear unit **90** and the first follower gear **92** while being transmitted to the second shaft **86**. The rotation of the first shaft **85** is reduced in the low-speed mode through the second driving gear unit **91** and the second follower gear **93** while being transmitted to the second shaft **86**. The rotation of the second shaft **86** is transmitted to the spindle **8** through the intermediate gear **106** and the output gear **107**.

[0089] The spindle **8** has the lower end extending through the reducer housing **3** to protrude downward. The spindle **8** receives a shaft holder **108** at the lower end. The shaft holder **108** is connectable with the upper end of the mixer shaft **9** with a screw.

[0090] An operator grips the left grip **68** and the right grip **69** in the handle **6** in the mixer **1** with the above structure with the battery pack **12** attached. The mixer **1** is thus held with the mixer shaft **9** protruding downward. This posture is normally taken in operation. For an operator with a certain height or due to another factor, the mixer shaft **9** may not extend vertically downward. For example, the mixer shaft **9** may be inclined to have the upper portion rearward and the lower portion frontward. In this case, the lengthwise direction of the mixer shaft **9** is defined as the vertical direction.

[0091] When the operator presses the trigger **71** in the right grip **69**, the switch **70** is turned on. The microcomputer in the control circuit board **46** then determines the rotational position of the rotor **21** based on a detection signal from the sensor circuit board **24**, and causes the six switching elements (e.g., a metal-oxide-semiconductor field-effect transistor, or MOSFET, and an insulated gate bipolar transistor, or IGBT) to perform the switching operation. This supplies a three-phase current to the stator **20**, energizing the coils **23** sequentially to rotate the rotor **21**. When the rotational shaft **25** rotates together with the rotor **21**, the rotation of the rotational shaft **25** is reduced by the reducer **7** in the high-speed mode or the low-speed mode as selected by the switch lever **98**, while being transmitted to the spindle **8**. This causes the mixer shaft **9** connected with the shaft holder **108** to rotate integrally with the spindle **8**. The blade **10** rotates together with the mixer shaft **9** to allow mixing of a paint or another material.

[0092] In the present embodiment, the button cover **73** (lock button **72**) and the adjustment dial **75** greatly improve usability. More specifically, the lock button **72** is operable to allow the motor **4** to remain rotating without operating the trigger **71**. Then, the operator can adjust the rotation of the motor **4** in accordance with the viscosity of the paint or the material being mixed simply by operating the adjustment dial **75**. When the operation is complete, the lock button **72** is operated to stop the rotation of the motor **4**.

[0093] In operation, the operator gripping the left and right grips **68** and **69** to support the mixer **1** views, from above the motor housing **2** and the battery cover **13**, for example, the blade **10** on the lower end of the mixer shaft **9**, the mixer shaft **9**, and the material being mixed. In this state, the attaching portion **60** in the handle **6**, which is not in front of the motor housing **2** and the battery cover **13**, can avoid obstructing the operator's field of view. The operator can thus reliably view, for example, the blade **10**.

[0094] The motor **4** and the controller **5** in the motor housing **2** are on the vertically same level. The external inlets **41** and the external outlets **42** are also on the same level. The motor housing **2** can thus be downsized vertically, improving the operability of the mixer **1**.

[0095] The fan **31** rotates as the rotational shaft **25** rotates. This draws the outside air into the motor housing **2** through the right and left external inlets **41** in the motor housing **2**. As indicated with dotted arrows in FIGS. **5** and **7**, this airflow passes between the controller **5** and the ribs **40** to come in contact with the case **45** (heat dissipator **48**). The airflow then rises and moves above the ribs **40** and rearward. The airflow then enters the inner housing **17** through the internal inlets **33** in the inner housing **17**. The airflow then moves downward in the inner housing **17** to cool the motor **4**. The airflow then exits through the front and rear internal outlets **32** in the inner housing **17** into the motor housing **2**. The airflow then diverges into right and left airflows and is discharged through the right and left external outlets **42** in the motor housing **2**.

[0096] The airflow thus cools the controller **5** upstream and the motor **4** downstream. The ribs **40** and the ridge **34** separating the controller **5** and the motor **4** allow the airflow to sequentially cool the controller **5** and the motor **4** without any shortcut, although the external inlets **41** and the external outlets **42** are on the same level.

[0097] The mixer **1** according to the present embodiment includes the motor **4** including the stator **20** and the rotor **21**, and the motor housing **2** accommodating the motor **4**. The mixer **1** further includes the reducer **7** drivable by the rotor **21**, and the reducer housing **3** located below the motor housing **2** and accommodating the reducer **7**. The mixer **1** further includes the shaft holder **108** protruding downward from the reducer housing **3** to hold the mixer shaft **9**, and the controller **5** (controller) controlling the motor **4**. The controller **5** is on the vertically same level as the motor **4**.

[0098] This structure allows the motor housing **2** to be downsized vertically, and thus allows the mixer **1** to be downsized vertically.

[0099] At least a part of the controller **5** may be on the vertically same level as at least a part of the motor **4**. For the controller **5** located upward and the motor **4** downward, for example, the lower end of the controller **5** and the upper end of the motor **4** may be on the same level, or the upper end of the controller **5** and the lower end of the motor **4** may be on the same level. For the inclined mixer **1**, being vertically on the same level refers to being on the corresponding front or rear position in the lengthwise direction of the mixer shaft **9**.

[0100] The rotor **21** includes the rotational shaft **25**. The motor **4** is accommodated in the motor housing **2** with the rotational shaft **25** extending vertically. The motor housing **2** can thus be smaller in the front-rear direction and the lateral direction.

[0101] The controller **5** extending vertically is accommodated in the motor housing **2**. This can save space horizontally when the controller **5** and the motor **4** are located on the same level. This also allows the airflow to be on the controller **5** for a longer period of time, thus achieving effective cooling.

[0102] The controller **5** is vertically within the vertical dimension of the rotational shaft **25**, allowing the motor housing **2** to remain downsized vertically.

[0103] The mixer **1** includes the fan **31** rotatable together with the rotor **21**. The motor housing **2** includes the external inlets **41** (inlets) for drawing in air by the rotation of the fan **31**, and the external outlets **42** (outlets) for discharging air by the rotation of the fan **31**. The external inlets **41** and the external outlets **42** are vertically on the same level.

[0104] The motor housing **2** is thus smaller vertically than a motor housing with the external inlets **41** and the external outlets **42** vertically apart. The motor housing **2** is thus downsized vertically.

[0105] The controller **5** is located to receive an airflow from the external inlets **41** to the external outlets **42**. The controller **5** can thus be cooled through the external inlets **41** and the external outlets **42** vertically on the same level.

[0106] The motor **4** is downstream in the airflow. The controller **5** is upstream in the airflow. The motor **4** and the controller **5** are thus cooled efficiently.

[0107] The motor **4** and the controller **5** are separated by the ribs **40** that define the path of the airflow. The motor **4** and the controller **5** can thus be reliably cooled when the external inlets **41** and the external outlets **42** are vertically on the same level.

[0108] The mixer **1** according to the present embodiment includes the motor **4** including the stator **20** and the rotor **21**, and the motor housing **2** accommodating the motor **4**. The mixer **1** further includes the reducer **7** drivable by the rotor **21**, and the reducer housing **3** located below the motor housing **2** and accommodating the reducer **7**. The mixer **1** further includes the shaft holder **108** protruding downward from the reducer housing **3**, drivable by the reducer **7**, and holding the mixer shaft **9**. The mixer **1** further includes the handle **6** including the metal attaching portion **60** attachable to the motor housing **2** and a pair of the left and right grips **68** and **69** (grips) connected to the left and right of the attaching portion **60**. The handle **6** is not located frontward from the motor housing **2** (a frontal plane onto which the motor housing **2** is projected with a parallel projection).

[0109] In this structure, the attaching portion **60** has a central portion that does not extend frontward from the motor housing **2**. This structure reliably provides visibility for the operator to easily view, for example, the blade **10** from above.

[0110] The motor housing **2** can be attached to the attaching portion **60** without being inserted through the attaching portion **60**. The handle **6** can thus be attached easily.

[0111] The attaching portion **60** is U-shaped in a plan view. The attaching portion **60** can thus be attached to the motor housing **2** easily.

[0112] The foremost surface **2***c* (front surface) of the motor housing **2** does not protrude frontward from the front edges of the pair of joints **61** (front edge of the handle **6**). The motor housing **2** at this position does not obstruct the operator's field of view, further improving visibility.

[0113] The motor housing **2** has the flat foremost surface **2***c* defined horizontally and vertically. The motor housing **2** with this shape does not obstruct the operator's field of view, further improving visibility.

[0114] The attaching portion **60** integrally includes, on its left and right, the joints **61** including pairs of the metal front arms **67**A and the metal rear arms **67**B (arms) extending leftward and rightward. The left and right grips **68** and **69** as the grips each extend between the edges of the corresponding front and rear arms **67**A and **67**B in the joints **61**. The handle **6** is thus easy to grip.

[0115] The left grip **68** is dividable into the upper half part **68***a* and the lower half part **68***b* by a plane extending in the front-rear direction being the extension direction of the left grip **68** extending between the edges of the front and rear arms **67**A and **67**B. The right grip **69** is dividable into the left half part **69***a* and the right half part **69***b* by a plane extending in the front-rear direction being the extension direction of the right grip **69** extending between the edges of the front and rear arms **67**A and **67**B. The front and rear ends of the half parts **68***a* and **68***b* are fastened to the edges of the front and rear arms **67**A and **67**B with screws. The front and rear ends of the half parts **69***a* and **69***b* are fastened to the edges of the front and rear arms **67**A and **67**B with screws. The left and right grips **68** and **69** are thus easily attachable.

[0116] The attaching portion **60** is a vertically thin metal sheet. The handle **6** is thus lightweight.

[0117] The motor housing **2** integrally includes, on its outer surface, the support protrusions **63** (supports) that support the attaching portion **60** from below. The attaching portion **60** is fastened to the support protrusions **63** with screws. The attaching portion **60** can thus be attached to the motor housing **2** easily.

[0118] The attaching portion **60** has its rear edge located rearward from the rear surface of the motor housing **2**. This prevents the motor housing **2** and the battery cover **13** from coming in contact with the operator.

[0119] The battery mount **11** for receiving the battery pack **12** is located on an upper portion of the motor housing **2**. This structure allows easy attachment and detachment of the battery pack **12**.

[0120] The battery cover **13** for covering the battery pack **12** received in the battery mount **11** from above is located on the motor housing **2** and can cover and uncover the battery mount **11**. This structure protects the battery mount **11** and the battery pack **12**.

[0121] The battery cover **13** has the flat foremost surface **13***a* (front surface) defined horizontally and vertically. The battery cover **13** can avoid obstructing the operator's field of view.

[0122] The mixer **1** according to the present embodiment includes the motor **4**, the reducer **7** drivable by the motor **4**, and the motor housing **2** accommodating the motor **4** and the reducer housing **3** (together referred to as the housing) accommodating the reducer **7**. The mixer **1** further includes the shaft holder **108** drivable by the reducer **7** and protruding from the reducer housing **3**. The mixer **1** further includes the attaching portion **60** and the joints **61** (metal members) each attached to the motor housing **2** and extending laterally, the right grip **69** located on the right end of the joint **61** and extending in the front-rear direction, and the left grip **68** located on the left end of the joint **61** and extending in the front-rear direction. The front of the motor housing **2** does not overlap the attaching portion **60** in a plan view.

[0123] In this structure, the attaching portion **60** has a central portion that does not extend frontward from the motor housing **2**. This structure reliably provides visibility for the operator to easily view, for example, the blade **10** from above.

[0124] Modifications of the present embodiment will now be described.

[0125] When the controller and the motor are on the same level, the controller may not be in front of the motor horizontally. When being on the same level as the motor, the controller may be located rearward, rightward, or leftward from the motor. The controller may not extend vertically, but may extend horizontally in the front-rear and right-left directions or may be in a tilt posture. A controller including multiple circuit boards may also be located on the same level as the motor. When the motor housing can be downsized, the controller may exceed the vertical dimension of the rotational shaft.

[0126] The rotational shaft of the motor may not extend vertically. The rotational shaft may be oriented to extend horizontally in the front-rear direction or right-left direction.

[0127] The numbers and the shapes of the inlets and the outlets are not limited to those described in the above embodiment. All of the inlets and the outlets may be located on the same level. The inlets and the outlets may be vertically apart from each other.

[0128] When the controller is oriented vertically in the motor housing, the controller may not be in front of the motor, but may be rearward, rightward or leftward from the motor. A controller including multiple circuit boards may have the circuit boards each oriented vertically. The rotational shaft of the motor may not extend vertically. The numbers and the positioning of the inlets and the outlets are not limited to those described in the above embodiment.

[0129] When the inlets and the outlets are located on the same level, the numbers and the shapes of the inlets and the outlets are not limited to those described in the above embodiment. All of the inlets and the outlets may be located on the same level. At least one of the inlets may be located on the same level as at least one of the outlets. The inlets may be apart from the outlets in the circumferential direction of the motor housing.

[0130] The attaching portion of the handle may be shaped other than in a U shape. The attaching portion of the handle may be in a C shape with a middle portion between its front ends open in front of the motor housing.

[0131] To attach the handle to the motor housing, the handle may not be mounted on the supports, but may be fixed to the lower surfaces of the supports. The motor housing may include, instead of the supports, a groove along the periphery to receive the attaching portion.

[0132] The attaching portion may not be thin vertically, but may be a rod or may be a band that is radially thin.

[0133] The grips may have another shape than that described in the above embodiment. Each grip may be dividable not by a plane extending in the front-rear direction. Each grip may be an integral rod or an integral cylinder, instead of being dividable into half parts.

[0134] The arms of the joints may be separate from the attaching portion and connected to the attaching portion. Instead of the front and rear arms, a single arm may be provided to receive the grips. The joints may be eliminated, and the grips may be attached directly to the attaching portion.

[0135] The front surfaces of the motor housing and the battery cover may not be flat when the attaching portion is shaped to reliably provides the field of view. The battery cover may be eliminated.

[0136] The motor may not be a brushless motor. The inner housing in the motor housing may be eliminated to have the inlets and outlets located in the motor housing alone. The motor may be upstream in the airflow, and the controller may be downstream.

[0137] The reducer may have more or fewer shafts and gears. The positions of the shafts may be changed as appropriate. A speed change assembly may be eliminated. The position of the spindle may be changed.

[0138] The battery mount may not be located on the upper portion of the motor housing, but may be located on the side surface or the rear surface of the motor housing.

[0139] The power supply is not limited to batteries. The technique according to the present disclosure is applicable to the structure including the motor to receive utility power (alternating current or AC) with a power cable.

[0140] The length of the mixer shaft, the attaching structure for the mixer shaft attached to the spindle, as well as the shape of the blade are not limited to those described in the above embodiment.

REFERENCE SIGNS LIST

[0141] **1** mixer
[0142] **2** motor housing
[0143] **3** reducer housing
[0144] **4** motor
[0145] **5** controller
[0146] **6** handle
[0147] **7** reducer
[0148] **8** spindle
[0149] **9** mixer shaft
[0150] **10** blade
[0151] **11** battery mount
[0152] **12** battery pack
[0153] **15** bracket plate
[0154] **17** inner housing
[0155] **25** rotational shaft
[0156] **31** fan
[0157] **32** internal outlet
[0158] **33** internal inlet
[0159] **40** rib
[0160] **41** external inlet
[0161] **42** external outlet
[0162] **46** control circuit board
[0163] **60** attaching portion
[0164] **61** joint
[0165] **67**A front arm
[0166] **67**B rear arm
[0167] **68** left grip
[0168] **69** right grip
[0169] **70** switch
[0170] **85** first shaft
[0171] **86** second shaft
[0172] **108** shaft holder

What is claimed is:

1. A mixer for holding a mixer shaft, the mixer comprising:

a motor including a stator and a rotor;

a motor housing accommodating the motor;

a reducer driven by the rotor;

a reducer housing below the motor housing and accommodating the reducer;

a shaft holder protruding downward from the reducer housing to hold the mixer shaft; and

a controller configured to control the motor, the controller being vertically on the same level as at least a part of the motor.

2. The mixer according to claim **1**, wherein

the rotor includes a rotational shaft, and

the motor is accommodated in the motor housing with the rotational shaft extending vertically.

3. The mixer according to claim **2**, wherein

the controller extends vertically in the motor housing.

4. The mixer according to claim **2**, wherein

the controller is vertically within a vertical dimension of the rotational shaft.

5. A mixer for holding a mixer shaft, the mixer comprising:

a motor including a stator and a rotor;

a motor housing accommodating the motor;

a reducer driven by the rotor;

a reducer housing below the motor housing and accommodating the reducer;

a shaft holder protruding downward from the reducer housing to hold the mixer shaft; and

a controller configured to control the motor, the controller extending vertically in the motor housing.

6. The mixer according to claim **5**, wherein

the rotor includes a rotational shaft, and

the motor is accommodated in the motor housing with the rotational shaft extending vertically.

7. The mixer according to claim **6**, wherein

the controller is vertically within a vertical dimension of the rotational shaft.

8. The mixer according to claim **1**, further comprising:

a fan rotatable together with the rotor,

wherein the motor housing includes

an inlet to draw in air in response to rotation of the fan, and

an outlet to discharge air in response to rotation of the fan, and the outlet is vertically on the same level as the inlet.

9. The mixer according to claim **8**, wherein

the fan is fixed to the rotational shaft, and

the motor is accommodated in the motor housing with the rotational shaft extending vertically.

10. The mixer according to claim **8**, wherein

the controller is located to receive an airflow from the inlet to the outlet.

11. The mixer according to claim **10**, wherein

the motor is downstream in the airflow, and

the controller is upstream in the airflow.

12. The mixer according to claim **11**, wherein

the motor and the controller are separated from each other with a rib to define the airflow.

13. The mixer according to claim **10**, wherein

the controller extends vertically.

14. The mixer according to claim **8**, wherein

the fan generates an airflow to move vertically along and on the controller.

15. The mixer according to claim **1**, further comprising:

a battery mount on an upper portion of the motor housing to receive a battery pack.

16. The mixer according to claim **15**, wherein

the motor housing further includes a battery cover to cover, from above, the battery pack attached to the battery mount.

17. The mixer according to claim **1**, further comprising:

a handle attached to the motor housing.

18. The mixer according to claim **1**, wherein

the reducer is configured to change a rotational speed of the shaft holder between two levels.

19. The mixer according to claim **5**, further comprising:

a fan rotatable together with the rotor,

wherein the motor housing includes

an inlet to draw in air in response to rotation of the fan, and

an outlet to discharge air in response to rotation of the fan, and the outlet is vertically on the same level as the inlet.

20. A mixer for holding a mixer shaft, the mixer comprising:

a motor including a stator and a rotor;

a fan rotatable together with the rotor;

a motor housing accommodating the motor, the motor housing including

an inlet to draw in air in response to rotation of the fan, and

an outlet to discharge air in response to rotation of the fan, the outlet being vertically on the same level as at least a part of the inlet;

a reducer driven by the rotor;

a reducer housing below the motor housing and accommodating the reducer; and

a shaft holder protruding downward from the reducer housing to hold the mixer shaft.

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