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(54) **WORK VEHICLE**

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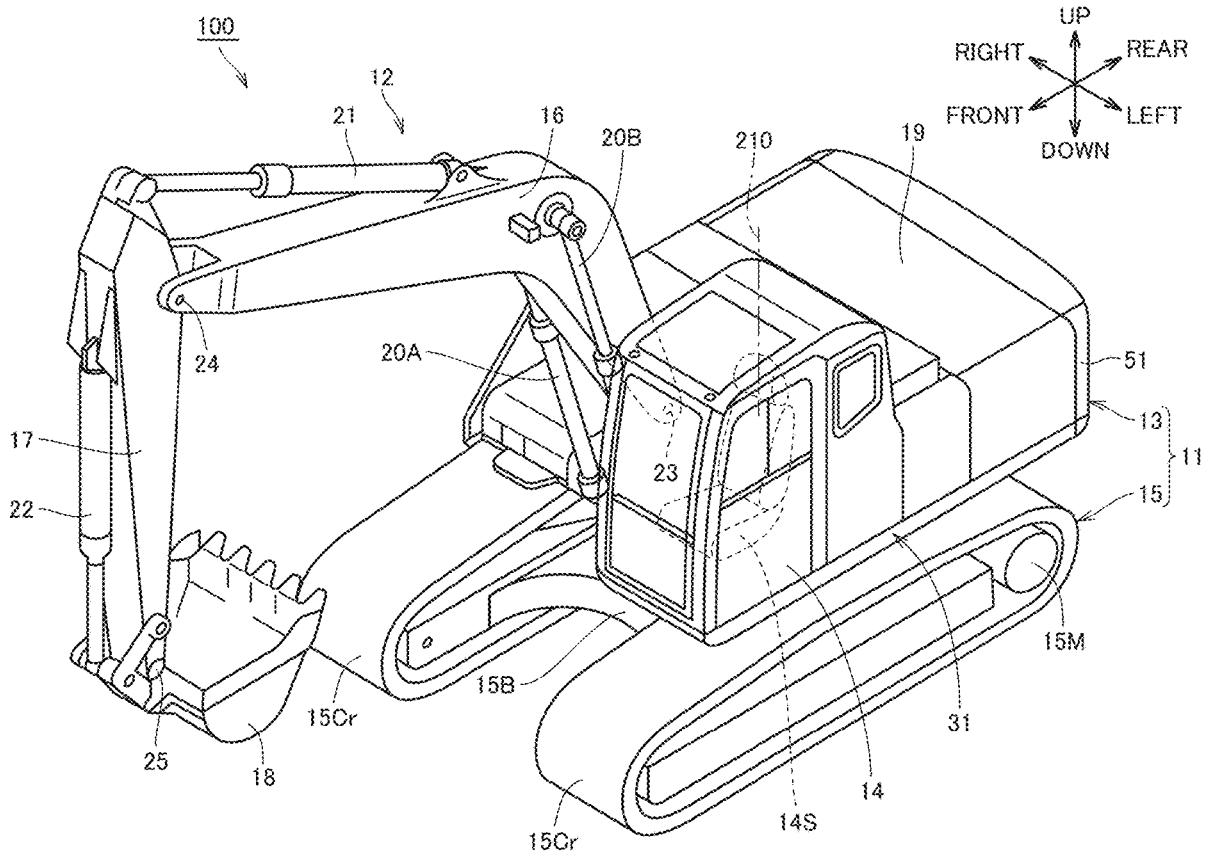
(57) **ABSTRACT**

A hydraulic excavator which is a work vehicle includes a traveling apparatus, a revolution frame mounted on the traveling apparatus and including a lower frame, and a first radar arranged on a side surface of the lower frame, the side surface of the lower frame extending in a fore/aft direction and being arranged on left and right, the first radar being provided at a position closer to a rear end portion of the lower frame.



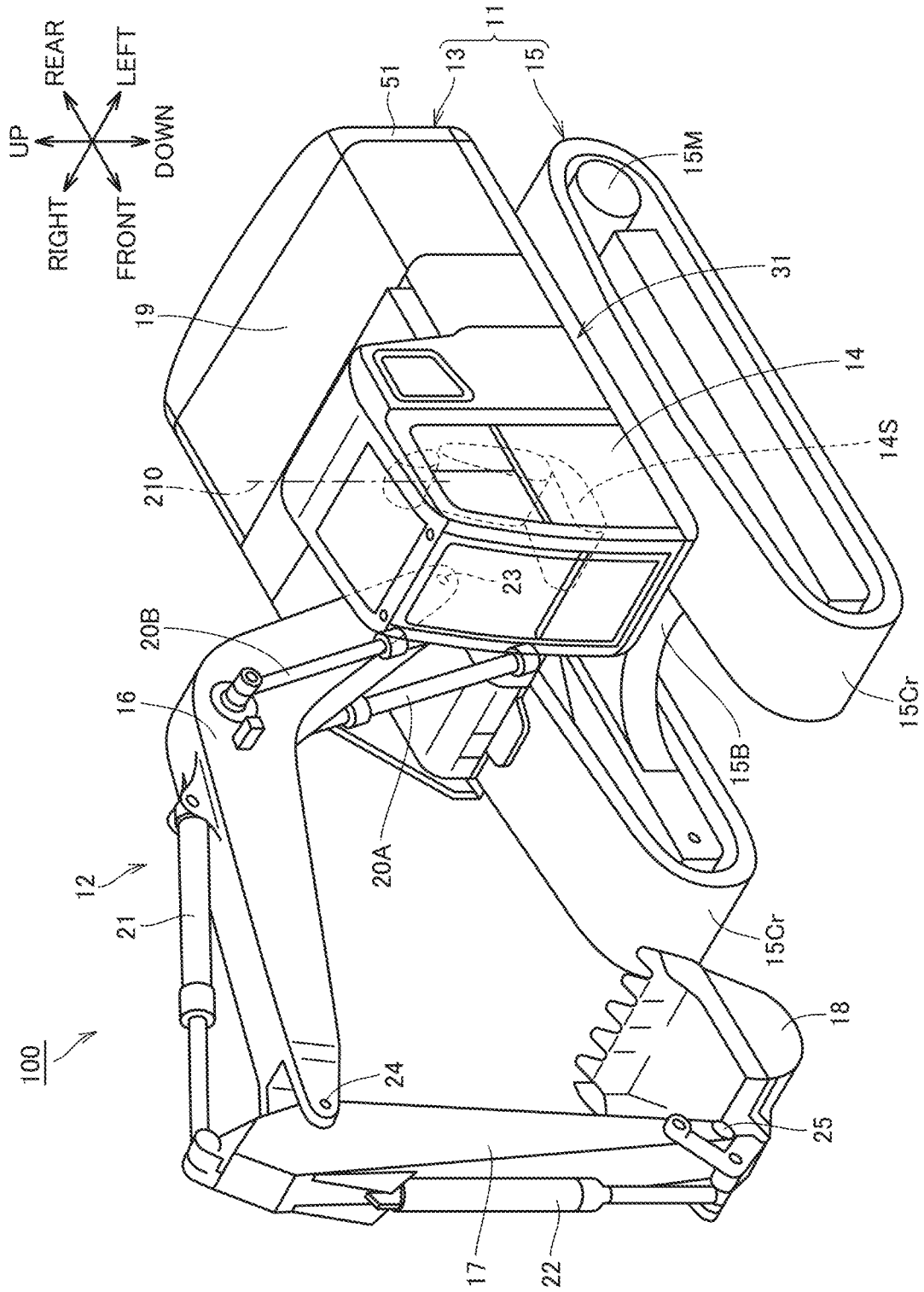

UP
REAR
LEFT
DOWN
RIGHT
FRONT
11
13
15
51
15M
31
19
14
14S
210
23
20B
16
15Cr
15B
20A
12
21
15Cr
18
100
24
25
17
22

FIG.1

FIG.2

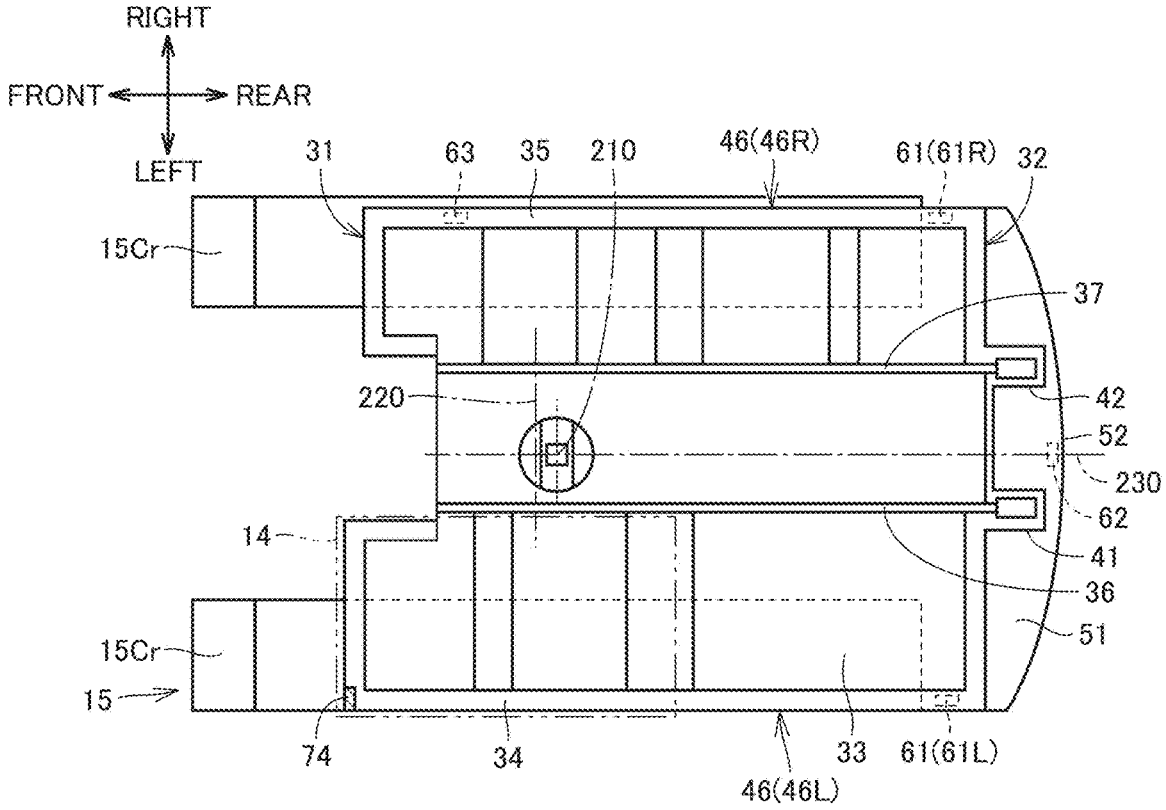

RIGHT
FRONT
REAR
LEFT
31
63
35
210
46(46R)
61(61R)
32
15Cr
37
220
42
52
230
62
14
41
36
51
15Cr
15
74
34
33
61(61L)
46(46L)

FIG.3

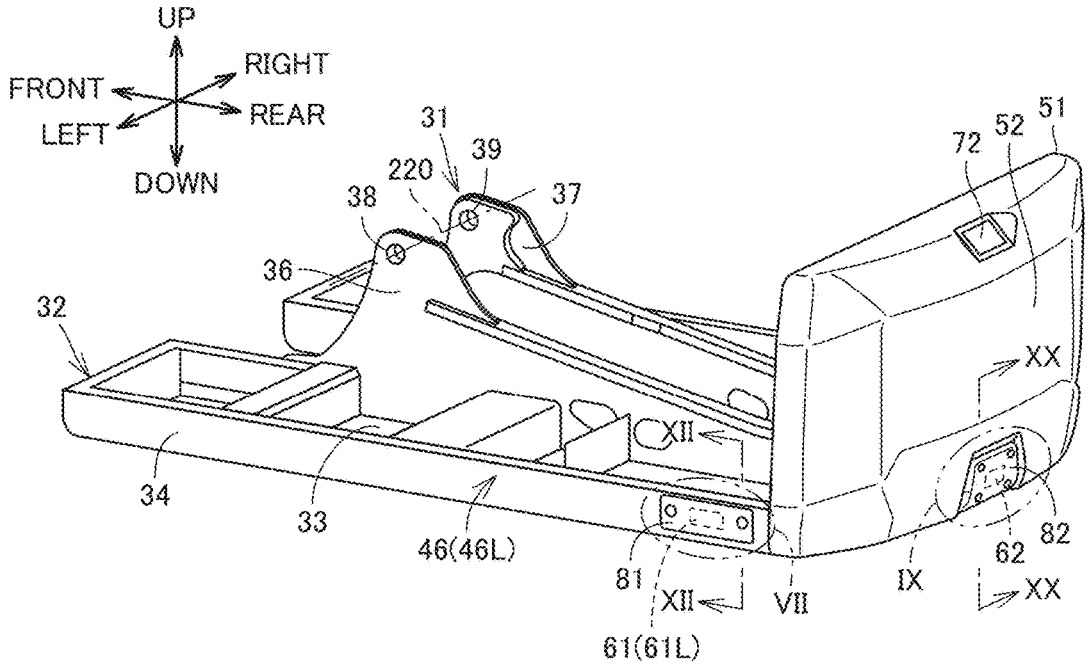

UP
FRONT
RIGHT
REAR
LEFT
DOWN
31
39
220
38
37
36
32
72
52
51
XX
XII
34
33
46(46L)
81
XII
VII
IX
62
82
XX
61(61L)

FIG.4

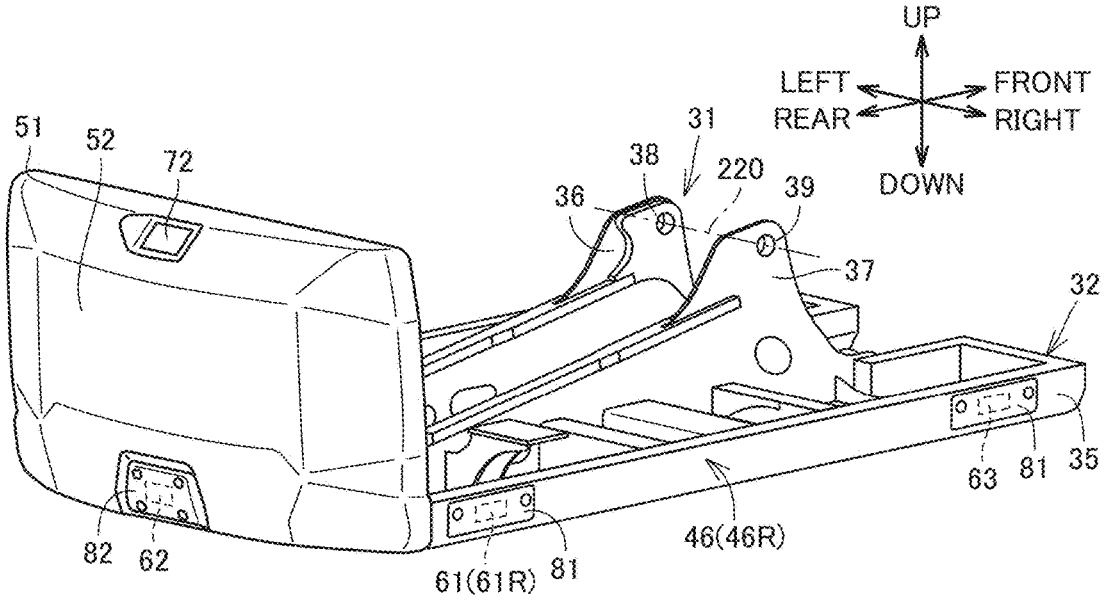

UP
LEFT
FRONT
REAR
RIGHT
DOWN
51
52
72
31
38
220
39
36
37
32
63
81
35
82
62
61(61R)
81
46(46R)

FIG.5

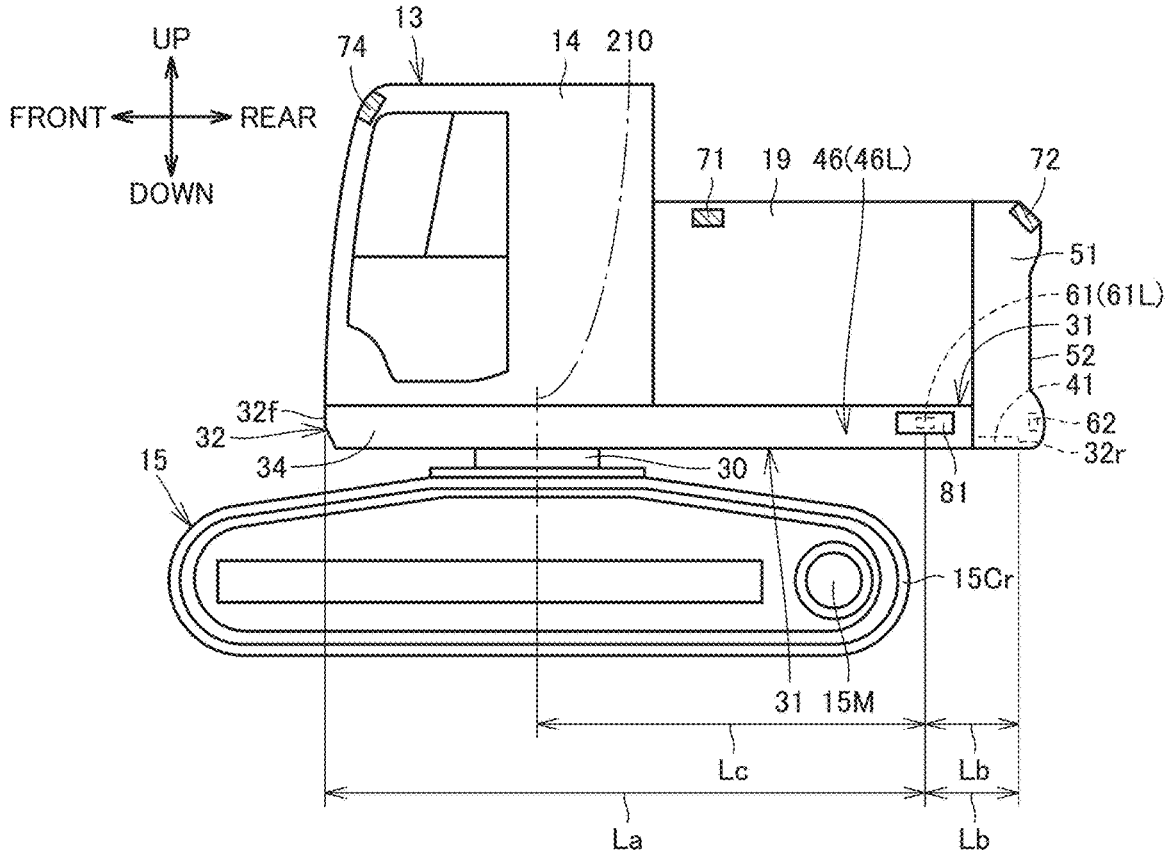

UP
FRONT
REAR
DOWN
74
13
14
210
71
19
46(46L)
72
51
61(61L)
31
52
41
62
32r
32f
32
34
30
81
15
15Cr
31
15M
Lc
Lb
La
Lb

FIG.6

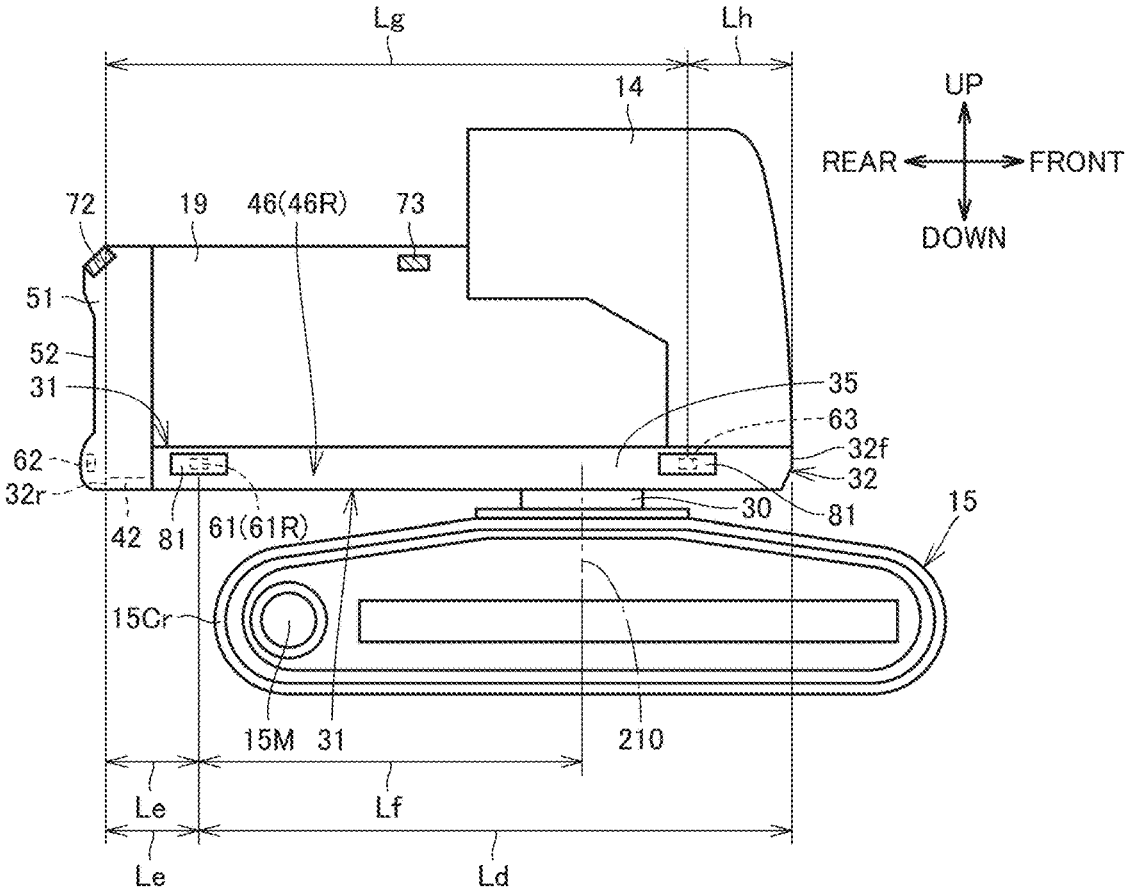

Lg
Lh
14
UP
REAR
FRONT
DOWN
72
19
46(46R)
73
51
52
31
35
63
62
32f
32
32r
30
81
15
42
81
61(61R)
15Cr
15M
31
210
Le
Lf
Le
Ld

FIG.7

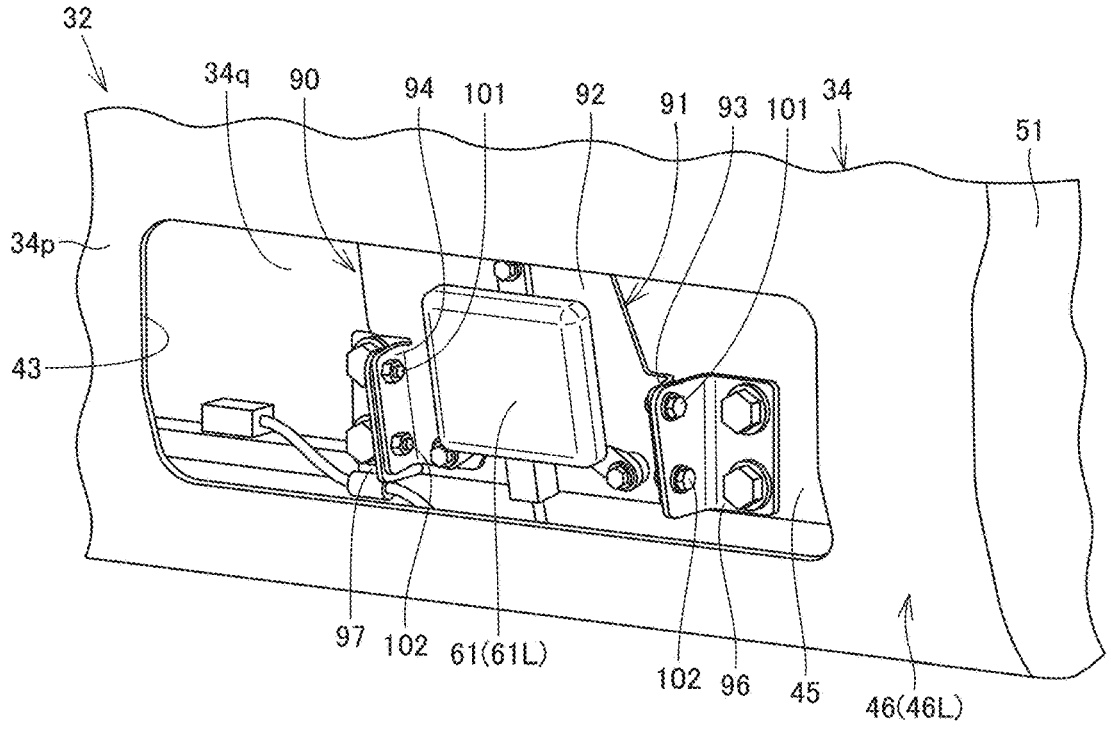

32
34q
90
94
101
92
91
93
101
34
51
34p
43
97
102
61(61L)
102
96
45
46(46L)

FIG.8

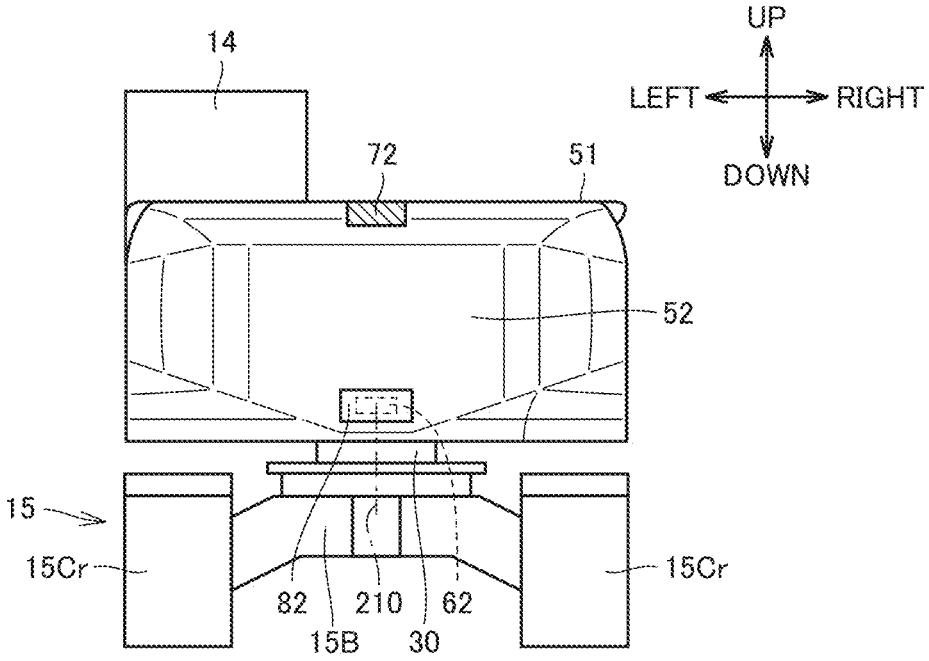

14
UP
LEFT
RIGHT
DOWN
72
51
52
15
15Cr
15Cr
82
210
62
15B
30

FIG.9

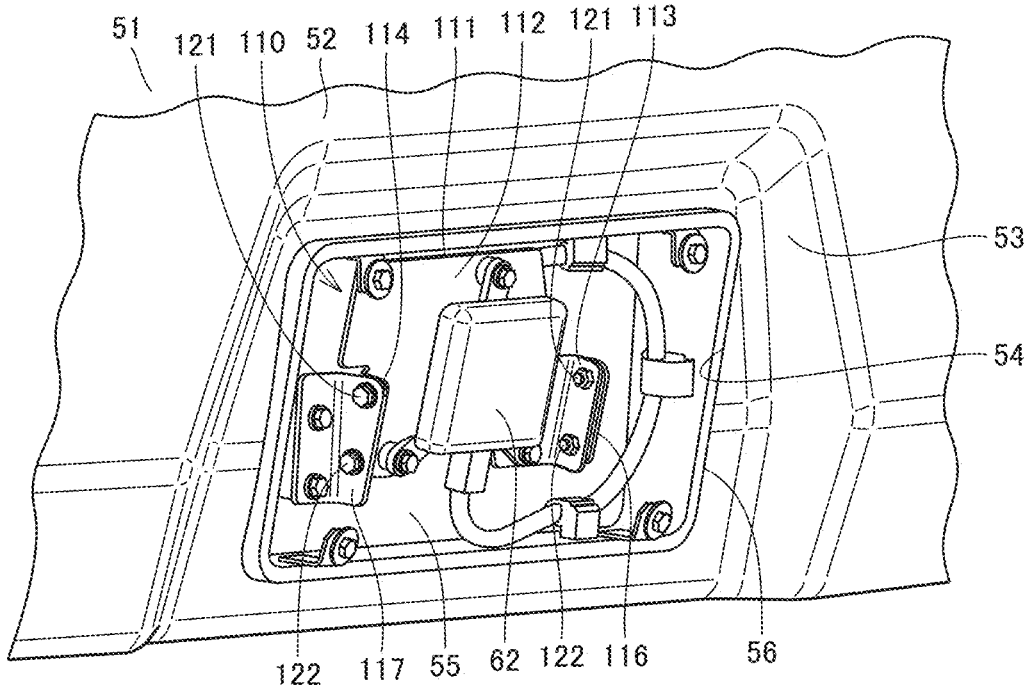

51
121
110
52
114
111
112
121
113
53
54
122
117
55
62
122
116
56

FIG.10

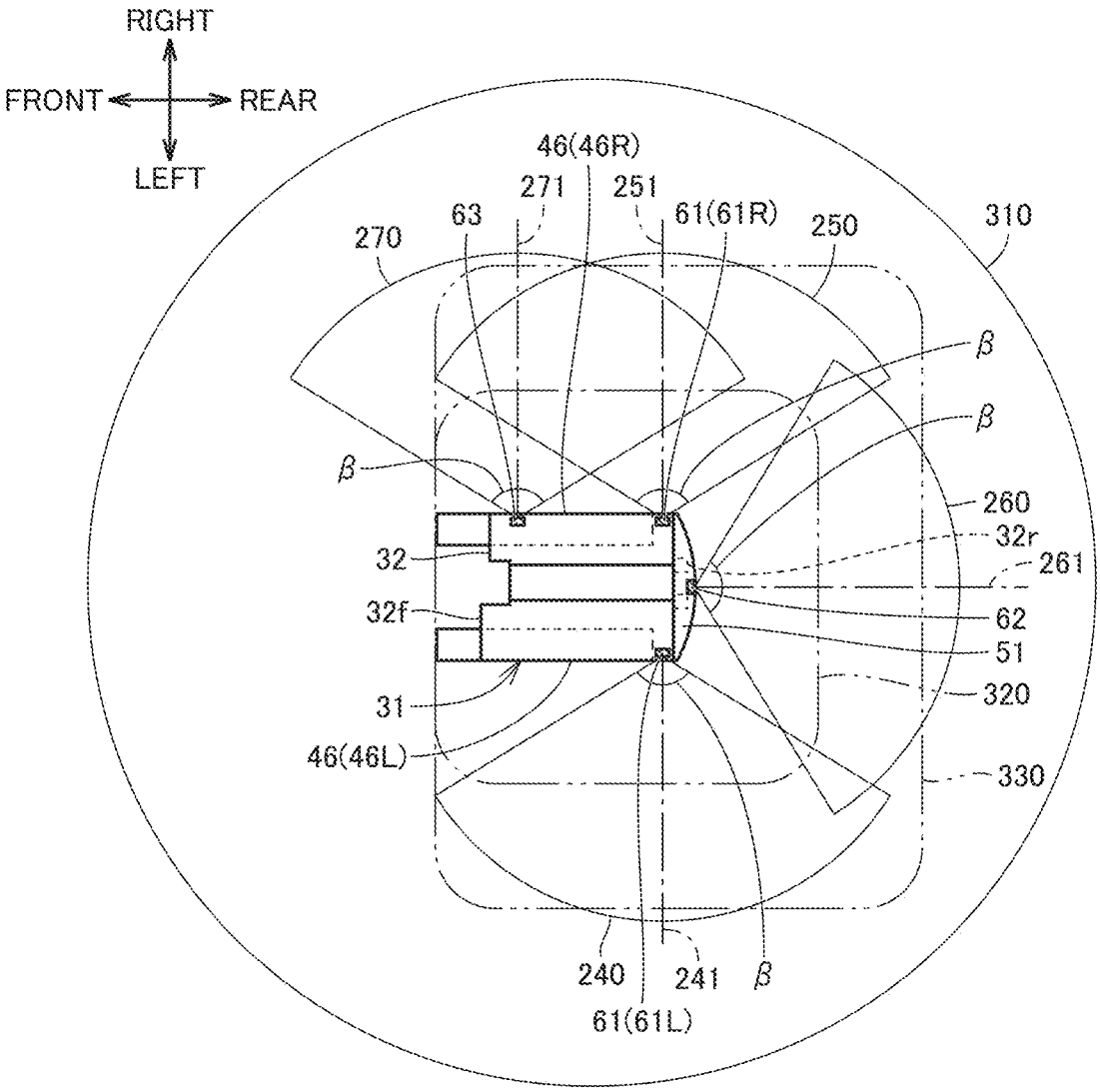

RIGHT
FRONT
REAR
LEFT
46(46R)
271
251
63
61(61R)
250
310
270
β
β
β
260
32r
261
32
32f
62
51
320
31
46(46L)
330
240
241
β
61(61L)

FIG.11

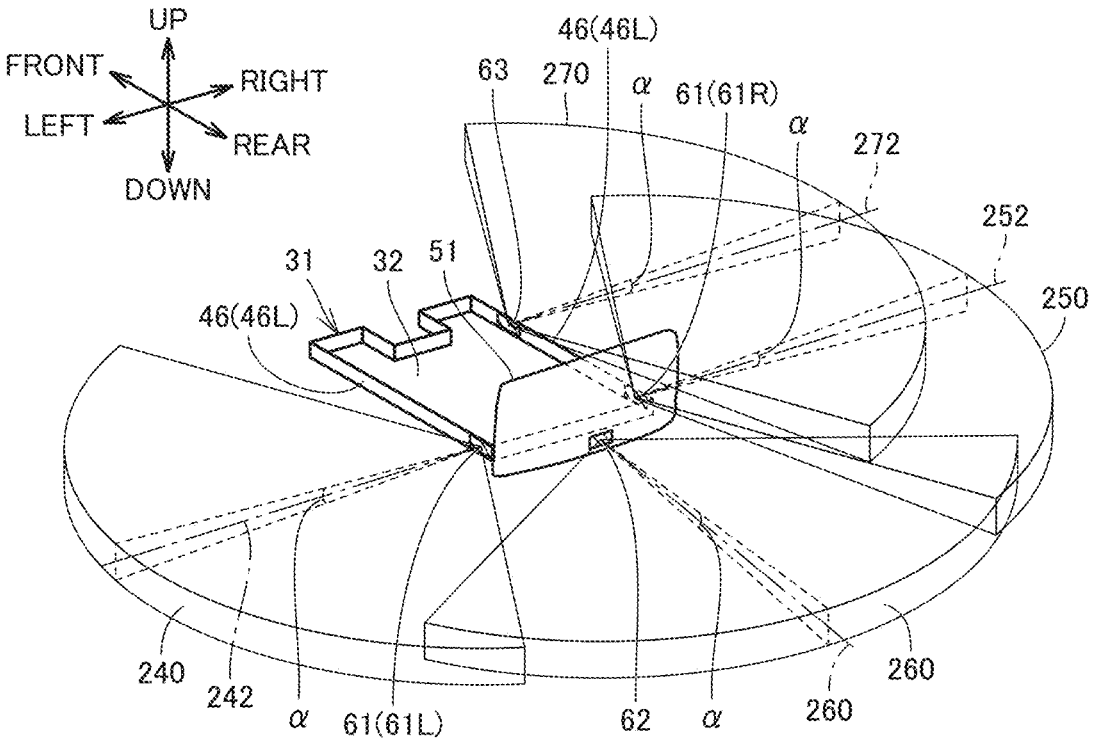

UP
FRONT
RIGHT
LEFT
REAR
DOWN
46(46L)
63
270
α
61(61R)
α
272
252
250
31
32
51
46(46L)
240
242
α
61(61L)
62
α
260
260

FIG.12

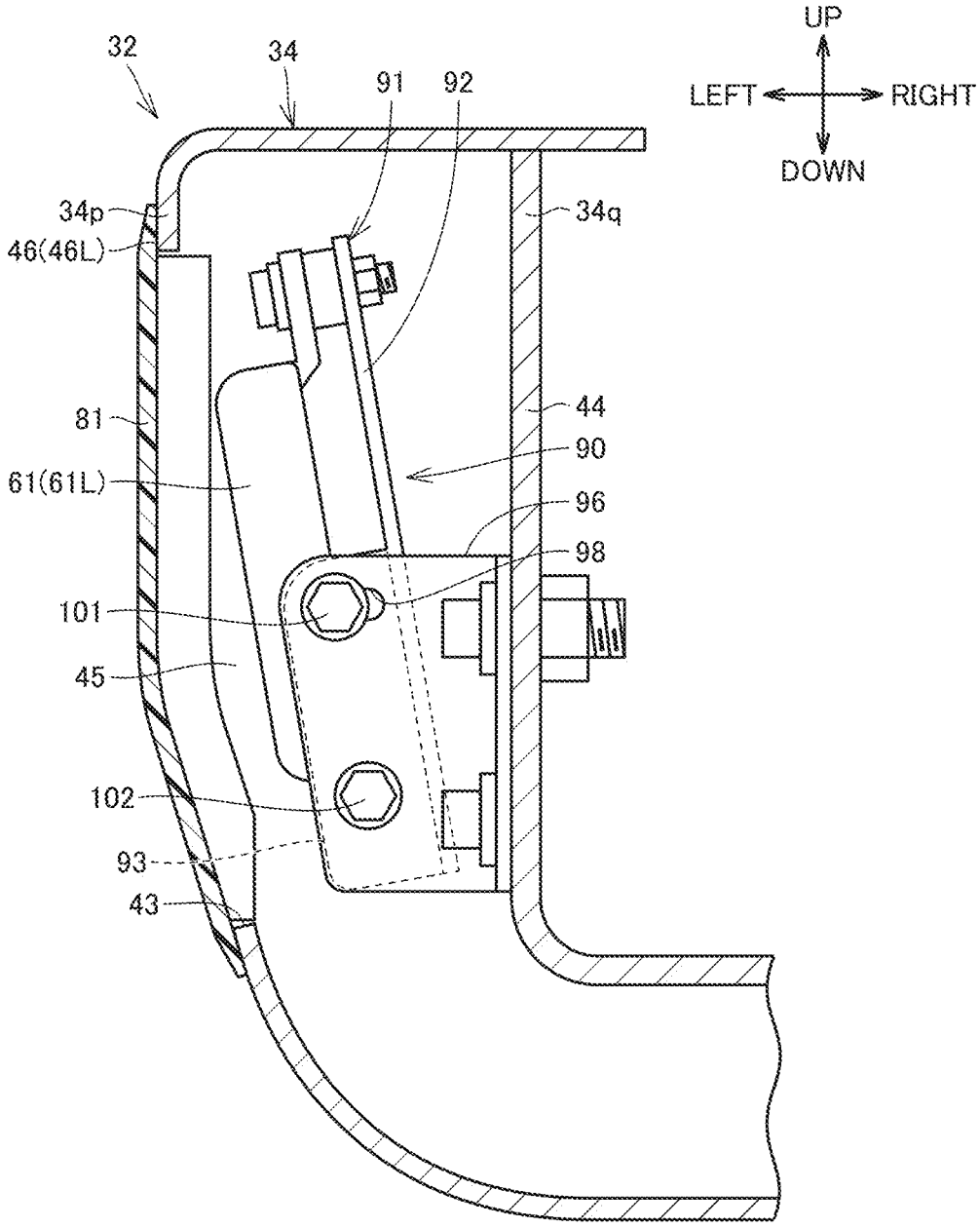

UP
LEFT
RIGHT
DOWN
32
34
91
92
34p
46(46L)
34q
81
61(61L)
44
90
96
98
101
45
102
93
43

FIG.13

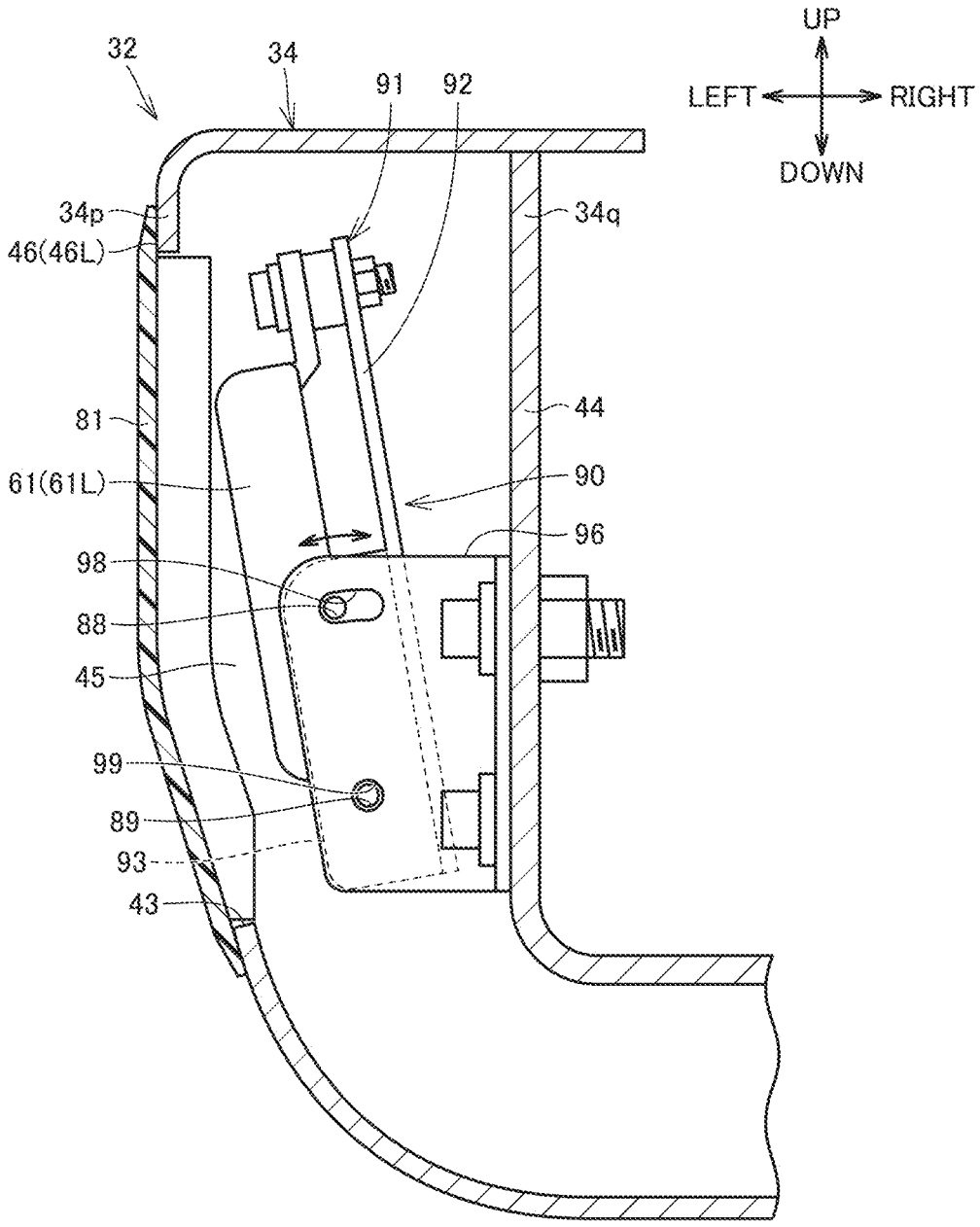

32
34
91
92
UP
LEFT
RIGHT
DOWN
34p
46(46L)
34q
81
61(61L)
44
90
96
98
88
45
99
89
93
43

FIG.14

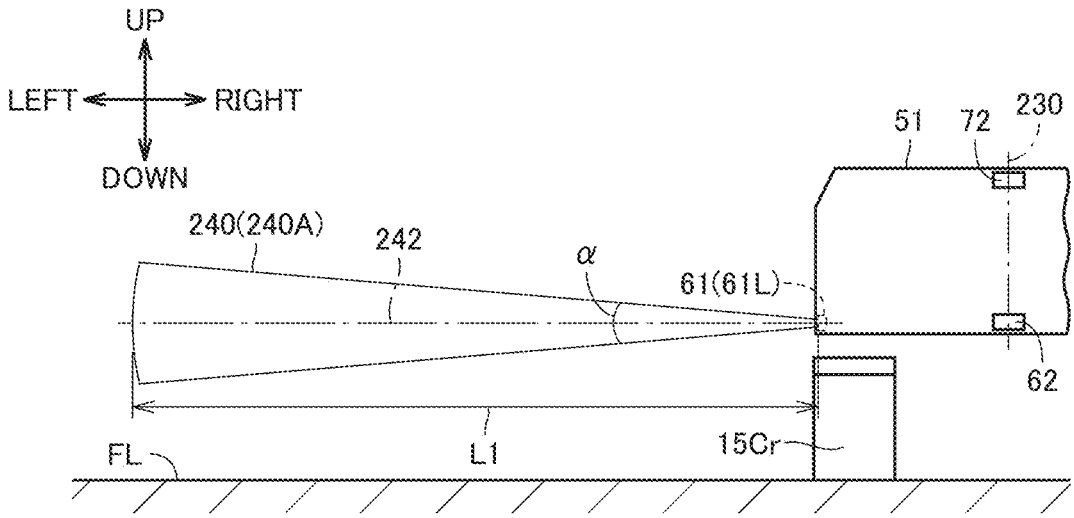

UP
LEFT
RIGHT
DOWN
240(240A)
242
α
61(61L)
51
72
230
62
FL
L1
15Cr

FIG.15

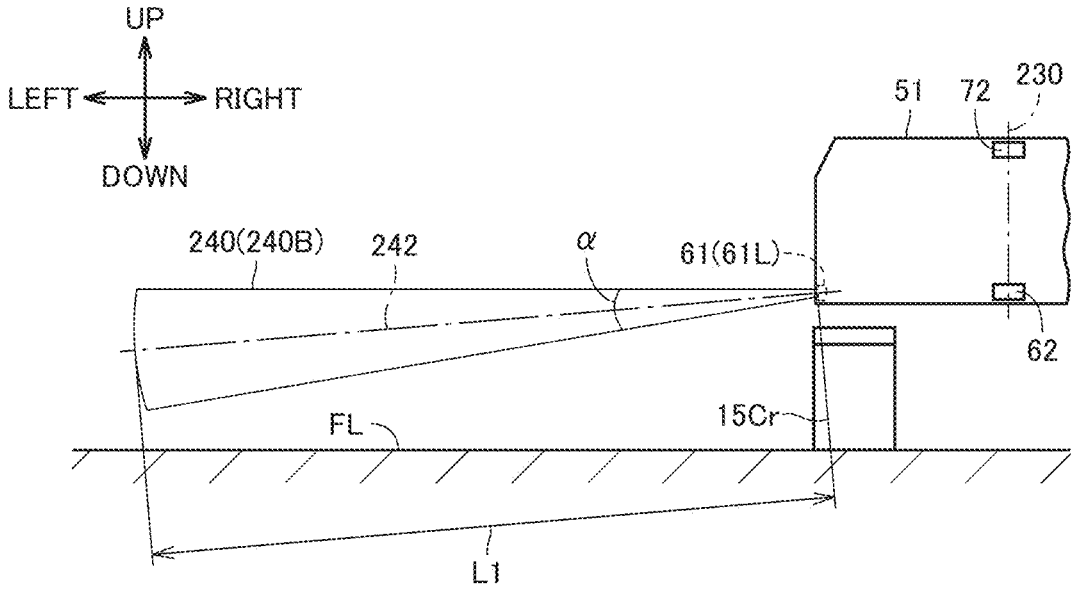

UP
LEFT
RIGHT
DOWN
240(240B)
242
α
61(61L)
51
72
230
62
FL
15Cr
L1

FIG.16

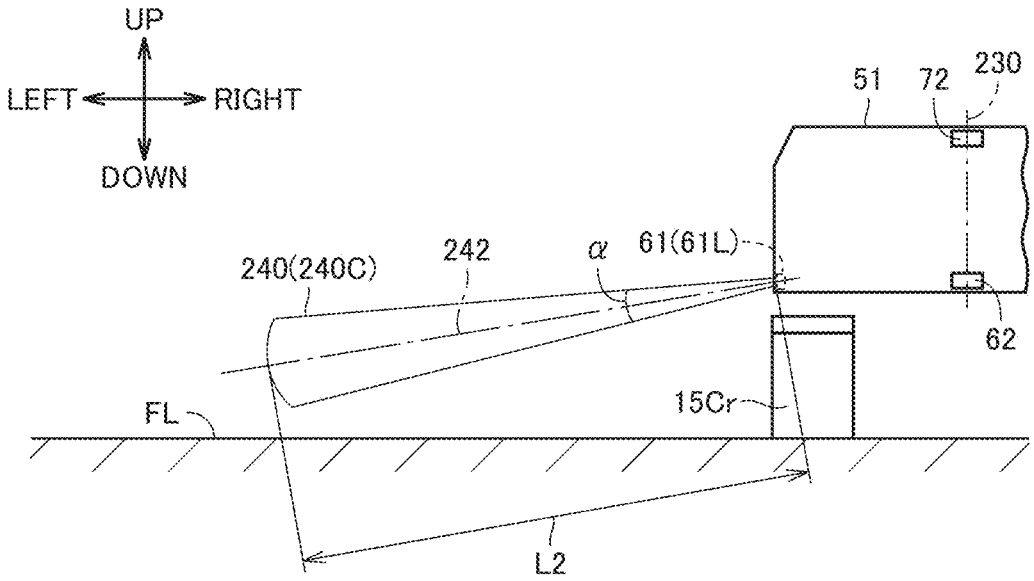

UP
LEFT
RIGHT
DOWN
51
72
230
240(240C)
242
α
61(61L)
62
FL
15Cr
L2

FIG.17

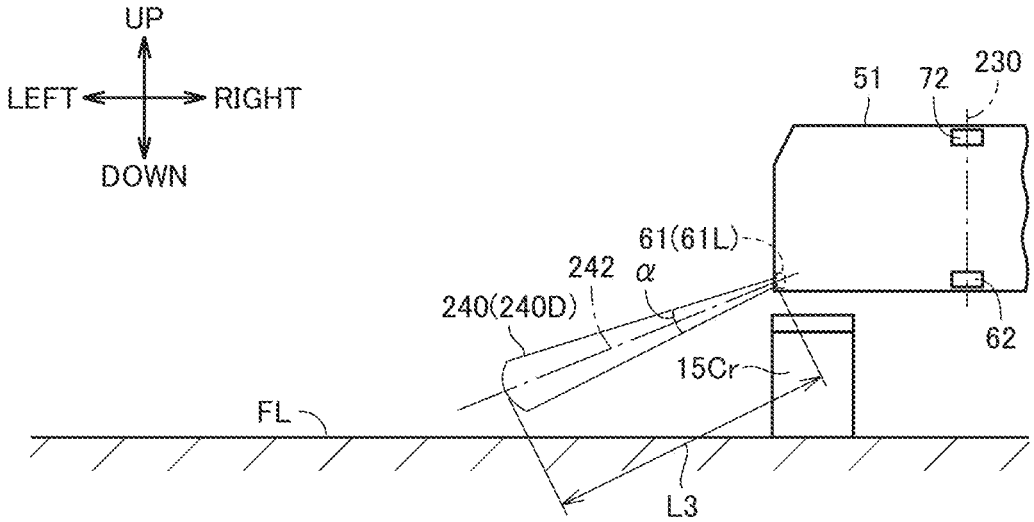

UP
LEFT
RIGHT
DOWN
51
72
230
61(61L)
242
α
240(240D)
62
15Cr
FL
L3

FIG.18

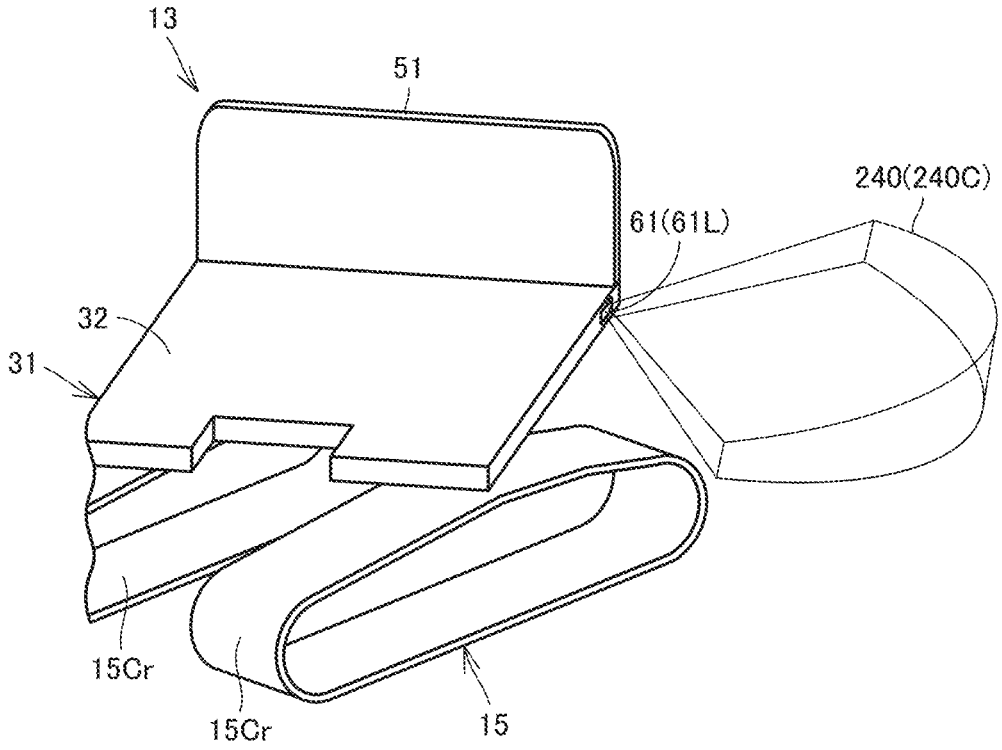

13
51
240(240C)
61(61L)
32
31
15Cr
15Cr
15

FIG.19

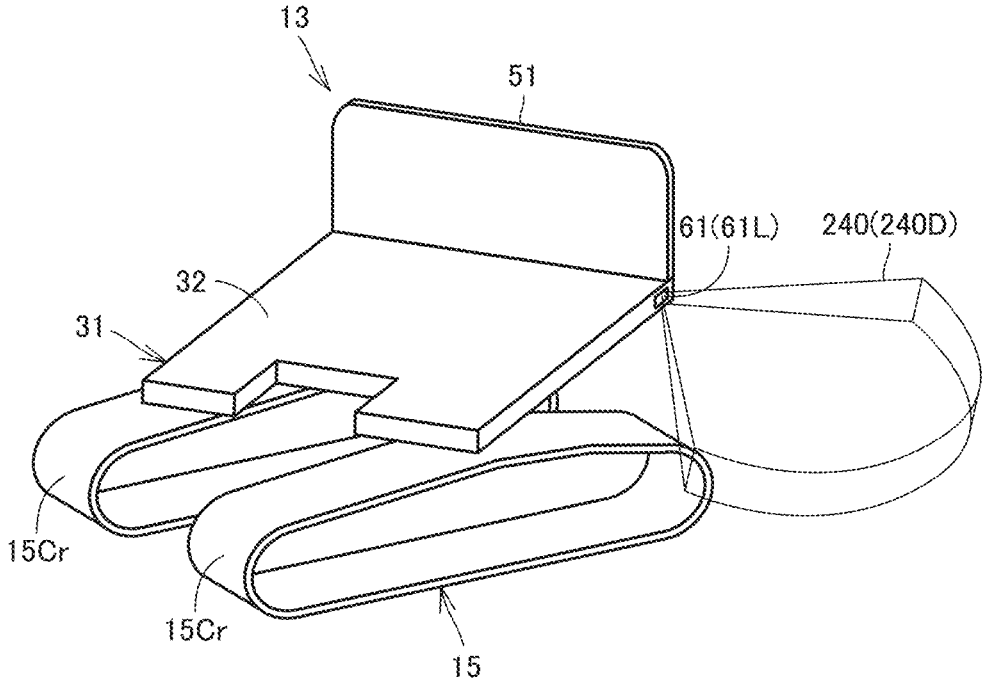
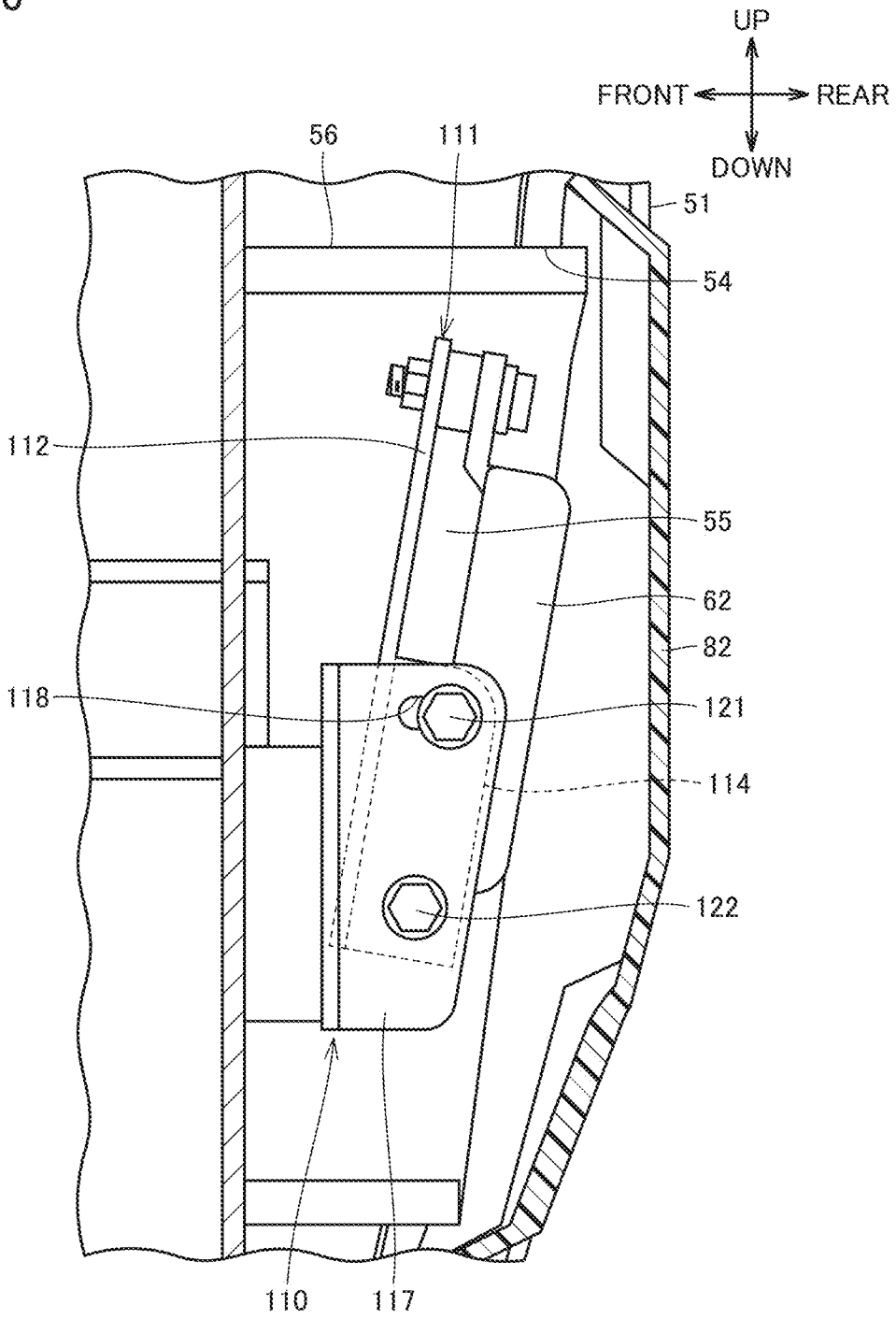

13
51
61(61L)
240(240D)
32
31
15Cr
15Cr
15

FIG.20


UP
FRONT
REAR
DOWN
56
111
51
54
112
55
62
82
118
121
114
122
110
117

WORK VEHICLE

TECHNICAL FIELD

[0001] The present disclosure relates to a work vehicle.

BACKGROUND ART

[0002] For example, Japanese Patent Laying-Open No. 2008-163719 (PTL 1) discloses a hydraulic excavator including a lower traveling unit and an upper revolving unit revolvably mounted on the lower traveling unit. An obstacle detector implemented by a laser radar is provided on each of left and right side surfaces and front and rear surfaces of the upper revolving unit.

CITATION LIST

Patent Literature

[0003] PTL 1: Japanese Patent Laying-Open No. 2008-163719

SUMMARY OF INVENTION

Technical Problem

[0004] As disclosed in PTL 1 described above, a sensor such as a radar has been used to detect an object such as a person or a structure around a hydraulic excavator. In this case, generally, a work vehicle such as a hydraulic excavator is large and an operator gets on board the vehicle at high elevations. Therefore, enhanced capability to detect an object located in the rear of a side surface of the work vehicle and around the ground has been demanded.

[0005] An object of the present disclosure is to solve the problem above and to provide a work vehicle that achieves enhanced capability to detect an object located in the rear of a side surface of the work vehicle and around the ground.

Solution to Problem

[0006] A work vehicle according to the present disclosure includes a traveling apparatus, a revolution frame, and a first obstacle detection sensor. The revolution frame is mounted on the traveling apparatus. The revolution frame includes a lower frame. The first obstacle detection sensor is arranged on a side surface of the lower frame that extends in a fore/aft direction and is arranged on the left and the right. The first obstacle detection sensor is provided at a position closer to a rear end portion of the lower frame.

Advantageous Effects of Invention

[0007] According to the present disclosure, a work vehicle that achieves enhanced capability to detect an object located in the rear of a side surface of the work vehicle and around the ground can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0008] FIG. **1** is a perspective view showing a hydraulic excavator.

[0009] FIG. **2** is a top view showing a frame structure of a revolving unit and a counterweight in FIG. **1**.

[0010] FIG. **3** is a perspective view showing the frame structure of the revolving unit and the counterweight in FIG. **1**.

[0011] FIG. **4** is another perspective view showing the frame structure of the revolving unit and the counterweight in FIG. **1**.

[0012] FIG. **5** is a left side view showing the hydraulic excavator in FIG. **1**.

[0013] FIG. **6** is a right side view showing the hydraulic excavator in FIG. **1**.

[0014] FIG. **7** is a perspective view showing the hydraulic excavator in a region (except for a lid portion) surrounded by a chain double-dotted line VII in FIG. **3**.

[0015] FIG. **8** is a rear view showing the hydraulic excavator in FIG. **1**.

[0016] FIG. **9** is a perspective view showing the hydraulic excavator in a region (except for a lid portion) surrounded by a chain double-dotted line IX in FIG. **3**.

[0017] FIG. **10** is a top view showing areas of detection by radars and cameras around the hydraulic excavator in FIG. **1**.

[0018] FIG. **11** is a perspective view showing the area of detection by the radars around the hydraulic excavator in FIG. **1**.

[0019] FIG. **12** is a cross-sectional view showing the hydraulic excavator in a direction along the line XII-XII in FIG. **3**.

[0020] FIG. **13** is a cross-sectional view of the hydraulic excavator in FIG. **12** from which a bolt for fastening an attachment plate was removed.

[0021] FIG. **14** is a rear view showing change of a first left radar detection area in adjustment of an attachment attitude of a first left radar.

[0022] FIG. **15** is a rear view showing change of the first left radar detection area in adjustment of the attachment attitude of the first left radar.

[0023] FIG. **16** is a rear view showing change of the first left radar detection area in adjustment of the attachment attitude of the first left radar.

[0024] FIG. **17** is a rear view showing change of the first left radar detection area in adjustment of the attachment attitude of the first left radar.

[0025] FIG. **18** is a perspective view showing change in positional relation between the first left radar detection area and a traveling apparatus in adjustment of the attachment attitude of the first left radar.

[0026] FIG. **19** is a perspective view showing change in positional relation between the first left radar detection area and the traveling apparatus in adjustment of the attachment attitude of the first left radar.

[0027] FIG. **20** is a cross-sectional view showing the hydraulic excavator in a direction along the line XX-XX in FIG. **3**.

DESCRIPTION OF EMBODIMENTS

[0028] An embodiment of the present disclosure will be described with reference to the drawings. The same or corresponding members in the drawings referred to below have the same reference characters allotted.

[0029] FIG. **1** is a perspective view showing a hydraulic excavator. As shown in FIG. **1**, a hydraulic excavator **100** includes a vehicular main body **11** and a work implement **12**. Vehicular main body **11** includes a revolving unit **13** and a traveling apparatus **15**.

[0030] Revolving unit **13** is provided on traveling apparatus **15**. Revolving unit **13** is revolvable around a revolution center axis **210** with respect to traveling apparatus **15**.

Revolution center axis **210** is an axis extending in an upward/downward direction. Revolving unit **13** includes a cab (operator's cab) **14**. An operator's seat **14**S is provided in cab **14**. An operator enters cab **14** and operates hydraulic excavator **100** while the operators sits in operator's seat **14**S.

[0031] The fore/aft direction herein refers to the fore/aft direction of an operator who sits in operator's seat **14**S. A direction in which the operator sitting in operator's seat **14**S faces is defined as the fore direction and a direction behind the operator sitting in operator's seat **14**S is defined as the aft direction. A lateral (side) direction refers to a lateral direction of the operator who sits in operator's seat **14**S. A right side and a left side at the time when the operator sitting in operator's seat **14**S faces front are defined as the right direction and the left direction, respectively. An upward/downward direction is a direction orthogonal to the plane including the fore/aft direction and the lateral direction. A side where the ground is located is defined as a lower side and a side where the sky is located is defined as an upper side.

[0032] Revolving unit **13** further includes an engine hood **19** and a counterweight **51**. An engine, a hydraulic oil tank, an air cleaner, a hydraulic pump, and the like are accommodated in engine hood **19**. Counterweight **51** is provided in the rear of engine hood **19**.

[0033] Traveling apparatus **15** includes a travel frame **15**B, a pair of left and right crawler belts **15**Cr, and a travel motor **15**M.

[0034] Travel frame **15**B is a frame body that serves as a base for traveling apparatus **15**, and supports crawler belts **15**Cr and travel motor **15**M thereon. Hydraulic excavator **100** can travel as crawler belts **15**Cr rotate. Travel motor **15**M is provided as a drive source of traveling apparatus **15**. Travel motor **15**M is a hydraulic motor driven by supply of hydraulic oil. Traveling apparatus **15** may include a wheel (tire).

[0035] Work implement **12** is attached to vehicular main body **11**. Work implement **12** is attached to revolving unit **13**. Work implement **12** do such works as excavation of the ground. Work implement **12** includes a boom **16**, an arm **17**, and a bucket **18**.

[0036] Boom **16** is pivotably coupled to vehicular main body **11** (revolving unit **13**) with a boom pin **23** being interposed. Arm **17** is pivotably coupled to boom **16** with an arm pin **24** being interposed. Bucket **18** is pivotably coupled to arm **17** with a bucket pin **25** being interposed.

[0037] Work implement **12** further includes a boom cylinder **20**A and a boom cylinder **20**B, an arm cylinder **21**, and a bucket cylinder **22**.

[0038] Boom cylinder **20**A, boom cylinder **20**B, arm cylinder **21**, and bucket cylinder **22** are each a hydraulic cylinder driven by hydraulic oil. Boom cylinder **20**A and boom cylinder **20**B are provided on opposing sides of boom **16** as a pair and they have boom **16** pivotally operate. Arm cylinder **21** has arm **17** pivotally operate. Bucket cylinder **22** has bucket **18** pivotally operate.

[0039] FIG. **2** is a top view showing a frame structure of the revolving unit and the counterweight in FIG. **1**. FIGS. **3** and **4** are perspective views showing the frame structure of the revolving unit and the counterweight in FIG. **1**.

[0040] As shown in FIGS. **2** to **4**, revolving unit **13** further includes a revolution frame **31**. Revolution frame **31** is a frame body that serves as the base for revolving unit **13** and formed from a steel plate. Revolution frame **31** is mounted on traveling apparatus **15**. Revolution frame **31** is revolvable around revolution center axis **210** with respect to traveling apparatus **15**. Revolution frame **31** is generally in a frame shape as extending in a direction orthogonal to the upward/downward direction (revolution center axis **210**). Counterweight **51** is a weight made of a metal. Counterweight **51** is provided at a rear end portion of revolution frame **31**.

[0041] Revolution frame **31** includes a lower frame **32** and a plurality of vertical plates **36** and **37**. Lower frame **32** is provided on traveling apparatus **15**. Lower frame **32** is connected to traveling apparatus **15**. Lower frame **32** is connected to travel frame **15**B with a revolution apparatus **30** (see FIGS. **5**, **6**, and **8** which will appear later) being interposed.

[0042] FIG. **2** shows a centerline **230** of lower frame **32** that passes through revolution center axis **210** and extends in the fore/aft direction. Centerline **230** is a straight line indicating the center of lower frame **32** in the lateral direction. Lower frame **32** may be constructed such that centerline **230** does not pass through revolution center axis **210**.

[0043] Lower frame **32** includes a bottom plate **33**, a left rising portion **34**, and a right rising portion **35**. Bottom plate **33** is in a plate shape that extends in the direction orthogonal to the upward/downward direction (revolution center axis **210**). Left rising portion **34** is provided at a left end of bottom plate **33**. Right rising portion **35** is provided at a right end of bottom plate **33**. Left rising portion **34** and right rising portion **35** extend in the fore/aft direction, as being in a projecting shape that rises upward from bottom plate **33**. Left rising portion **34** and right rising portion **35** are each in a bag shape having a rectangular cross-section when cut along a plane orthogonal to the fore/aft direction.

[0044] Left rising portion **34** and right rising portion **35** are each provided in a side surface **46** of lower frame **32** that extends in the fore/aft direction and is arranged on the left and the right. Left rising portion **34** is provided in a left side surface **46**L of lower frame **32** arranged on the left. Right rising portion **35** is provided in a right side surface **46**R of lower frame **32** arranged on the right. Side surfaces **46** face the lateral direction. Left side surface **46**L faces to the left. Right side surface **46**R faces to the right.

[0045] Lower frame **32** further includes a protruding portion **41** and a protruding portion **42**. Protruding portion **41** and protruding portion **42** are arranged at a rear end portion of lower frame **32**. Protruding portion **41** and protruding portion **42** are in a protruding shape that protrudes rearward at the rear end portion of lower frame **32**. Protruding portion **41** and protruding portion **42** are provided at a distance in the lateral direction with centerline **230** of lower frame **32** lying therebetween. Counterweight **51** is provided above protruding portion **41** and protruding portion **42**.

[0046] Vertical plate **36** and vertical plate **37** are erected on bottom plate **33**. Vertical plate **36** and vertical plate **37** are each in a plate shape that extends in the direction orthogonal to the lateral direction. Vertical plate **36** and vertical plate **37** are arranged at a distance from each other in the lateral direction. Vertical plate **36** and vertical plate **37** are provided at a distance in the lateral direction with centerline **230** of lower frame **32** lying therebetween. Vertical plate **36** and vertical plate **37** are provided at a distance in the lateral direction with revolution center axis **210** lying therebetween.

[0047] Vertical plate **36** is provided with a pin insertion hole **38**. Vertical plate **37** is provided with a pin insertion

hole **39**. Pin insertion hole **38** and pin insertion hole **39** are through holes that pass through vertical plate **36** and vertical plate **37**, respectively. Pin insertion hole **38** and pin insertion hole **39** are arranged on a pivot center axis **220** extending in the lateral direction.

[0048] As shown in FIGS. **1** to **4**, boom **16** is inserted between vertical plate **36** and vertical plate **37**. Boom **16** is pivotably coupled to vertical plate **36** and vertical plate **37** by means of boom pin **23** inserted in pin insertion hole **38** and pin insertion hole **39**.

[0049] In such a construction, boom **16** pivotally operates around pivot center axis **220**. Pivot center axis **220** extends in the lateral direction at a position distant upward from bottom plate **33**. Pivot center axis **220** is arranged in front of revolution center axis **210**. Vertical plate **36** and vertical plate **37** are each in such a chevron shape as extending forward and rearward in a diagonally downward direction from a position where pivot center axis **220** of boom **16** is arranged, with the position where pivot center axis **220** of boom **16** is arranged being defined as a top portion.

[0050] FIG. **5** is a left side view showing the hydraulic excavator in FIG. **1**. FIG. **6** is a right side view showing the hydraulic excavator in FIG. **1**.

[0051] As shown in FIGS. **2** to **6**, hydraulic excavator **100** further includes a first radar **61**. First radar **61** is, for example, a millimeter wave radar apparatus that emits radio waves in a 20 to 300 GHz band. First radar **61** is arranged on side surface **46** of lower frame **32**.

[0052] Hydraulic excavator **100** includes a first left radar **61**L and a first right radar **61**R as first radar **61**. First left radar **61**L is arranged on left side surface **46**L of lower frame **32**. First left radar **61**L is attached to left rising portion **34** of lower frame **32**. First right radar **61**R is arranged on right side surface **46**R of lower frame **32**. First right radar **61**R is attached to right rising portion **35** of lower frame **32**.

[0053] As shown in FIGS. **5** and **6**, first radar **61** is provided at a position closer to a rear end portion **32***r* of lower frame **32**. First radar **61** is provided at a position closer to rear end portion **32***r* of lower frame **32** than to a front end portion **32***f* of lower frame **32** in the fore/aft direction.

[0054] As shown in FIG. **5**, a distance Lb between rear end portion **32***r* of lower frame **32** and first left radar **61**L in the fore/aft direction is shorter than a distance La between front end portion **32***f* of lower frame **32** and first left radar **61**L in the fore/aft direction (Lb<La). As shown in FIG. **6**, a distance Le between rear end portion **32***r* of lower frame **32** and first right radar **61**R in the fore/aft direction is shorter than a distance Ld between front end portion **32***f* of lower frame **32** and first right radar **61**R in the fore/aft direction (Le<Ld).

[0055] As shown in FIGS. **5** and **6**, revolution center axis **210** is arranged in front of first radar **61**. First radar **61** is provided at a position closer to rear end portion **32***r* of lower frame **32** than to revolution center axis **210** in the fore/aft direction.

[0056] As shown in FIG. **5**, distance Lb between rear end portion **32***r* of lower frame **32** and first left radar **61**L in the fore/aft direction is shorter than a distance Lc between revolution center axis **210** and first left radar **61**L in the fore/aft direction (Lb<Lc). As shown in FIG. **6**, distance Le between rear end portion **32***r* of lower frame **32** and first right radar **61**R in the fore/aft direction is shorter than a distance Lf between revolution center axis **210** and first right radar **61**R in the fore/aft direction (Le<Lf).

[0057] A reference position in specifying a position of a radar in a prescribed direction herein is set to a central position of the radar in the prescribed direction.

[0058] As shown in FIGS. **2** to **6**, first radar **61** is provided in the rear of pivot center axis **220** of boom **16**. First radar **61** is provided in the rear of cab **14**. First radar **61** is provided between cab **14** and counterweight **51** in the fore/aft direction. First radar **61** is provided in the rear of traveling apparatus **15**. First radar **61** is provided in the rear of the pair of crawler belts **15**Cr. First radar **61** is provided in the rear of travel motor **15**M. First radar **61** is provided in front of counterweight **51**.

[0059] First radar **61** is provided below pivot center axis **220** of boom **16**. First radar **61** is provided below engine hood **19**. First radar **61** is provided below cab **14**. First radar **61** is provided below operator's seat **14**S in FIG. **1**. First left radar **61**L and first right radar **61**R are provided at positions at the same height. First left radar **61**L and first right radar **61**R may be provided at positions at heights different from each other.

[0060] First left radar **61**L and first right radar **61**R are provided at positions symmetric to each other with respect to centerline **230** of lower frame **32**. First left radar **61**L and first right radar **61**R may be provided at positions asymmetric to each other with respect to centerline **230** of lower frame **32**.

[0061] FIG. **7** is a perspective view showing the hydraulic excavator in a region (except for a lid portion) surrounded by a chain double-dotted line VII in FIG. **3**.

[0062] As shown in FIGS. **2**, **3**, and **7**, lower frame **32** is provided with a recess portion **45**. Recess portion **45** is in a recessed shape in left side surface **46**L of lower frame **32**.

[0063] More specifically, left rising portion **34** includes an outer plate portion **34***p* and an inner plate portion **34***q*. Outer plate portion **34***p* and inner plate portion **34***q* are each in a plate shape extending in the direction orthogonal to the lateral direction. Outer plate portion **34***p* and inner plate portion **34***q* extend such that the fore/aft direction is defined as a longitudinal direction thereof while they are opposed to each other at a distance from each other in the lateral direction. Outer plate portion **34***p* is arranged on an outer side of lower frame **32** relative to inner plate portion **34***q*. A length of lower frame **32** between centerline **230** and outer plate portion **34***p* in the lateral direction is longer than a length of lower frame **32** between centerline **230** and inner plate portion **34***q* in the lateral direction.

[0064] Outer plate portion **34***p* is provided with an opening portion **43**. Opening portion **43** is provided as a through hole that passes through outer plate portion **34***p* in the lateral direction. Opening portion **43** is in such a rectangular opening shape that the fore/aft direction is defined as a direction of a long side thereof and the upward/downward direction is defined as a direction of a short side thereof. According to such a construction, lower frame **32** is provided with recess portion **45** that opens to the left through opening portion **43** and is recessed from outer plate portion **34***p* toward inner plate portion **34***q*.

[0065] First left radar **61**L is accommodated in recess portion **45**. First left radar **61**L is attached to inner plate portion **34***q* by an attachment member **90** which will be described later.

[0066] Hydraulic excavator **100** further includes a lid portion **81**. Lid portion **81** is made of a resin. Lid portion **81** is attached to lower frame **32** to close the opening in recess

portion **45**. Lid portion **81** is attached to outer plate portion **34***p* to close opening portion **43**.

[0067] Though an attachment structure for first left radar **61**L is described, first right radar **61**R is also attached to right rising portion **35** of lower frame **32** in a manner similar to first left radar **61**L.

[0068] FIG. **8** is a rear view showing the hydraulic excavator in FIG. **1**. As shown in FIGS. **2** to **4** and **8**, hydraulic excavator **100** further includes a second radar **62**. Second radar **62** is, for example, a millimeter radar apparatus that emits radio waves in a 20 to 300 GHz band. Second radar **62** is arranged on a rear surface **52** of counterweight **51**.

[0069] Rear surface **52** faces the rear.

[0070] Second radar **62** is provided in the rear of first radar **61**. Second radar **62** is provided at a position superimposed on centerline **230** of lower frame **32** in a top view. Second radar **62** is provided at a lower end of counterweight **51**. Second radar **62** is provided at a position higher than first radar **61**. Second radar **62** may be provided at a position displaced from centerline **230** of lower frame **32** in the top view, a position lower than first radar **61**, or a position as high as first radar **61**.

[0071] FIG. **9** is a perspective view showing the hydraulic excavator in a region (except for the lid portion) surrounded by a chain double-dotted line IX in FIG. **3**.

[0072] As shown in FIGS. **3**, **4**, and **9**, counterweight **51** is provided with a recess portion **55**. Recess portion **55** is in a recessed shape in rear surface **52** of counterweight **51**.

[0073] More specifically, counterweight **51** is provided with a dished portion **53**. Dished portion **53** is in a shape dished forward from rear surface **52** of counterweight **51**. Counterweight **51** is provided with an opening portion **54**. Opening portion **54** is provided at the bottom of dished portion **53**.

[0074] Counterweight **51** includes a casing body **56**. Casing body **56** is in a dish shape that opens in one direction. Casing body **56** is inserted in opening portion **54** to open rearward. According to such a construction, counterweight **51** is provided with recess portion **55** that opens rearward and is delimited in the inside of casing body **56**. Recess portion **55** is provided at a position deeper than dished portion **53**.

[0075] Second radar **62** is accommodated in recess portion **55**. Second radar **62** is attached to casing body **56** by an attachment member **110** which will be described later.

[0076] Hydraulic excavator **100** further includes a lid portion **82**. Lid portion **82** is made of a resin. Lid portion **82** is attached to counterweight **51** to close the opening in recess portion **55**. Lid portion **82** is attached to casing body **56** to close the opening in casing body **56**. Lid portion **82** is arranged in dished portion **53**.

[0077] As shown in FIGS. **2** and **5**, cab **14** is provided on lower frame **32**. Cab **14** is provided at a position shifted to the left with respect to centerline **230** of lower frame **32**.

[0078] As shown in FIGS. **2**, **4**, and **6**, hydraulic excavator **100** further includes a third radar **63**. Third radar **63** is, for example, a millimeter radar apparatus that emits radio waves in a 20 to 300 GHz band.

[0079] Third radar **63** is arranged on right side surface **46**R of lower frame **32**. Third radar **63** is provided opposite to cab **14** with respect to centerline **230** of lower frame **32**. Third radar **63** is attached to right rising portion **35** of lower frame **32** in a manner the same as first right radar **61**R.

[0080] As shown in FIG. **6**, third radar **63** is provided at a position closer to front end portion **32***f* of lower frame **32**. Third radar **63** is provided at a position closer to front end portion **32***f* of lower frame **32** than to rear end portion **32***r* of lower frame **32** in the fore/aft direction. A distance Lh between front end portion **32***f* of lower frame **32** and third radar **63** in the fore/aft direction is shorter than a distance Lg between rear end portion **32***r* of lower frame **32** and third radar **63** in the fore/aft direction (Lh<Lg).

[0081] As shown in FIGS. **2** and **6**, third radar **63** is provided in front of first radar **61**. Third radar **63** is provided in front of revolution center axis **210**. Third radar **63** is provided in front of pivot center axis **220** of boom **16**. In the top view shown in FIG. **2**, third radar **63** is provided at a position opposed to cab **14** with centerline **230** of lower frame **32** lying therebetween.

[0082] Third radar **63** is provided at a position as high as first radar **61**. Third radar **63** may be provided at a position different in height from first radar **61**. By way of example, the height where first radar **61**, second radar **62**, and third radar **63** are provided is within a range not lower than 1 m and not higher than 1.5 m with the ground where hydraulic excavator **100** travels being defined as the reference.

[0083] As shown in FIGS. **5**, **6**, and **8**, hydraulic excavator **100** further includes a first camera **71**, a second camera **72**, a third camera **73**, and a fourth camera **74**. First camera **71**, second camera **72**, third camera **73**, and fourth camera **74** are each, for example, a camera of a monocular type, and contains an image pick-up element such as a charge coupled device (CCD) or a complementary metal oxide semiconductor (CMOS).

[0084] First camera **71** is arranged on a left side surface of revolving unit **13** that faces to the left. First camera **71** is attached to an upper exterior of revolving unit **13**. First camera **71** is provided in front of first left radar **61**L. First camera **71** is provided in the rear of revolution center axis **210**. First camera **71** is provided in the rear of pivot center axis **220** of boom **16**. First camera **71** is provided above first left radar **61**L.

[0085] Second camera **72** is arranged on a rear surface of revolving unit **13** that faces the rear. Second camera **72** is provided in counterweight **51**. Second camera **72** is provided at a position superimposed on centerline **230** of lower frame **32** in the top view. Second camera **72** is provided at an upper end of counterweight **51**. Second camera **72** is provided above second radar **62**.

[0086] Third camera **73** is arranged on a right side surface of revolving unit **13** that faces to the right. Third camera **73** is attached to engine hood **19**. Third camera **73** is provided in front of first right radar **61**R. Third camera **73** is provided between third radar **63** and first right radar **61**R in the fore/aft direction. Third camera **73** is provided in the rear of revolution center axis **210**. Third camera **73** is provided in the rear of pivot center axis **220** of boom **16**. Third camera **73** is provided above first right radar **61**R and third radar **63**.

[0087] First camera **71**, second camera **72**, and third camera **73** are provided at positions at the same height. First camera **71**, second camera **72**, and third camera **73** may be provided at positions at heights different from one another.

[0088] As shown in FIGS. **2** and **5**, fourth camera **74** is arranged on a front surface of revolving unit **13** that faces the front. Fourth camera **74** is attached to cab **14**.

[0089] Fourth camera **74** is provided at an upper left corner of a front surface of cab **14**. Fourth camera **74** is

provided in front of revolution center axis **210**. Fourth camera **74** is provided in front of pivot center axis **220** of boom **16**. Fourth camera **74** is provided above first camera **71**, second camera **72**, and third camera **73**.

[0090] FIG. **10** is a top view showing areas of detection by the radars and the cameras around the hydraulic excavator in FIG. **1**. FIG. **11** is a perspective view showing the areas of detection by the radars around the hydraulic excavator in FIG. **1**.

[0091] As shown in FIGS. **10** and **11**, first left radar **61**L, first right radar **61**R, second radar **62**, and third radar **63** emit radio waves to areas around hydraulic excavator **100** and receive radio waves reflected by an object located around hydraulic excavator **100**, to thereby detect the object. First left radar **61**L, first right radar **61**R, second radar **62**, and third radar **63** form a first left radar detection area **240**, a first right radar detection area **250**, a second radar detection area **260**, and a third radar detection area **270** as ranges of emission of radio waves from them, respectively.

[0092] First left radar detection area **240**, first right radar detection area **250**, second radar detection area **260**, and third radar detection area **270** are each a spatial area in a shape of a sector at an angle β around corresponding one of first left radar **61**L, first right radar **61**R, second radar **62**, and third radar **63** in the top view shown in FIG. **10** and in a shape of a sector at an angle α around corresponding one of first left radar **61**L, first right radar **61**R, second radar **62**, and third radar **63** in a vertical plane shown in FIG. **11**.

[0093] By way of example, each of first left radar detection area **240**, first right radar detection area **250**, second radar detection area **260**, and third radar detection area **270** has a radius within a range not smaller than 0.25 m and not larger than 5 m. Angle α is within a range not smaller than 10° and not larger than 20° and angle β is within a range not smaller than 110° and not larger than 130°.

[0094] As shown in FIG. **10**, a bisector **241** of first left radar detection area **240** that bisects angle β extends to the left from first left radar **61**L. First left radar detection area **240** extends as far as the front of front end portion **32***f* of lower frame **32** and the rear of rear end portion **32***r* of lower frame **32**. A bisector **251** of first right radar detection area **250** that bisects angle β extends to the right from first right radar **61**R. First right radar detection area **250** extends as far as the front of front end portion **32***f* of lower frame **32** and the rear of rear end portion **32***r* of lower frame **32**.

[0095] Bisector **241** and bisector **251** may extend in a direction inclined with respect to the lateral direction. Bisector **241** and bisector **251** may extend in a direction inclined rearward with respect to the lateral direction.

[0096] A bisector **261** of second radar detection area **260** that bisects angle β extends rearward from second radar **62**. Second radar detection area **260** partially overlaps with first left radar detection area **240** and first right radar detection area **250**.

[0097] A bisector **271** of third radar detection area **270** that bisects angle β extends to the right from third radar **63**. Third radar detection area **270** partially overlaps with first right radar detection area **250**. Bisector **271** may extend in a direction inclined with respect to the lateral direction.

[0098] As shown in FIG. **11**, a bisector **242** of first left radar detection area **240** that bisects angle α extends in a horizontal direction or a diagonally downward direction from first left radar **61**L. A bisector **252** of first right radar detection area **250** that bisects angle α extends in the horizontal direction or the diagonally downward direction from first right radar **61**R. A bisector **262** of second radar detection area **260** that bisects angle α extends in the horizontal direction or the diagonally downward direction from second radar **62**. A bisector **272** of third radar detection area **270** that bisects angle α extends in the horizontal direction or the diagonally downward direction from third radar **63**.

[0099] As shown in FIG. **10**, first camera **71**, second camera **72**, third camera **73**, and fourth camera **74** form a shooting area **310** around hydraulic excavator **100**. Shooting area **310** extends over an angular range of 360° around hydraulic excavator **100**. First left radar detection area **240**, first right radar detection area **250**, second radar detection area **260**, and third radar detection area **270** are included in shooting area **310**.

[0100] Images shot by first camera **71**, second camera **72**, third camera **73**, and fourth camera **74** are shown on a monitor provided in cab **14**. As an object such as a person or a structure is detected in a detection area **330** within shooting area **310**, a warning may be given through representation on the monitor or a buzzer, or travel of hydraulic excavator **100** may be decelerated. Furthermore, an object such as a person or a structure is detected in a stop control area **320** within shooting area **310**, travel of hydraulic excavator **100** is stopped.

[0101] Each of first left radar detection area **240**, first right radar detection area **250**, second radar detection area **260**, and third radar detection area **270** extends as far as the outside of stop control area **320** and further as far as the outside of detection area **330**. The rear end portion of each of first left radar detection area **240** and first right radar detection area **250** is located in the rear of a rear end portion of stop control area **320**.

[0102] Lower frame **32** is located directly on traveling apparatus **15** in revolution frame **31** mounted on traveling apparatus **15**. In hydraulic excavator **100**, first left radar **61**L and first right radar **61**R are arranged on left side surface **46**L and right side surface **46**R of lower frame **32**, respectively. Therefore, first left radar **61**L and first right radar **61**R can be provided in side portions of hydraulic excavator **100** at positions closer to the ground where hydraulic excavator **100** travels. First left radar **61**L and first right radar **61**R are provided at positions closer to rear end portion **32***r* of lower frame **32**. First left radar **61**L and first right radar **61**R can thus be provided as being brought further closer to the rear portion of hydraulic excavator **100**.

[0103] Therefore, with first left radar **61**L and first right radar **61**R, capability to detect an object located in the rear of the side surface of hydraulic excavator **100** and at a position close to the ground can be enhanced.

[0104] Hydraulic excavator **100** includes first camera **71**, second camera **72**, third camera **73**, and fourth camera **74**, and monitors an area for a person around hydraulic excavator **100**. By providing first left radar **61**L and first right radar **61**R in addition to these cameras, a person who crouches on the ground in the rear of the side surface of hydraulic excavator **100** can more reliably be detected.

[0105] The distance between first radar **61** (first right radar **61**R or first left radar **61**L) and rear end portion **32***r* of lower frame **32** in the fore/aft direction is shorter than the distance between revolution center axis **210** of revolution frame **31** and first radar **61** (first right radar **61**R or first left radar **61**L) in the fore/aft direction. Thus, first left radar **61**L and first

right radar **61**R can be provided as being brought further closer to the rear portion of hydraulic excavator **100** so that capability to detect an object located in the rear of the side surface of hydraulic excavator **100** can further be enhanced.

[0106] Bisector **242** of first left radar detection area **240** that bisects angle α extends from first left radar **61**L in the horizontal direction or the diagonally downward direction. Bisector **252** of first right radar detection area **250** that bisects angle α extends from first right radar **61**R in the horizontal direction or the diagonally downward direction. Thus, with first left radar **61**L and first right radar **61**R, capability to detect an object located at a position close to the ground can further be enhanced.

[0107] First left radar **61**L and first right radar **61**R are each accommodated in recess portion **45** provided in lower frame **32**. Since first radar **61** is thus surrounded by lower frame **32** that forms the frame structure, first radar **61** can appropriately be protected by lower frame **32** even in case of external application of great impact to first radar **61**.

[0108] Second radar **62** is arranged on rear surface **52** of counterweight **51**. Thus, with second radar **62** together with first radar **61**, capability to detect an object located in the rear of the side surface of hydraulic excavator **100** can further be enhanced.

[0109] Third radar **63** is provided at a position which is opposite to cab **14** in the lateral direction and closer to front end portion **32***f* of lower frame **32**. Thus, with third radar **63**, capability to detect an object located at a position in front of the right side surface of hydraulic excavator **100** which is difficult for the operator in cab **14** to visually recognize can be enhanced.

[0110] FIG. **12** is a cross-sectional view showing the hydraulic excavator in a direction along the line XII-XII in FIG. **3**. FIG. **13** is a cross-sectional view of the hydraulic excavator in FIG. **12** from which a bolt for fastening an attachment plate was removed.

[0111] As shown in FIGS. **7**, **11**, **12**, and **13**, hydraulic excavator **100** further includes attachment member **90**. First left radar **61**L is attached to lower frame **32** by means of attachment member **90**.

[0112] Attachment member **90** is provided with an attitude adjustment mechanism that changes an attitude of attachment of first left radar **61**L to lower frame **32** such that the direction of extension of bisector **242** of first left radar detection area **240** that bisects angle α changes. A structure of the attitude adjustment mechanism provided in attachment member **90** will be described below.

[0113] Attachment member **90** includes a radar attachment plate **91** and radar attachment angles **96** and **97**. First left radar **61**L is attached to inner plate portion **34***q* of left rising portion **34** in lower frame **32** with radar attachment plate **91** and radar attachment angles **96** and **97** being interposed.

[0114] Radar attachment plate **91** includes a flat plate portion **92** and bent portions **93** and **94**. Flat plate portion **92** is in a plate shape extending in a direction intersecting with the lateral direction. First left radar **61**L is fastened to flat plate portion **92** with a bolt. Bent portion **93** is bent from a front end portion of flat plate portion **92** toward the opening of opening portion **43**. Bent portion **94** is bent from a rear end portion of flat plate portion **92** toward the opening of opening portion **43**. Bent portion **93** and bent portion **94** are each provided with a bolt insertion hole **88** and a bolt insertion hole **89**. Bolt insertion hole **88** is provided above bolt insertion hole **89**.

[0115] Radar attachment angle **96** and radar attachment angle **97** are each an L-shaped angle. Radar attachment angle **96** and radar attachment angle **97** are arranged at a distance from each other in the fore/aft direction. Radar attachment angle **96** and radar attachment angle **97** are fastened to inner plate portion **34***q* with a bolt. Radar attachment angle **96** and radar attachment angle **97** are each provided with a long hole **98** and a round hole **99**. Long hole **98** is provided above round hole **99**. Round hole **99** is in a shape of an annular opening. Long hole **98** is in a shape of a long hole extending in an arc around round hole **99**, with a constant width in a direction of radius of round hole **99**.

[0116] Bent portion **93** and bent portion **94** are fastened to radar attachment angle **96** and radar attachment angle **97**, respectively, with a bolt **101** and a bolt **102**. Bolt **101** is inserted in long hole **98** and bolt insertion hole **88**. Bolt **102** is inserted in round hole **99** and bolt insertion hole **89**.

[0117] In such a construction, by moving a position of fastening of bolt **101** to long hole **98** in a circumferential direction around round hole **99**, the attitude of attachment of first left radar **61**L to lower frame **32** can be adjusted to change the direction of extension of bisector **242** of first left radar detection area **240** that bisects angle α.

[0118] FIGS. **14** to **17** are rear views showing change of the first left radar detection area in adjustment of the attachment attitude of the first left radar.

[0119] FIG. **14** shows first left radar detection area **240** (**240**A) when the direction of extension of bisector **242** is set to the horizontal direction, FIG. **15** shows first left radar detection area **240** (**240**B) when the direction of extension of bisector **242** is set to the diagonally downward direction at an angle of 5° with respect to the horizontal direction, FIG. **16** shows first left radar detection area **240** (**240**C) when the direction of extension of bisector **242** is set to the diagonally downward direction at an angle of 10° with respect to the horizontal direction, and FIG. **17** shows first left radar detection area **240** (**240**D) when the direction of extension of bisector **242** is set to the diagonally downward direction at an angle of 25° with respect to the horizontal direction.

[0120] As shown in FIGS. **14** and **15**, when the direction of extension of bisector **242** is set to the horizontal direction or the diagonally downward direction at a relatively small angle with respect to the horizontal direction, an object located at a position lower than the height where first left radar **61**L is provided can be detected with first left radar **61**L. Though the length of first left radar detection area **240**A or **240**B in the upward/downward direction increases as the distance from first left radar **61**L increases, a ground FL is not erroneously detected even at a position distant from first left radar **61**L by a radius L1 of first left radar detection area **240**A or **240**B.

[0121] As shown in FIG. **16**, when the direction of extension of bisector **242** is set to the diagonally downward direction at an angle of intermediate magnitude with respect to the horizontal direction, an object located at a position closer to first left radar **61**L and lower than in the example shown in FIGS. **14** and **15** can be detected with first left radar **61**L. In order to avoid erroneous detection of ground FL at a position distant from first left radar **61**L, on the other hand, a small radius L2 of first left radar detection area **240**C should be set (L2<L1).

[0122] As shown in FIG. **17**, when the direction of extension of bisector **242** is set to the diagonally downward direction at a relatively large angle with respect to the

horizontal direction, an object located at a position further closer to first left radar **61**L and further lower than in an example shown in FIG. **16** can be detected with first left radar **61**L. In order to avoid erroneous detection of ground FL at a position distant from first left radar **61**L, on the other hand, a smaller radius L3 of first left radar detection area **240**D should be set (L3<L2).

[0123] In hydraulic excavator **100**, in consideration of the distance from first left radar **61**L to an object to be detected or the height from ground FL to the object to be detected, the attachment attitude of first left radar **61**L can be adjusted.

[0124] FIGS. **18** and **19** are perspective views showing change in positional relation between the first left radar detection area and the traveling apparatus in adjustment of the attachment attitude of the first left radar.

[0125] First left radar detection area **240**C shown in FIG. **18** corresponds to first left radar detection area **240**C shown in FIG. **16**, and first left radar detection area **240**D shown in FIG. **19** corresponds to first left radar detection area **240**D shown in FIG. **17**.

[0126] As revolution frame **31** revolves with respect to traveling apparatus **15**, crawler belts **15**Cr of traveling apparatus **15** are positioned in the diagonally downward direction of first left radar **61**L.

[0127] As shown in FIGS. **16** and **18**, when the direction of extension of bisector **242** is set to the diagonally downward direction at an angle of intermediate magnitude with respect to the horizontal direction, first left radar detection area **240**C in revolution of revolution frame **31** is distant from traveling apparatus **15** (crawler belts **15**Cr). When the direction of extension of bisector **242** is set to the horizontal direction or the diagonally downward direction at a relatively small angle with respect to the horizontal direction shown in FIGS. **14** and **15** as well, first left radar detection area **240**A or **240**B in revolution of revolution frame **31** is distant from traveling apparatus **15** (crawler belts **15**Cr).

[0128] As shown in FIGS. **17** and **19**, on the other hand, when the direction of extension of bisector **242** is set to the diagonally downward direction at a relatively large angle with respect to the horizontal direction, first left radar detection area **240**D in revolution of revolution frame **31** interferes with traveling apparatus **15** (crawler belts **15**Cr). Therefore, in determining the attachment attitude of first left radar **61**L, prevention of erroneous detection of traveling apparatus **15** (crawler belts **15**Cr) is also taken into account.

[0129] Though first left radar **61**L is representatively described, an attitude adjustment mechanism similar to that for first left radar **61**L is also provided for first right radar **61**R. As the attachment attitude of first right radar **61**R is adjusted, first right radar detection area **250** also changes similarly to first left radar detection area **240**.

[0130] FIG. **20** is a cross-sectional view showing the hydraulic excavator in a direction along the line XX-XX in FIG. **3**. As shown in FIGS. **9** and **20**, hydraulic excavator **100** further includes attachment member **110**. Second radar **62** is attached to counterweight **51** by means of attachment member **110**.

[0131] Attachment member **110** is provided with an attitude adjustment mechanism that changes an attitude of attachment of second left radar **62** to counterweight **51** such that the direction of extension of bisector **262** of second radar detection area **260** that bisects angle α in FIG. **11** changes. The attitude adjustment mechanism provided in attachment member **110** is similar in structure to the attitude adjustment mechanism provided in attachment member **90** shown in FIGS. **7**, **12**, and **13**.

[0132] Attachment member **110** includes a radar attachment plate **111** and radar attachment angles **116** and **117**. Radar attachment plate **111** corresponds to radar attachment plate **91** in attachment member **90** and radar attachment angles **116** and **117** correspond to radar attachment angles **96** and **97** in attachment member **90**.

[0133] Radar attachment plate **111** includes a flat plate portion **112** and bent portions **113** and **114**. Flat plate portion **112** corresponds to flat plate portion **92** in radar attachment plate **91** and bent portions **113** and **114** correspond to bent portions **93** and **94** in radar attachment plate **91**. Second radar **62** is fastened to flat plate portion **112** with a bolt.

[0134] Radar attachment angles **116** and **117** are fastened to casing body **56** with a bolt. Radar attachment angles **116** and **117** are each provided with a long hole **118**. Long hole **118** corresponds to long hole **98** provided in radar attachment angles **96** and **97**. Bent portion **113** and bent portion **114** are fastened to radar attachment angle **116** and radar attachment angle **117**, respectively, with a bolt **121** and a bolt **122**.

[0135] With such an attitude adjustment mechanism, similarly to first radar **61**, the attachment attitude of second radar **62** can be adjusted.

[0136] The construction and effects of hydraulic excavator **100** in the present embodiment described above will be summarized.

[0137] Hydraulic excavator **100** as the work vehicle according to the present disclosure includes traveling apparatus **15**, revolution frame **31**, and first radar **61** as the first obstacle detection sensor. Revolution frame **31** is mounted on traveling apparatus **15**. Revolution frame **31** includes lower frame **32**. First radar **61** is arranged on side surface **46** of lower frame **32** that extends in the fore/aft direction and is arranged on the left and the right. First radar **61** is provided at a position closer to rear end portion **32***r* of lower frame **32**.

[0138] According to such a construction, first radar **61** is arranged on side surface **46** of lower frame **32** in revolution frame **31** mounted on traveling apparatus **15**. Therefore, first radar **61** can be provided in the side portion of hydraulic excavator **100** and at a position closer to the ground. Since first radar **61** is provided at the position closer to rear end portion **32***r* of lower frame **32**, first radar **61** can be provided as being further closer to the rear portion of hydraulic excavator **100**. Thus, with first radar **61**, capability to detect an object located in the rear of the side surface of hydraulic excavator **100** and at a position close to the ground can be enhanced.

[0139] First radar **61** includes first right radar **61**R as the first obstacle detection right sensor and first left radar **61**L as the first obstacle detection left sensor. First right radar **61**R is arranged on right side surface **46**R of lower frame **32**. First left radar **61**L is arranged on left side surface **46**L of lower frame **32**.

[0140] According to such a construction, with first right radar **61**R and first left radar **61**L, capability to detect an object located in the rear of the side surfaces on both of left and right sides of hydraulic excavator **100** and at a position close to the ground can be enhanced.

[0141] The distance between first radar **61** and rear end portion **32***r* of lower frame **32** in the fore/aft direction is

shorter than the distance between revolution center axis **210** of revolution frame **31** and first radar **61** in the fore/aft direction.

[0142] According to such a construction, first radar **61** can be provided as being brought further closer to the rear portion of hydraulic excavator **100**. Thus, with first radar **61**, capability to detect an object located in the rear of the side surface of hydraulic excavator **100** can further be enhanced.

[0143] Lower frame **32** is provided with recess portion **45**. Recess portion **45** is in the recessed shape in side surface **46** of lower frame **32** that is arranged on the left and the right. First radar **61** is accommodated in recess portion **45**.

[0144] According to such a construction, even when large external force is externally applied to first radar **61**, first radar **61** can appropriately be protected by lower frame **32**.

[0145] First radar **61** emits radio waves to an area at angle α in the vertical plane. First radar **61** is provided such that the bisector of that area that bisects angle α extends from first radar **61** in the horizontal direction or the diagonally downward direction.

[0146] According to such a construction, with first radar **61**, capability to detect an object located at a position close to the ground can further be enhanced.

[0147] Hydraulic excavator **100** further includes attachment member **90**. First radar **61** is attached to lower frame **32** by means of attachment member **90**. First radar **61** emits radio waves to the area at angle α in the vertical plane. Attachment member **90** is provided with an attitude adjustment mechanism. The attitude adjustment mechanism changes an attitude of attachment of first radar **61** to lower frame **32** such that the direction of extension of the bisector of that area that bisects angle α changes.

[0148] According to such a construction, in conformity with contents of works by hydraulic excavator **100**, an environment around hydraulic excavator **100**, or an object to be detected by first radar **61**, an orientation of radio waves emitted from first radar **61** can be adjusted in the upward/downward direction.

[0149] A range of emission of radio waves from first radar **61** in revolution of revolution frame **31** is distant from traveling apparatus **15**.

[0150] According to such a construction, erroneous detection of traveling apparatus **15** as an obstacle around hydraulic excavator **100** by first radar **61** in revolution of revolution frame **31** can be prevented.

[0151] Hydraulic excavator **100** further includes counterweight **51** and second radar **62** as the second obstacle detection sensor. Counterweight **51** is provided at the rear end portion of revolution frame **31**. Second radar **62** is arranged on rear surface **52** of counterweight **51**.

[0152] According to such a construction, with first radar **61** and second radar **62**, capability to detect an object located in the rear of the side surface of hydraulic excavator **100** can further be enhanced.

[0153] Hydraulic excavator **100** further includes cab **14** and third radar **63** as the third obstacle detection sensor. Cab **14** is provided on lower frame **32**. Cab **14** is provided at a position shifted to the left which is any one of the left and the right with respect to centerline **230** of lower frame **32** extending in the fore/aft direction. Third radar **63** is arranged on right side surface **46**R of lower frame **32** arranged on the right which is any the other of the left and the right. Third radar **63** is provided at a position closer to front end portion **32***f* of lower frame **32**.

[0154] According to such a construction, cab **14** where the operator rides is provided on the left of centerline **230** of lower frame **32** extending in the fore/aft direction. Therefore, the operator's viewability of the front of the side surface of hydraulic excavator **100** can satisfactorily be obtained. On the right of centerline **230** of lower frame **32** extending in the fore/aft direction, third radar **63** is provided at a position closer to front end portion **32***f* of lower frame **32**. Therefore, with third radar **63**, capability of detection in front of the side surface of hydraulic excavator **100** can be ensured.

[0155] The obstacle detection sensor in the present disclosure is not particularly limited so long as the sensor is able to detect an object such as a person or a structure around the work vehicle. For example, light detection and ranging (LiDAR), an ultrasonic sensor, or an infrared sensor may be applicable. The work vehicle in the present disclosure is not limited to the hydraulic excavator, and for example, a crane or the like is applicable.

[0156] It should be understood that the embodiment disclosed herein is illustrative and non-restrictive in every respect. The scope of the present invention is defined by the terms of the claims rather than the description above and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

REFERENCE SIGNS LIST

[0157] **11** vehicular main body; **12** work implement; **13** revolving unit; **14** cab; **14**S operator's seat; **15** traveling apparatus; **15**B travel frame; **15**Cr crawler belt; **15**M travel motor; **16** boom; **17** arm; **18** bucket; **19** engine hood; **20**A, **20**B boom cylinder; **21** arm cylinder; **22** bucket cylinder; **23** boom pin; **24** arm pin; **25** bucket pin; **30** revolution apparatus; **31** revolution frame; **32** lower frame; **32***f* front end portion; **32***r* rear end portion; **33** bottom plate; **34** left rising portion; **34***p* outer plate portion; **34***q* inner plate portion; **35** right rising portion; **36**, **37** vertical plate; **38**, **39** pin insertion hole; **41**, **42** protruding portion; **43**, **54** opening portion; **45**, **55** recess portion; **46** side surface; **46**L left side surface; **46**R right side surface; **51** counterweight; **52** rear surface; **53** dished portion; **93**, **94**, **113**, **114** bent portion; **56** casing body; **61** first radar; **61**L first left radar; **61**R first right radar; **62** second radar; **63** third radar; **71** first camera; **72** second camera; **73** third camera; **74** fourth camera; **81**, **82** lid portion; **88**, **89** bolt insertion hole; **90**, **110** attachment member; **91**, **111** radar attachment plate; **92**, **112** flat plate portion; **96**, **97**, **116**, **117** radar attachment angle; **98**, **118** long hole; **99** round hole; **100** hydraulic excavator; **101**, **102**, **121**, **122** bolt; **210** revolution center axis; **220** pivot center axis; **230** centerline; **240**, **240**A, **240**B, **240**C, **240**D first left radar detection area; **241**, **242**, **251**, **252**, **261**, **262**, **271**, **272** bisector; **250** first right radar detection area; **260** second radar detection area; **270** third radar detection area; **310** shooting area; **320** stop control area; **330** detection area

1. A work vehicle comprising:

a traveling apparatus;

a revolution frame mounted on the traveling apparatus and including a lower frame; and

a first obstacle detection sensor arranged on a side surface of the lower frame, the side surface of the lower frame extending in a fore/aft direction and being arranged on left and right, the first obstacle detection sensor being provided at a position closer to a rear end portion of the lower frame.

2. The work vehicle according to claim 1, wherein
the first obstacle detection sensor includes
a first obstacle detection right sensor arranged on a right side surface of the lower frame, and
a first obstacle detection left sensor arranged on a left side surface of the lower frame.

3. The work vehicle according to claim 1, wherein
a distance between the first obstacle detection sensor and the rear end portion of the lower frame in the fore/aft direction is shorter than a distance between a revolution center axis of the revolution frame and the first obstacle detection sensor in the fore/aft direction.

4. The work vehicle according to claim 1, wherein
the lower frame is provided with a recess portion in a recessed shape in the side surface of the lower frame arranged on the left and the right, and
the first obstacle detection sensor is accommodated in the recess portion.

5. The work vehicle according to claim 1, wherein
the first obstacle detection sensor is a radar,
the radar emits radio waves to an area at an angle α in a vertical plane, and
the radar is provided such that a bisector of the area that bisects the angle α extends from the radar in a horizontal direction or a diagonally downward direction.

6. The work vehicle according to claim 5, further comprising an attachment member for attachment of the radar to the lower frame, wherein
the radar emits radio waves to the area at the angle α in the vertical plane, and
the attachment member is provided with an attitude adjustment mechanism that changes an attitude of attachment of the radar to the lower frame such that a direction of extension of the bisector of the area that bisects the angle α changes.

7. The work vehicle according to claim 5, wherein
a range of emission of the radio waves from the radar in revolution of the revolution frame is distant from the traveling apparatus.

8. The work vehicle according to claim 1, further comprising:
a counterweight provided at a rear end portion of the revolution frame; and
a second obstacle detection sensor arranged on a rear surface of the counterweight.

9. The work vehicle according to claim 1, further comprising:
a cab provided on the lower frame and provided at a position shifted toward any one of the left and the right with respect to a centerline of the lower frame that extends in the fore/aft direction; and
a third obstacle detection sensor arranged on a side surface of the lower frame arranged on any the other of the left and the right and provided at a position closer to a front end portion of the lower frame.

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