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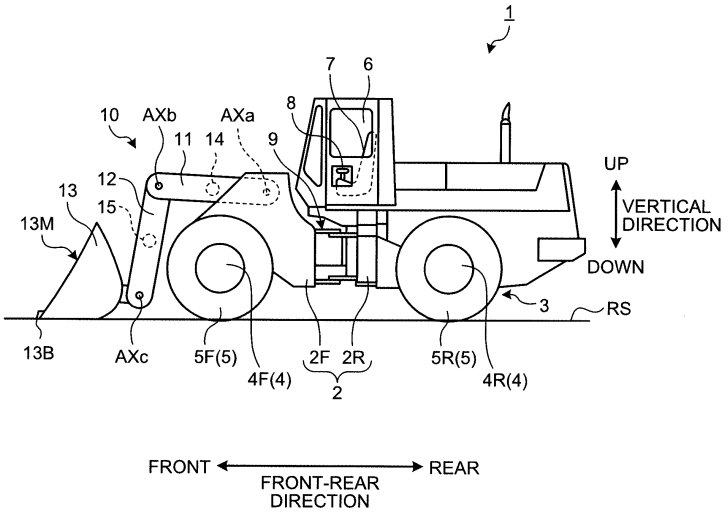
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(54) **WORK MACHINE**

(57) A work machine includes a vehicle body supported by wheels, a boom drivable with respect to the vehicle body, an arm drivable with respect to the boom, a bucket including an opening and drivable with respect to the arm in a manner such that the opening faces forward, a boom actuator that drives the boom, an arm actuator that drives the arm, and a bucket actuator that drives the bucket.

FIG.1



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Description

Field

[0001] The present invention relates to a work machine.

Background

[0002] A wheel loader is known as one of work machines. The wheel loader includes a boom and a bucket. The wheel loader excavates an excavation target with a bucket, and loads an excavated object on the bed of a transport vehicle.

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2007-186929 A

Summary

Technical Problem

[0004] When excavating an excavation target with a bucket, a wheel loader moves forward toward the excavation target with the bucket close to the ground, and inserts the bucket near a boundary between the ground and the excavation target. When loading an excavated object scooped by the bucket onto the bed of a transport vehicle, the wheel loader moves backward to be separated from the excavation target and, then, raises the boom while moving forward toward the transport vehicle. After positioning the bucket at a position higher than the bed by raising the boom, the wheel loader causes the bucket to perform a dumping operation to discharge the excavated object from the bucket to the bed. In this manner, the bucket is positioned at a low position near the ground in excavation work for excavating an excavation target, and the bucket is positioned at a position higher than the bed in loading work for loading an excavated object on the bed. Thus, the wheel loader needs to greatly move the bucket in the vertical direction between the excavation work and the loading work. If the bucket needs to be greatly moved in the vertical direction, this requires a large power, and the fuel consumption of the wheel loader can increase. In addition, if the bucket needs to be greatly moved in the vertical direction while the wheel loader is moving forward or backward, the moving distance and the moving time of the bucket become longer, and the working time of the wheel loader becomes longer.

[0005] An aspect of the present invention is to reduce fuel consumption and to shorten working time.

Solution to Problem

[0006] According to an aspect of the present invention, a work machine comprises: a vehicle body supported by wheels; a boom drivable with respect to the vehicle body; an arm drivable with respect to the boom; a bucket including an opening and drivable with respect to the arm in a manner such that the opening faces forward; a boom actuator configured to drive the boom; an arm actuator configured to drive the arm; and a bucket actuator configured to drive the bucket.

Advantageous Effects of Invention

[0007] According to an aspect of the present invention, it is possible to reduce fuel consumption and to shorten working time.

Brief Description of Drawings

[0008]

FIG. 1 is a side view schematically illustrating a work machine according to an embodiment.
FIG. 2 is a plan view schematically illustrating the work machine according to the embodiment.
FIG. 3 is a diagram schematically illustrating the work machine according to the embodiment.
FIG. 4 is a diagram schematically illustrating a part of the work machine according to the embodiment.
FIG. 5 is a diagram schematically illustrating a part of the work machine according to the embodiment.
FIG. 6 is a diagram schematically illustrating an operation of the work machine according to the embodiment.
FIG. 7 is a diagram schematically illustrating excavation work of the work machine according to the embodiment.
FIG. 8 is a diagram schematically illustrating loading work of the work machine according to the embodiment. Description of Embodiment

[0009] Hereinafter, an embodiment of the present invention is described with reference to the drawings, but the present invention is not limited thereto. The constituent elements of the embodiment described below can be appropriately combined. In addition, some constituent elements cannot be used.

[Work machine]

[0010] FIG. 1 is a side view schematically illustrating a work machine 1 according to an embodiment. FIG. 2 is a plan view schematically illustrating the work machine 1 according to the embodiment. In the present embodiment, the work machine 1 is a wheel loader. The work machine 1 loads an excavated object scooped by a bucket 13 on the bed of a transport vehicle.

[0011] As illustrated in FIGS. 1 and 2, the work machine 1 includes a vehicle body 2 supported by wheels 4, a traveling device 3 that supports the vehicle body 2 and

travels, and a working equipment 10 supported by the vehicle body 2.

[0012] The vehicle body 2 includes a front vehicle body 2F, a rear vehicle body 2R, and a joint mechanism 9 that couples the front vehicle body 2F and the rear vehicle body 2R so as to be bendable. The rear vehicle body 2R is provided with a cab 6. The cab 6 is provided with an operation seat 7 and an operation device 8. The operator of the work machine 1 operates the operation device 8 while sitting on the operation seat 7. Note that, one or both of the operation seat 7 and the operation device 8 may not be provided in the cab 6.

[0013] The traveling device 3 supports the vehicle body 2. The traveling device 3 includes the joint mechanism 9 and the wheels 4. The joint mechanism 9 includes a steering cylinder. One end of the joint mechanism 9 is coupled to the front vehicle body 2F, and the other end of the joint mechanism 9 is coupled to the rear vehicle body 2R. The steering cylinder extends and retracts, and the vehicle body 2 thereby bends. The vehicle body 2 bends, and the work machine 1 thereby swings. The wheels 4 are rotated by power generated by an engine (not illustrated) mounted on the vehicle body 2. The wheels 4 include two front wheels 4F supporting the front vehicle body 2F and two rear wheels 4R supporting the rear vehicle body 2R. The wheels 4 are mounted with tires 5. The tires 5 include front tires 5F mounted on the front wheels 4F and rear tires 5R mounted on the rear wheels 4R. The wheels 4 rotate, and the work machine 1 thereby travels on a ground RS.

[0014] In the following description, positional relationships of the elements are described using the terms "vertical direction", "front-rear direction", and "vehicle width direction". The vertical direction means a direction orthogonal to the ground contact surface of the tires 5 in contact with the ground RS. The front-rear direction means a direction orthogonal to the rotation axis of the wheels 4 and the vertical direction. The vehicle width direction means a direction parallel to the rotation axis of the wheels 4. The vehicle width direction indicates the width direction of the vehicle body 2, and has the same meaning as the left-right direction.

[0015] The term "upward" means a direction to be separated from the ground contact surface of the tires 5 in the vertical direction, and the term "downward" means a direction opposite to the term "upward" in the vertical direction. The term "forward" means a direction from the wheels 4 toward the working equipment 10, and the term "backward" means a direction opposite to the term "forward" in the front-rear direction. The term "leftward" means a direction toward the left side of the operator sitting on the operation seat 7 facing forward, and the term "rightward" means a direction opposite to the term "leftward" in the left-right direction.

[0016] The operation device 8 includes an accelerator pedal, a brake pedal, a steering lever or a steering wheel, a forward/backward changeover switch, and a working-equipment operation lever, which are not illustrated.

[0017] The operator can operate the accelerator pedal, the brake pedal, the steering lever, and the forward/reverse changeover switch of the operation device 8 to switch driving, braking, swinging, and moving forward/backward of the traveling device 3. The accelerator pedal and the brake pedal of the operation device 8 are operated, and the traveling device 3 thereby performs driving, braking, and adjusting the traveling speed. The steering lever or the steering wheel of the operation device 8 is operated, and the work machine 1 thereby swings. The forward/backward switchover lever is operated, and the work machine 1 thereby switches moving forward and backward.

[0018] The working equipment 10 is supported by the vehicle body 2. The working equipment 10 includes a boom 11 coupled to the vehicle body 2, an arm 12 coupled to the boom 11, and a bucket 13 including an opening 13M and coupled to the arm 12 so that the opening 13M faces forward.

[0019] The boom 11 is rotatably coupled to the front vehicle body 2F and is drivable with respect to the front vehicle body 2F. The boom 11 is rotatable about a boom rotation axis AXa. The boom rotation axis AXa extends in the vehicle width direction. The boom 11 includes a base end and a distal end. The base end of the boom 11 is coupled to the front vehicle body 2F. The arm 12 is coupled to the distal end of the boom 11.

[0020] The arm 12 is rotatably coupled to the boom 11 and is drivable with respect to the boom 11. The arm 12 is rotatable about an arm rotation axis AXb. The arm rotation axis AXb is parallel to the boom rotation axis AXa. The arm 12 includes a base end and a distal end. The base end of the arm 12 is coupled to the distal end of the boom 11. The bucket 13 is coupled to the distal end of the arm 12.

[0021] The bucket 13 is rotatably coupled to the arm 12 and is drivable with respect to the arm 12. The bucket 13 is rotatable about a bucket rotation axis AXc. The bucket rotation axis AXc is parallel to the boom rotation axis AXa and the arm rotation axis AXb. The bucket 13 includes the opening 13M and a distal end 13B including a cutting edge. The bucket 13 scoops an excavated object. The work machine 1 discharges the excavated object scooped by the bucket 13 to the bed of a transport vehicle. The excavated object discharged from the bucket 13 is loaded on the bed.

[0022] The bucket 13 is coupled to the arm 12 so that the opening 13M faces forward. While the boom 11 and the arm 12 are lowered and the bucket 13 is in contact with the ground RS, the opening 13M of the bucket 13 faces forward. The excavated object comes inside the bucket 13 through the opening 13M and is held in the bucket 13. The excavated object held in the bucket 13 is discharged from the bucket 13 through the opening 13M. The working equipment 10 is a front-loading working equipment.

[0023] As illustrated in FIG. 2, the boom 11 includes a first boom 11A disposed on the left side with respect to

the center of the vehicle body 2 in the vehicle width direction, and a second boom 11B disposed on the right side. The arm 12 includes a first arm 12A disposed on the left side with respect to the center of the vehicle body 2 in the vehicle width direction, and a second arm 12B disposed on the right side. The first arm 12A is coupled to the first boom 11A. Second arm 12B is coupled to second boom 11B. The first boom 11A and the second boom 11B are coupled via a boom coupling member 14. The boom coupling member 14 couples the center portion of the first boom 11A in the longitudinal direction and the center portion of the second boom 11B in the longitudinal direction. The first arm 12A and the second arm 12B are coupled via an arm coupling member 15. The arm coupling member 15 couples the center portion of the first arm 12A in the longitudinal direction and the center portion of the second arm 12B in the longitudinal direction.

[0024] Each of the first boom 11A and the second boom 11B is rotatable about the boom rotation axis AXa. Each of the first arm 12A and the second arm 12B is rotatable about the arm rotation axis AXb.

[0025] In the vehicle width direction of the vehicle body 2, the size of the bucket 13 is larger than the size of the vehicle body 2. In the vehicle width direction, the center of the vehicle body 2 and the center of the bucket 13 are aligned. In the vehicle width direction, the operation seat 7 disposed in the cab 6 is disposed between the first boom 11A and the second boom 11B and between the first arm 12A and the second arm 12B.

[0026] FIG. 3 is a diagram schematically illustrating the work machine 1 according to the present embodiment. As illustrated in FIG. 3, the work machine 1 includes a boom cylinder 21, an arm cylinder 22, and a bucket cylinder 23. The boom cylinder 21 is a boom actuator that drives the boom 11. The arm cylinder 22 is an arm actuator that drives the arm 12. The bucket cylinder 23 is a bucket actuator that drives the bucket 13 Each of the boom cylinder 21, the arm cylinder 22, and the bucket cylinder 23 is a hydraulic cylinder that generates power from hydraulic oil supplied from a hydraulic pump mounted on the vehicle body 2. The hydraulic pump is driven by power generated by the engine mounted on the vehicle body 2. The engine is a diesel engine and is driven by being supplied with fuel. The drive source of the hydraulic pump may not be the engine, and may be an electric drive source including a power storage unit and a motor. As the drive source of the hydraulic pump, both an engine and an electric drive source may be used.

[0027] The boom cylinder 21 generates power for driving the boom 11. One end of the boom cylinder 21 is coupled to the front vehicle body 2F. The other end of the boom cylinder 21 is coupled to the boom 11. The boom cylinder 21 extends and retracts, and the boom 11 thereby rotates about the boom rotation axis AXa. When the boom cylinder 21 extends, the boom 11 is raised, and when the boom cylinder 21 retracts, the boom 11 is lowered.

[0028] The arm cylinder 22 generates power for driving the arm 12. One end of the arm cylinder 22 is coupled to the boom 11. The other end of the arm cylinder 22 is coupled to the arm 12. The arm cylinder 22 extends and retracts, and the arm 12 thereby rotates about the arm rotation axis AXb. When the arm cylinder 22 extends, the arm 12 is raised, and when the arm cylinder 22 retracts, the arm 12 is lowered.

[0029] The bucket cylinder 23 generates power for driving the bucket 13. One end of the bucket cylinder 23 is coupled to the arm 12. The other end of the bucket cylinder 23 is coupled to the bucket 13. The bucket cylinder 23 extends and retracts, and the bucket 13 thereby rotates about the bucket rotation axis AXc. When the bucket cylinder 23 extends, the bucket 13 performs a dumping operation, and when the bucket cylinder 23 retracts, the bucket 13 performs a tilt operation.

[0030] The dumping operation of the bucket 13 means that the bucket 13 rotates so that the opening 13M of the bucket 13 faces downward and the distal end 13B approaches the ground. The tilt operation of the bucket 13 means that the bucket 13 rotates so that the opening 13M faces upward and the distal end 13B moves to be separated from the ground. The bucket 13 performs the dumping operation, and the excavated object held in the bucket 13 is thereby discharged from the bucket 13. The bucket 13 performs the tilt operation, and the bucket 13 thereby scoops the excavated object.

[0031] Note that, one or both of the arm cylinder 22 and the bucket cylinder 23 may be drivable with respect to the vehicle body 2.

[0032] The operator can operate the working-equipment operation lever of the operation device 8 to operate the boom cylinder 21, the arm cylinder 22, and the bucket cylinder 23.

[0033] FIG. 4 is a diagram schematically illustrating a part of the working equipment 10 according to the present embodiment. FIG. 4 illustrates a coupling mechanism 30 that couples the arm 12, the bucket 13, and the bucket cylinder 23 The coupling mechanism 30 includes a four-joint link mechanism in which four rotation axes (joints) are formed in an annular shape. The coupling mechanism 30 includes a bucket pin 33A including a first rotation axis, a first link pin 33B including a second rotation axis, a second link pin 33C including a third rotation axis, and a bucket-cylinder top pin 33D including a fourth rotation axis. The first to fourth rotation axes correspond to the four rotation axes. Each of the four rotation axes of the coupling mechanism 30 extends in the vehicle width direction. The arm 12, the bucket 13, and the bucket cylinder 23 are coupled via the four-joint link mechanism.

[0034] A bracket 34 is fixed to the rear of the bucket 13. The distal end of the arm 12 and the bracket 34 are coupled by the bucket pin 33A. The bucket pin 33A includes the bucket rotation axis AXc.

[0035] The coupling mechanism 30 includes a link member 31 rotatably coupled to the arm 12 via the first link pin 33B. The base end of the link member 31 is cou-

pled to the arm 12 via the first link pin 33B. The distal end of the link member 31 is coupled to the bucket cylinder 23 via the second link pin 33C. The distal end of the bucket cylinder 23 is coupled to the bracket 34 via the bucket-cylinder top pin 33D.

[0036] The bucket cylinder 23 extends and retracts, and the bracket 34 and the bucket 13 thereby rotate about the bucket rotation axis AXc.

[0037] FIG. 5 is a diagram schematically illustrating a part of the working equipment 10 according to the present embodiment, and illustrates a coupling mechanism 30 according to another embodiment. In the example illustrated in FIG. 5, the coupling mechanism 30 includes a bucket pin 33E including a first rotation axis, a first link pin 33F including a second rotation axis, a second link pin 33G including a third rotation axis, and a third link pin 33H including a fourth rotation axis.

[0038] The coupling mechanism 30 further includes a link member 31 rotatably coupled to the arm 12 via the first link pin 33F, and a link member 32 coupled to the distal end of the link member 31 via the second link pin 33G and coupled to the bracket 34 via the third link pin 33H. The distal end of the bucket cylinder 23 is coupled to the bucket pin 33E or the bucket 13 near the bucket pin 33E. A middle portion of the link member 31 is coupled to the bucket cylinder 23 via the link pin 33I. In the example illustrated in FIG. 5, when the bucket cylinder 23 extends and retracts, the bracket 34 and the bucket 13 rotate about the bucket rotation axis AXc, similarly.

[Operation]

[0039] Next, operations of the work machine 1 according to the present embodiment are described. The work machine 1 performs excavation work for excavating an excavation target DS with the bucket 13 and loading work for loading the excavated object scooped by the bucket 13 in the excavation work onto the bed BE of a transport vehicle LS. The excavation target DS is, for example, natural ground. The excavated object is, for example, earth and sand. The transport vehicle LS is, for example, a dump truck.

[0040] The operation modes of the work machine 1 include "V shape", "excavation without movement", and "scooping excavation".

[0041] The "V shape" means that the bucket 13 is moved in the vertical direction while the work machine 1 is moved forward or backward to perform the excavation work and the loading work. That is, the "V shape" means to perform the excavation work and the loading work with the wheels 4 rotated.

[0042] The "Excavation without movement" means that the bucket 13 is moved in the vertical direction without moving the traveling device 3 of the work machine 1 to perform the excavation work and the loading work. That is, the "excavation without movement" means to perform the excavation work and the loading work without rotating the wheels 4.

[0043] The "scooping excavation" means that the bucket 13 is inserted into the excavation target DS with the distal end 13B of the bucket 13 close to the ground RS, and, then, the boom 11 and the arm 12 are raised to scoop the excavation target DS with the bucket 13.

[0044] FIG. 6 is a diagram schematically illustrating an operation of the work machine 1 according to the present embodiment, and illustrating the "V shape". When excavating the excavation target DS in the "V shape" operation mode, the work machine 1 moves forward toward the excavation target DS as indicated by an arrow M1 in FIG. 6. The work machine 1 excavates the excavation target DS with the bucket 13.

[0045] After the excavation target DS is excavated by the bucket 13 and the bucket 13 scoops the excavated object, the work machine 1 moves backward to be separated from the excavation target DS as indicated by an arrow M2 in FIG. 6.

[0046] When loading the excavated object scooped by the bucket 13 onto the transport vehicle, the work machine 1 moves forward toward the transport vehicle LS while swinging as illustrated by an arrow M3 in FIG. 6. The work machine 1 raises the bucket 13 while moving forward toward the transport vehicle LS. The work machine 1 raises at least one of the boom 11 and the arm 12 while moving forward toward the transport vehicle LS. By raising at least one of the boom 11 and the arm 12, the bucket 13 is positioned at a position higher than the bed BE of the transport vehicle LS.

[0047] After positioning the bucket 13 at the position higher than the bed BE of the transport vehicle LS by raising at least one of the boom 11 and the arm 12, the work machine 1 causes the bucket 13 to perform the dumping operation to discharge the excavated object from the bucket 13 to the bed BE. The excavated object is thereby loaded on the bed BE.

[0048] After discharging the excavated object from the bucket 13, the work machine 1 moves backward to be separated from the transport vehicle LS as indicated by an arrow M4 in FIG. 6. After moving backward, the work machine 1 moves forward toward the excavation target DS as indicated by the arrow M1 in FIG. 6. The work machine 1 repeats the above operations until the bed BE is filled with excavated objects. The above series of operations is called the "V shape".

[0049] FIG. 7 is a diagram schematically illustrating the excavation work of the work machine 1 according to the present embodiment, and illustrating the excavation work in the "V shape". When excavating the excavation target DS with the bucket 13 in the "V shape" operation mode, the work machine 1 moves forward toward the excavation target DS while appropriately including a bending operation of the vehicle body 2 according to the operation of the steering cylinder. The work machine 1 can move forward toward the excavation target DS with the bucket 13 separated from the ground RS. In the example illustrated in FIG. 7, the work machine 1 moves forward toward the excavation target DS with the bucket 13 positioned at a

position separated upward from the ground RS by a distance Ha. In the "V shape" operation mode, the work machine 1 raises at least one of the boom 11 and the arm 12 while moving forward toward the excavation target CS, and causes the bucket 13 to perform the tilt operation in parallel to the raising operation of at least one of the boom 11 and the arm 12. The work machine 1 can insert the bucket 13 into a part PH on the slope of the excavation target DS that is separated upward from the ground RS by the distance Ha. The distance Ha may be, for example, longer than the distance between the ground contact surface of the tires 5 and the rotation axis of the wheels 4. The distance Ha may be, for example, longer than the diameter of the tires 5.

[0050] FIG. 8 is a diagram schematically illustrating the loading work of the work machine 1 according to the present embodiment, and illustrating the loading work in the "V shape". When loading the excavated object scooped by the bucket 13 onto the bed BE of the transport vehicle LS in the "V shape" operation mode, the work machine 1 raises at least one of the boom 11 and the arm 12 while moving forward toward the transport vehicle LS. After positioning the bucket 13 at a position higher than the bed BE by raising at least one of the boom 11 and the arm 12, the work machine 1 causes the bucket 13 to perform the dumping operation to discharge the excavated object from the bucket 13 to the bed BE. In the example illustrated in FIG. 8, the work machine 1 can raise the bucket 13 to a position separated upward from the ground RS by the sum of the distance Ha and a distance Hb to raise the bucket 13 above a vessel BE.

[0051] In this manner, the bucket 13 is positioned at a position separated from the ground RS by the distance Ha in the excavation work for excavating the excavation target DS, and the bucket 13 is positioned at a position higher than the bed BE in the loading work for loading the excavated object onto the bed BE. In the present embodiment, the work machine 1 is only required to move the bucket 13 in the vertical direction by the distance Hb between the excavation work and the loading work. Since the bucket 13 does not need to be greatly moved in the vertical direction, the engine and the hydraulic pump mounted on the work machine 1 do not need to output excessive power. Thus, the fuel consumption of the engine of the work machine 1 is reduced. In addition, since the bucket 13 does not need to be greatly moved in the vertical direction, the moving distance and the moving time of the bucket 13 in the vertical direction are shortened. Thus, the working time of the work machine 1 is prevented from becoming longer. In addition, as indicated by the arrows M1, M2, M3, and M4 in FIG. 6, the moving distance when the work machine 1 moves on the ground RS in the excavation work and the loading work is shortened. The work machine 1 can perform the excavation work and the loading work while repeating moving forward and backward in a small area of the ground RS.

[0052] The excavation work and loading work of the "V shape" have been described with reference to FIGS. 7 and 8. In the excavation work of the "excavation without movement", the work machine 1 positions the bucket 13 at a position separated from the ground RS by the distance Ha without rotating the wheels 4. In the loading work of the "excavation without movement", the work machine 1 positions the bucket 13 at a position higher than the bed BE without rotating the wheels 4. With these operations, in the "movement without movement", the fuel consumption of the engine of the work machine 1 is also reduced, and the moving distance and the moving time of the bucket 13 in the vertical direction are shortened.

[0053] In the "scooping excavation", as illustrated by the dotted line in FIG. 7, the work machine 1 lowers the boom 11 and the arm 12 and inserts the bucket 13 into the excavation target DS with the distal end 13B of the bucket 13 close to the ground RS, and, then, raises the boom 11 and the arm 12 to raise the bucket 13 above the work machine 1. With this operation, the excavation target DS is scooped by the bucket 13.

[Effects]

[0054] As described above, since the working equipment 10 includes the boom 11, the arm 12, and the bucket 13 according to the present embodiment, the work machine 1 can excavate the excavation target DS while the bucket 13 is separated from the ground RS in the excavation work. Thus, the work machine 1 is only required to raise the bucket 13 by the distance Hb in the loading work. Since the work machine 1 does not need to greatly move the bucket 13 in the vertical direction between the excavation work and the loading work, the fuel consumption of the work machine 1 is reduced, and the working time of the work machine 1 is shortened.

[0055] Since an existing wheel loader does not have an arm, when excavating an excavation target with the bucket, the wheel loader is required to move forward toward the excavation target DS with the bucket close to the ground RS, and insert the bucket 13 near a boundary PL (see FIG. 7) between the ground RS and the excavation target DS. In this case, when loading the excavated object scooped by the bucket onto the bed BE of the transport vehicle LS, the wheel loader is required to raise the boom by the sum of the distance Ha and the distance Hb. That is, the existing wheel loader is required to greatly move the bucket in the vertical direction between the excavation work and the loading work. If the bucket needs to be greatly moved in the vertical direction, this requires a large power, and the fuel consumption of the wheel loader can increase. In addition, if the bucket needs to be greatly moved in the vertical direction, the moving time of the bucket becomes longer, and the working time of the wheel loader can become longer.

[0056] According to the present embodiment, since the work machine 1 includes the arm 12, the work machine 1 can position the bucket 13 at a position separated upward from the ground RS by the distance Ha in the ex-

cavation work. Thus, the work machine 1 is only required to raise the bucket 13 by the distance Hb in the loading work, and does not need to greatly move the bucket 13 in the vertical direction. Accordingly, the fuel consumption of the work machine 1 can be reduced, and the working time can be shortened.

[0057] In the present embodiment, the work machine 1 is an articulated work machine in which the front vehicle body 2F and the rear vehicle body 2R are coupled via the joint mechanism 9. For this reason, the work machine 1 can perform the excavation work and the loading work while repeating moving forward and backward in a small area of the ground RS, as illustrated in FIG. 6.

[0058] In the present embodiment, the boom 11 includes the first boom 11A and the second boom 11B, and the arm 12 includes the first arm 12A and the second arm 12B. Thus, a space is formed between the first boom 11A and the second boom 11B and between the first arm 12A and the second arm 12B. For this reason, the operator sitting on the operation seat 7 can visually recognize the bucket 13, the excavation target DS, and the transport vehicle LS through the space. Accordingly, the operator can smoothly perform the excavation work and the loading work.

[0059] In the present embodiment, the size of the bucket 13 is larger than the size of the vehicle body 2 in the vehicle width direction. Accordingly, the bucket 13 can scoop a large amount of excavated object in one excavation work. Thus, the work efficiency of the work machine 1 is improved.

[Other embodiments]

[0060] In the above embodiment, the work machine 1 has been operated by the operator operating the operation device 8. The operator may not get on the work machine 1. The work machine 1 may be remotely operated, or may autonomously operate by a control device.

[0061] In the above embodiment, the boom actuator, the arm actuator, and the bucket actuator have been the boom cylinder 21, the arm cylinder 22, and the bucket cylinder 23 that are hydraulic cylinders, respectively. At least one of the boom actuator, the arm actuator, and the bucket actuator may not be a hydraulic cylinder, and may include a motor and a gear.

Reference Signs List

[0062]

1	Work machine
2	Vehicle body
2F	Front vehicle body
2R	Rear vehicle body
3	Traveling device
4	Wheel
4F	Front wheel
4R	Rear wheel
5	Tire
5F	Front tire
5R	Rear tire
6	Cab
7	Operation seat
8	Operation device
9	Joint mechanism
10	Working equipment
11	Boom
11A	First boom
11B	Second boom
12	Arm
12A	First arm
12B	Second arm
13	Bucket
13B	Distal end
13M	Opening
14	Boom coupling member
15	Arm coupling member
21	Boom cylinder
22	Arm cylinder
23	Bucket cylinder
30	Coupling mechanism
31	Link member
32	Link member
33A	Bucket pin
33B	First link pin
33C	Second link pin
33D	Bucket-cylinder top pin
33E	Bucket pin
33F	First link pin
33G	Second link pin
33H	Third link pin
331	Link pin
34	Bracket
AXa	Boom rotation axis
AXb	Arm rotation axis
AXc	Bucket rotation axis
BE	Bed
DS	Excavation target
LS	Transport vehicle
PH	Part
PL	Boundary
RS	Ground

Claims

1. A work machine comprising:

a vehicle body supported by wheels;
a boom drivable with respect to the vehicle body;
an arm drivable with respect to the boom;
a bucket including an opening and drivable with respect to the arm in a manner such that the opening faces forward;
a boom actuator configured to drive the boom;
an arm actuator configured to drive the arm; and

a bucket actuator configured to drive the bucket.

2. The work machine according to claim 1, wherein the wheels include:

a rear wheel; and
a front wheel, and
the vehicle body includes:

a rear vehicle body supported by the rear wheel; and
a front vehicle body coupled to the rear vehicle body via a joint mechanism and supported by the front wheel.

3. The work machine according to claim 1 or 2, wherein the bucket has a larger size than a size of the vehicle body in a vehicle width direction of the vehicle body.

4. The work machine according to claim 3, wherein the boom includes:

a first boom disposed on one side with respect to a center of the vehicle body in the vehicle width direction; and
a second boom disposed on the other side, and
the arm includes:

a first arm coupled to the first boom; and
a second arm coupled to the second boom.

5. The work machine according to any one of claims 1 to 4, wherein the arm, the bucket, and the bucket actuator are coupled via a four-joint link mechanism.

FIG.1

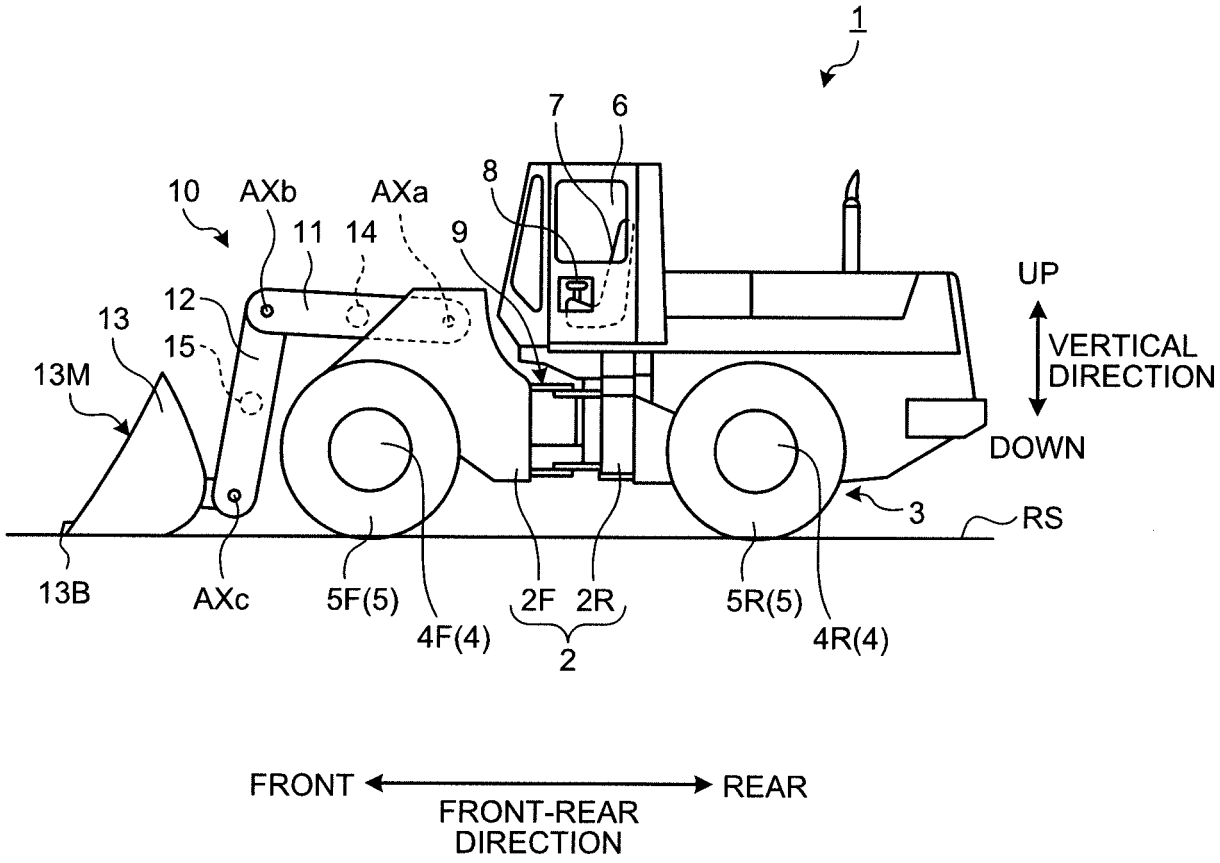

1
7
6
8
10
AXb
AXa
11
14
9
12
13
15
13M
UP
VERTICAL DIRECTION
DOWN
3
RS
13B
AXc
5F(5)
4F(4)
2F
2R
2
5R(5)
4R(4)
FRONT
REAR
FRONT-REAR DIRECTION

FIG.2

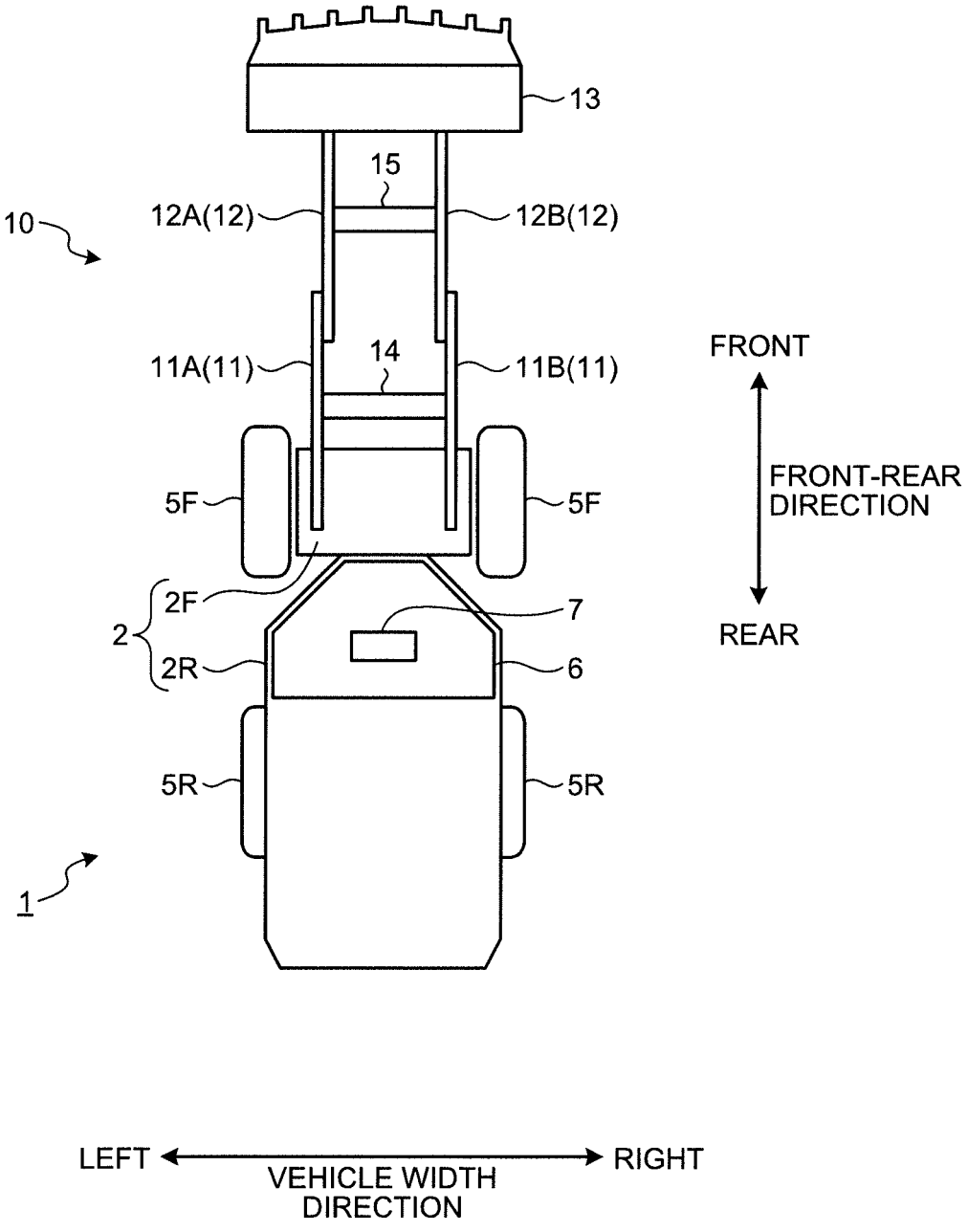

13
15
10
12A(12)
12B(12)
11A(11)
14
11B(11)
FRONT
FRONT-REAR DIRECTION
REAR
5F
5F
2F
2
2R
7
6
5R
5R
1
LEFT
RIGHT
VEHICLE WIDTH DIRECTION

FIG.3

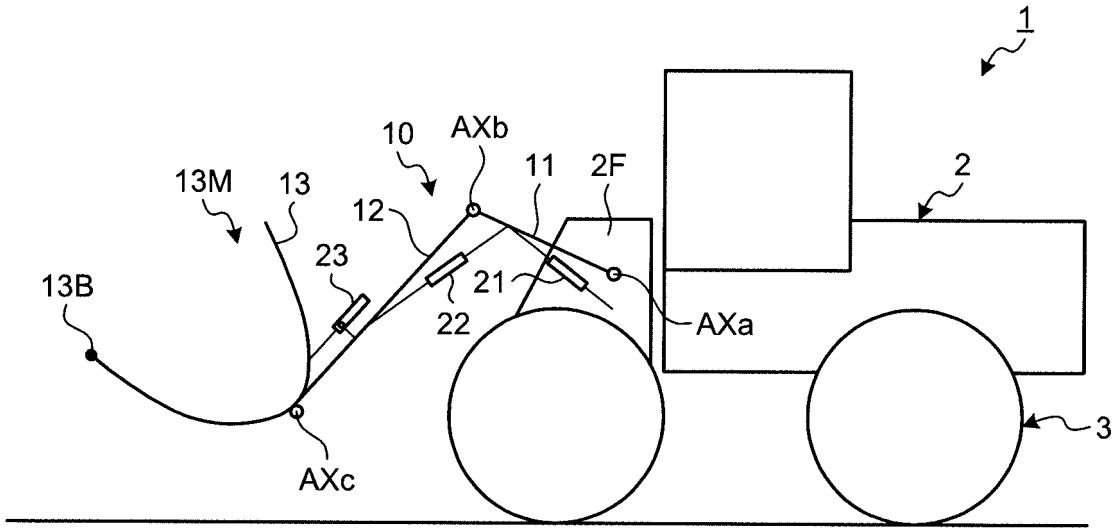

1
10
AXb
11
2F
2
13M
13
12
23
21
13B
22
AXa
3
AXc

FIG.4

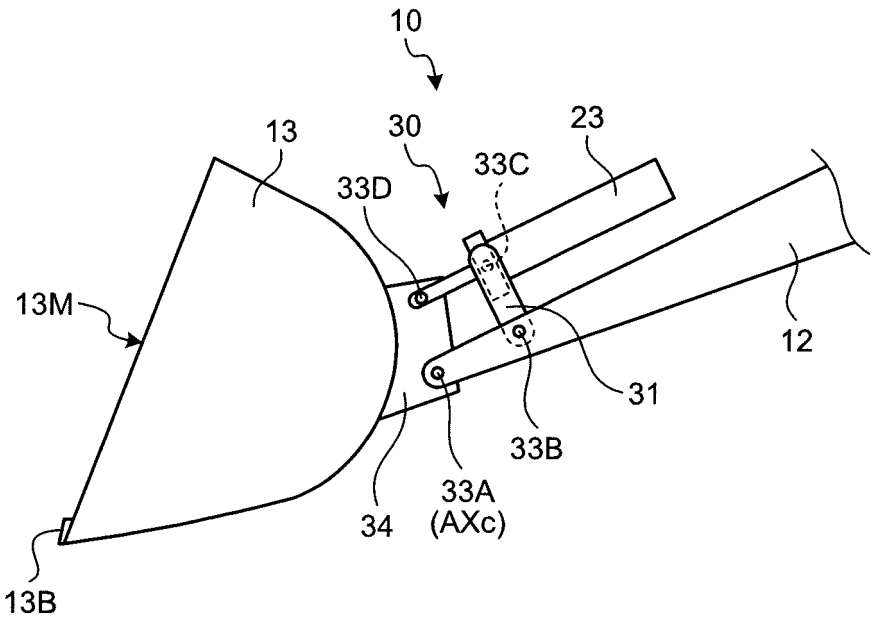

10
13
30
23
33C
33D
13M
12
31
33B
33A
(AXc)
34
13B

FIG.5

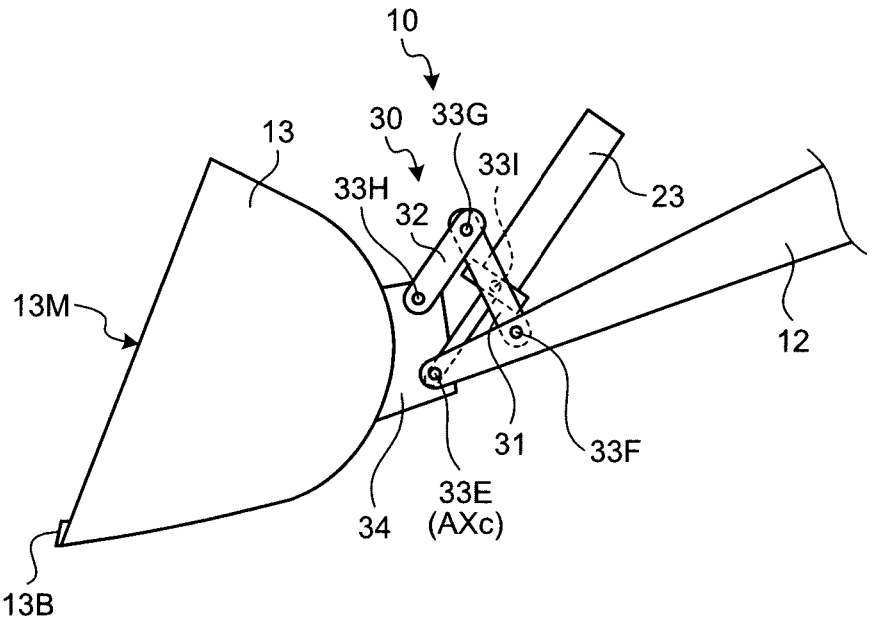


FIG.6

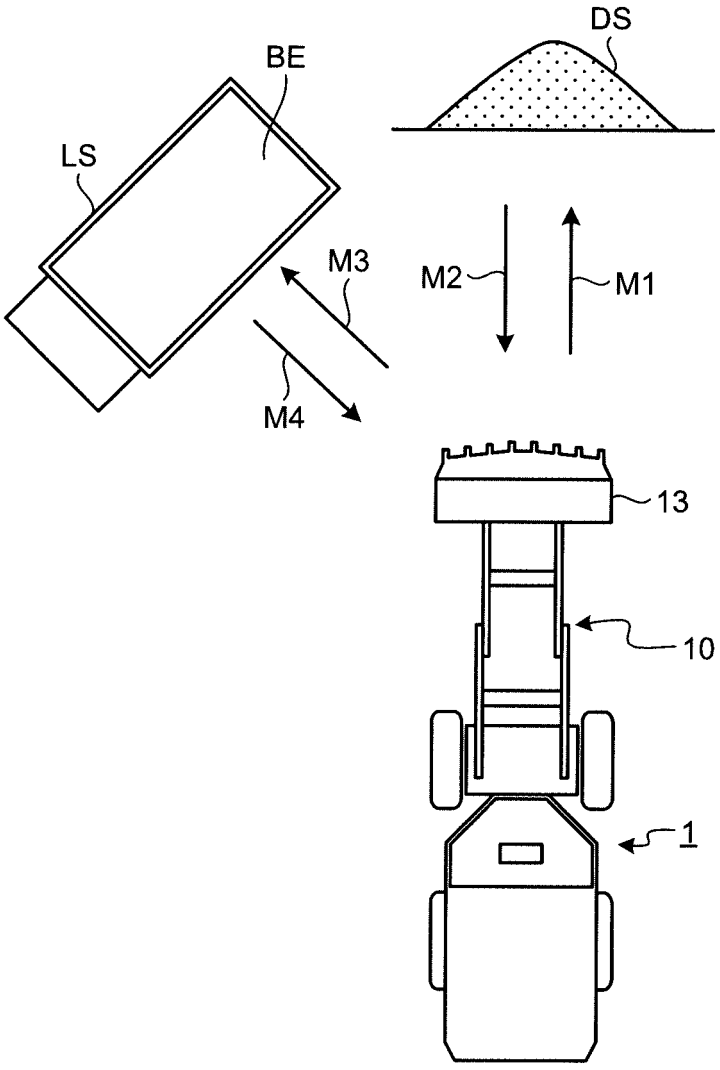


FIG.7

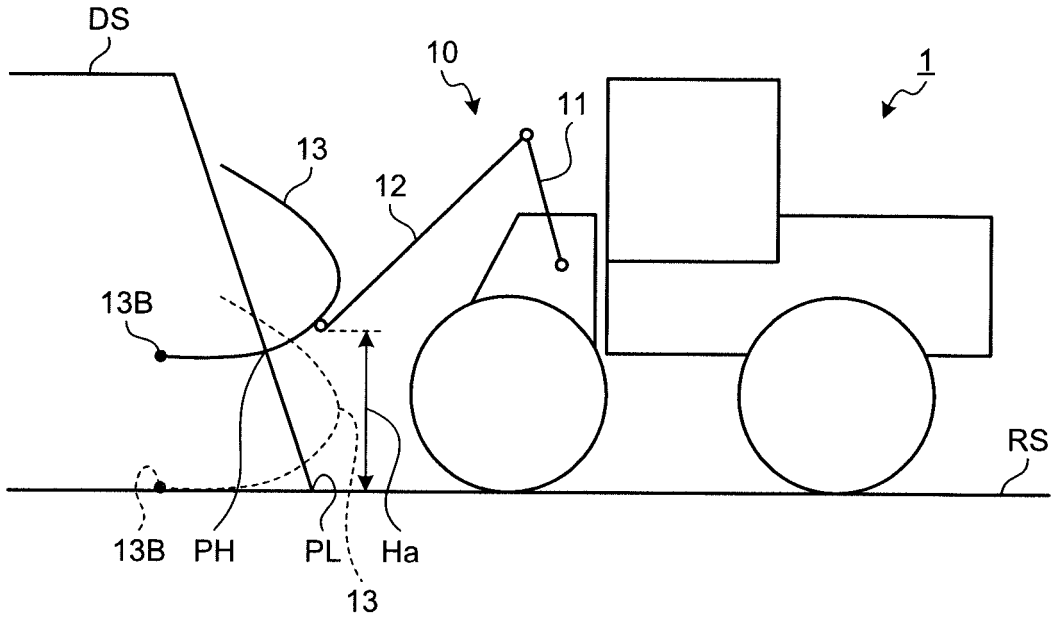
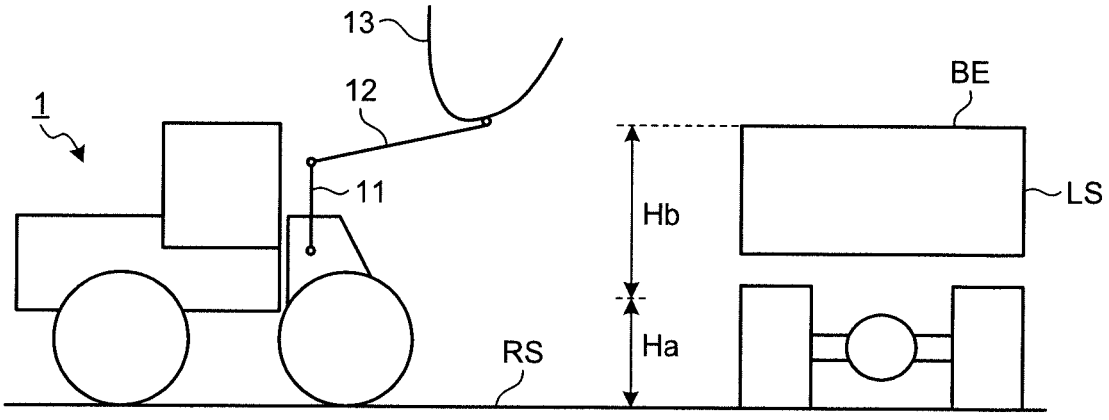


FIG.8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/003474

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. E02F3/34(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. E02F3/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2008-231671 A (CATERPILLAR JAPAN LTD.) 02 October 2008, paragraphs [0001]-[0006], [0011]-[0019], fig. 1, 2 (Family: none)	1-3 4-5
Y	JP 2007-262829 A (KUBOTA CORP.) 11 October 2007, paragraphs [0001], [0010], [0042]-[0051], fig. 1-3, 6 (Family: none)	4-5
Y	JP 2001-020310 A (TCM CORP.) 23 January 2001, paragraphs [0001], [0009]-[0025], fig. 1, 2 (Family: none)	4-5
A	JP 2016-516928 A (CATERPILLAR INC.) 09 June 2016, fig. 1 & US 2014/0317967 A1, fig. 1 & WO 2014/176039 A1	3-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17.04.2019	07.05.2019
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/003474

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10-121505 A (KOMATSU LTD.) 12 May 1998, fig. 6, 7 (Family: none)	4-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007186929 A **[0003]**