



US 20240376689A1

(19) **United States**

(12) **Patent Application Publication**  
**TSUJIMOTO**

(10) **Pub. No.: US 2024/0376689 A1**

(43) **Pub. Date: Nov. 14, 2024**

(54) **WORK MACHINE**

(52) **U.S. Cl.**

CPC ..... *E02F 9/18* (2013.01)

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(57)

**ABSTRACT**

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An attachment base (15) to which a counterweight (13) is attached is provided at a rear portion of an upper turning body (4), a boss hole (15a) is provided to penetrate through the attachment base (15), and a boss recessed portion (13a) is formed in a front surface of the counterweight (13). A boss member (18) is inserted into the boss recessed portion (13a) of the counterweight (13) via the boss hole (15a) in the attachment base from a front side, and a bolt (21) is caused to be screwed into the boss member (18) through the counterweight (13) from a rear side. An abutment surface (18c) of the boss member (18) is caused to abut a front surface of the attachment base (15) with a fastening force of the bolt (21) to thereby fasten the counterweight (13) to the attachment base (15) and cause the attachment base (15) to support a weight of the counterweight (13) via the boss member (18).

(21) Appl. No.: **18/689,461**

(22) PCT Filed: **Mar. 23, 2023**

(86) PCT No.: **PCT/JP2023/011401**

§ 371 (c)(1),

(2) Date: **Mar. 6, 2024**

(30) **Foreign Application Priority Data**

Mar. 23, 2022 (JP) ..... 2022-046570

**Publication Classification**

(51) **Int. Cl.**

*E02F 9/18*

(2006.01)

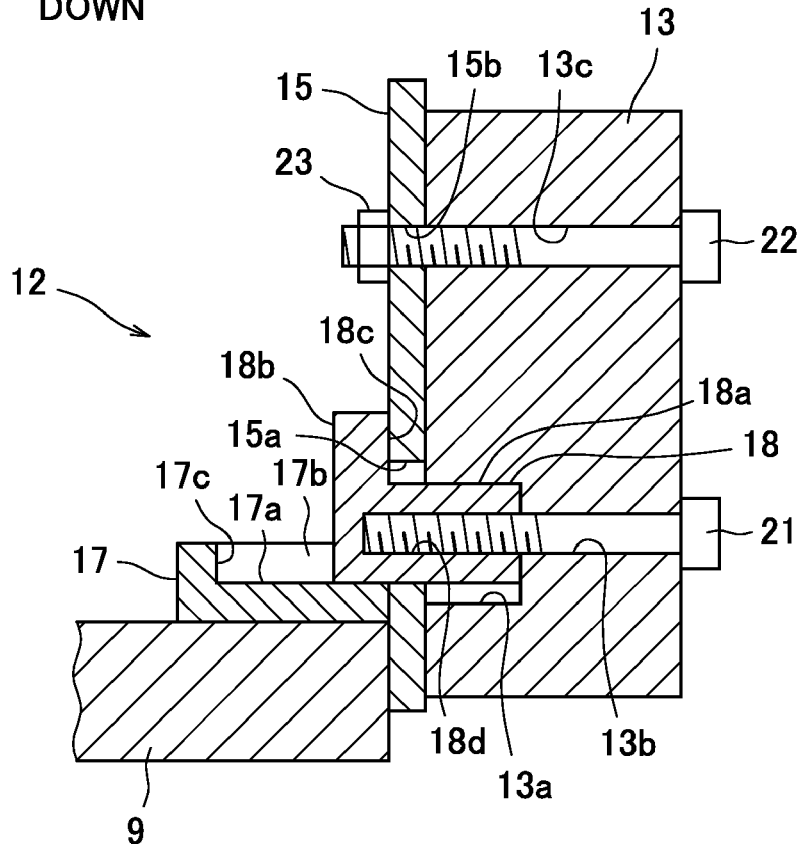
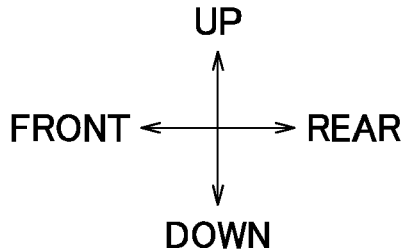


FIG. 1

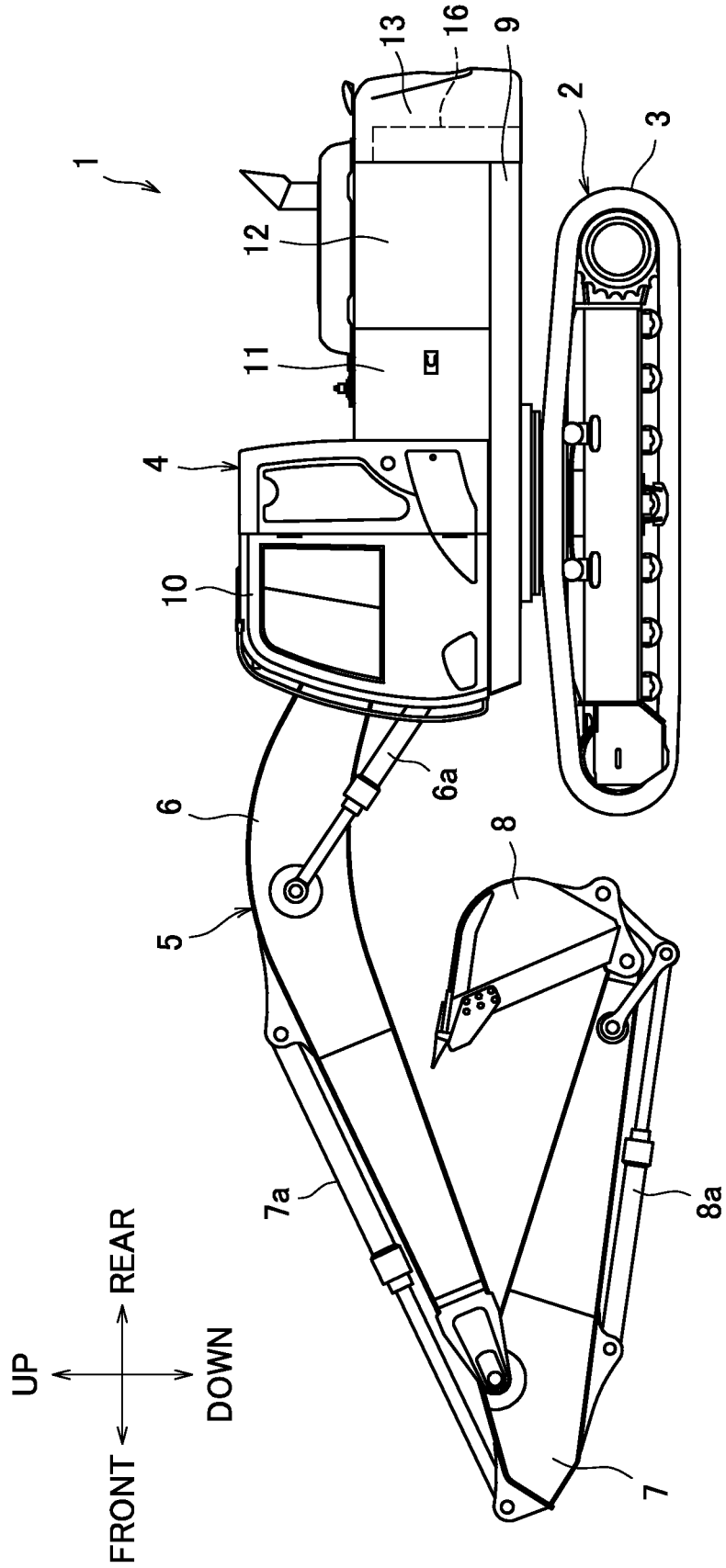


FIG. 2

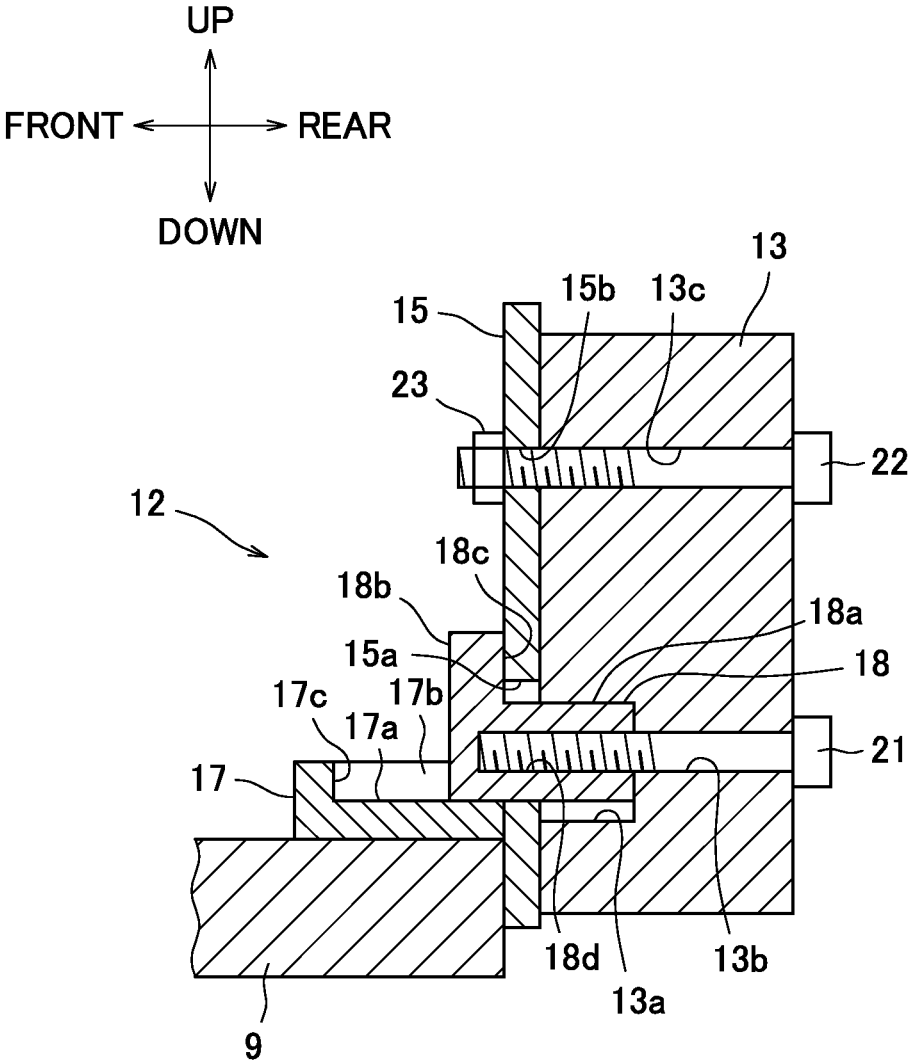


FIG. 3

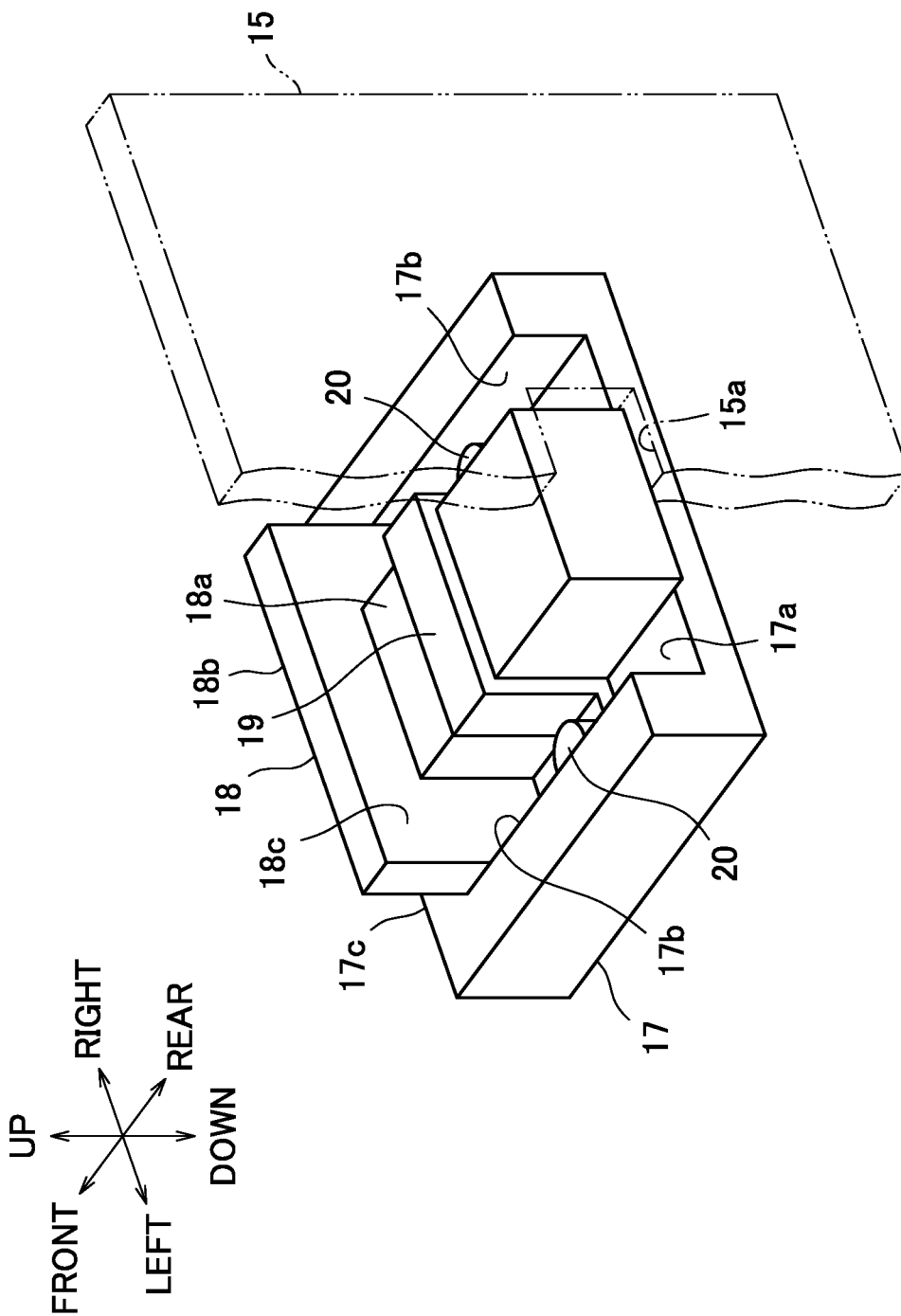


FIG. 4

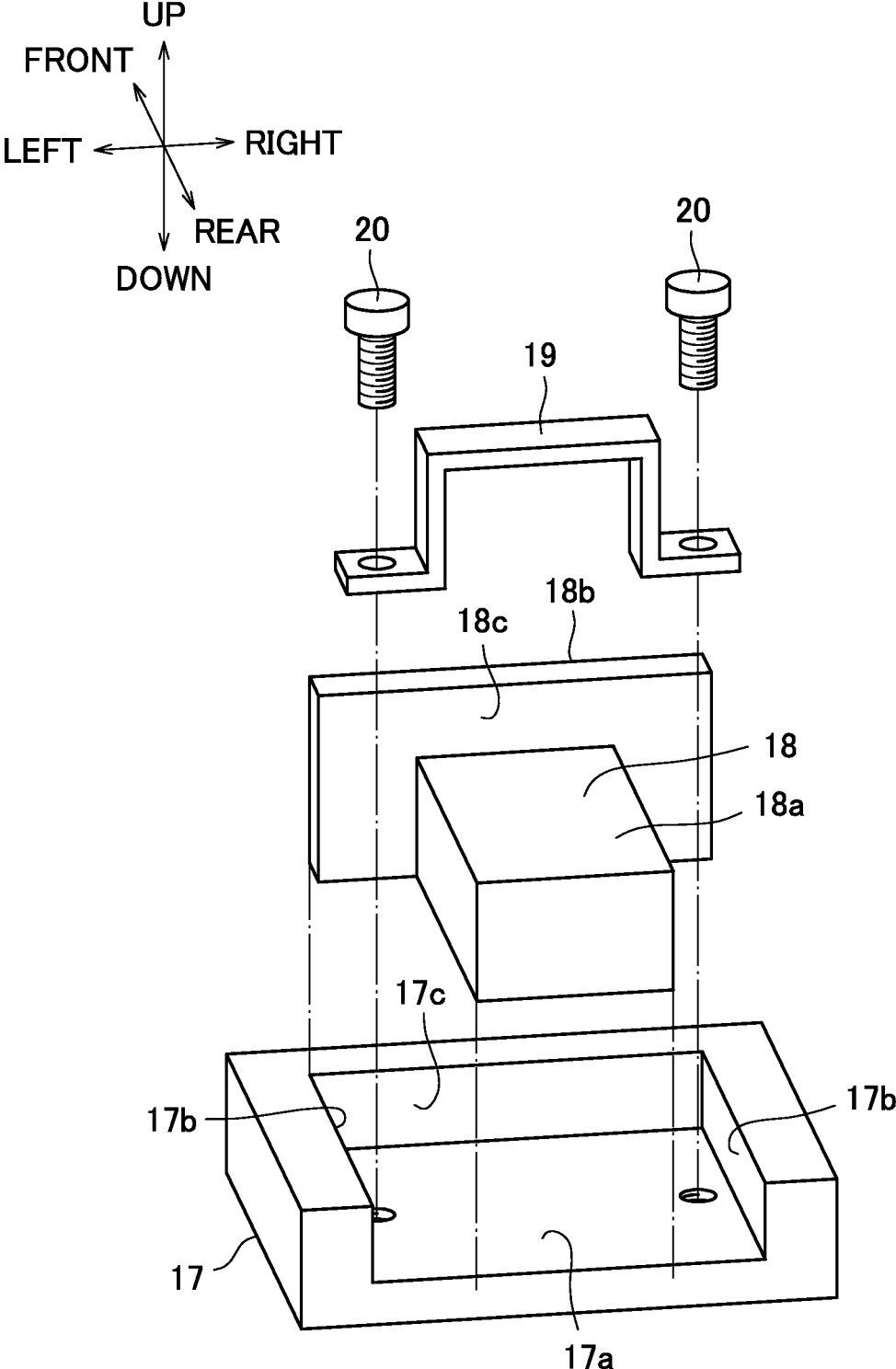


FIG. 5

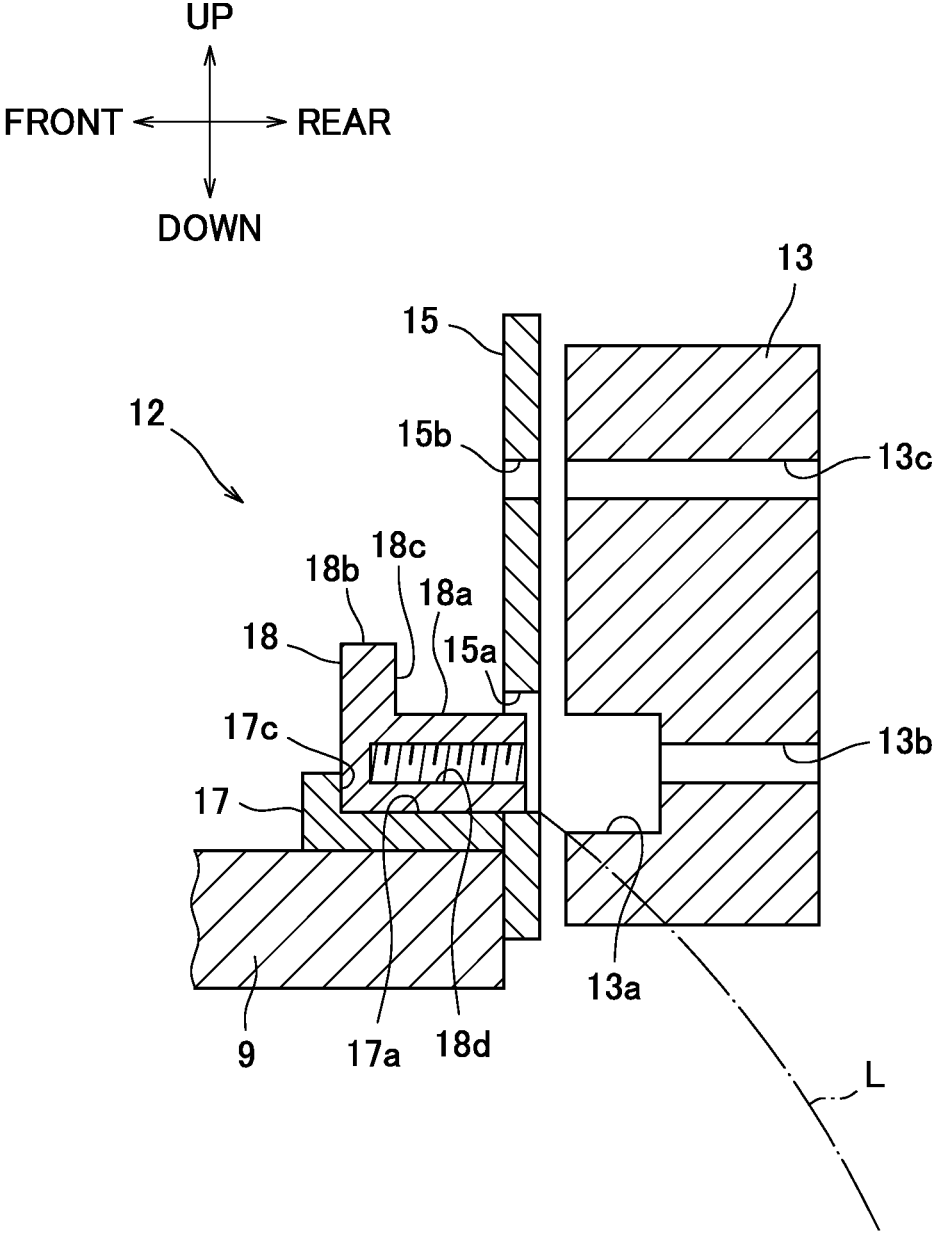


FIG. 6

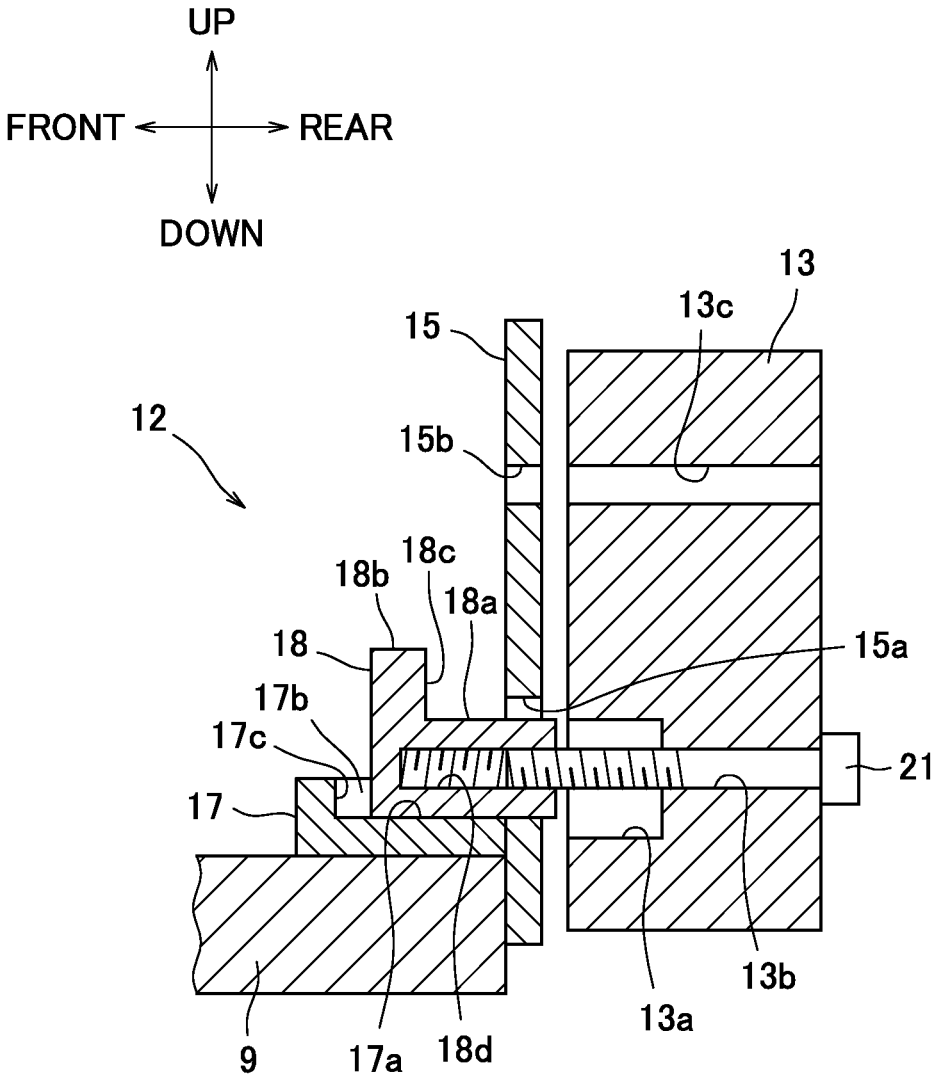


FIG. 7

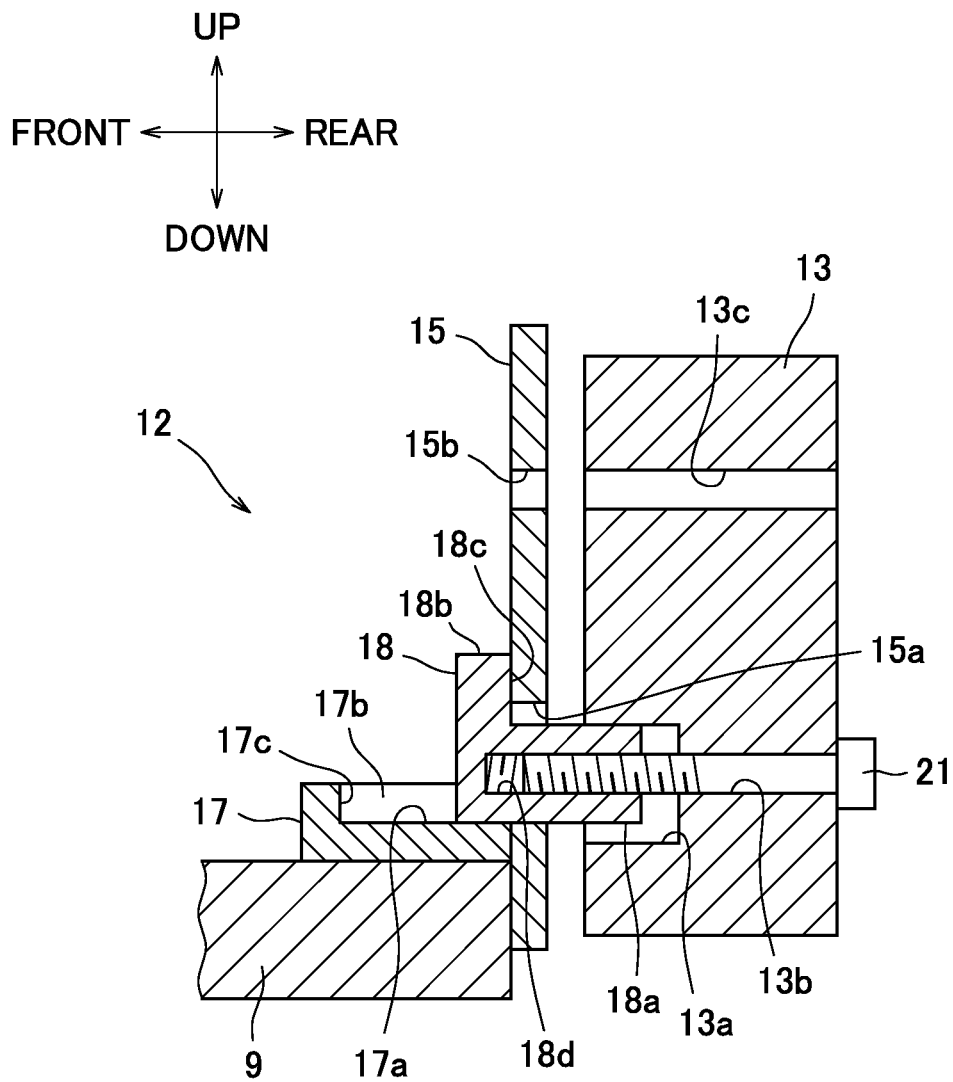


FIG. 8

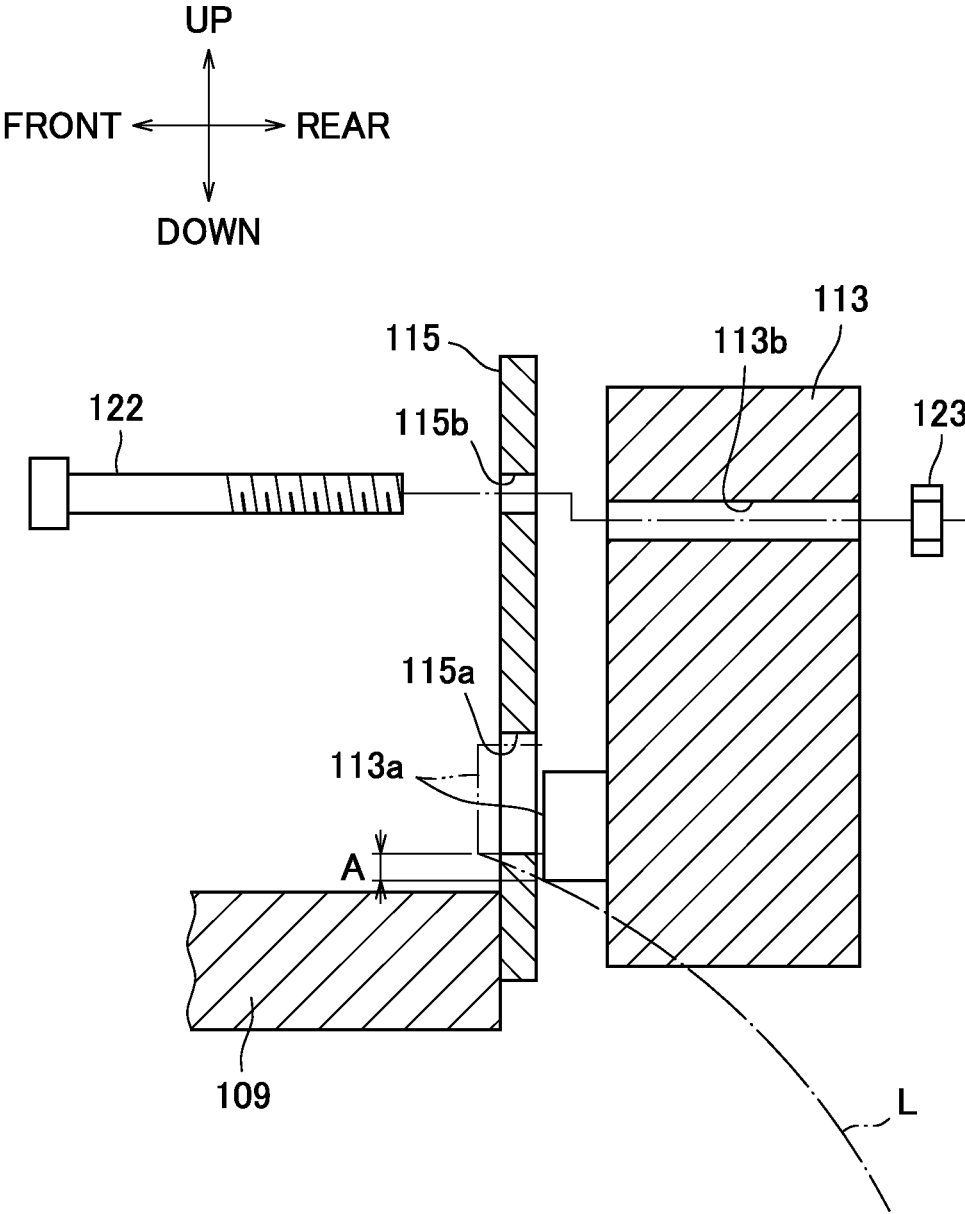
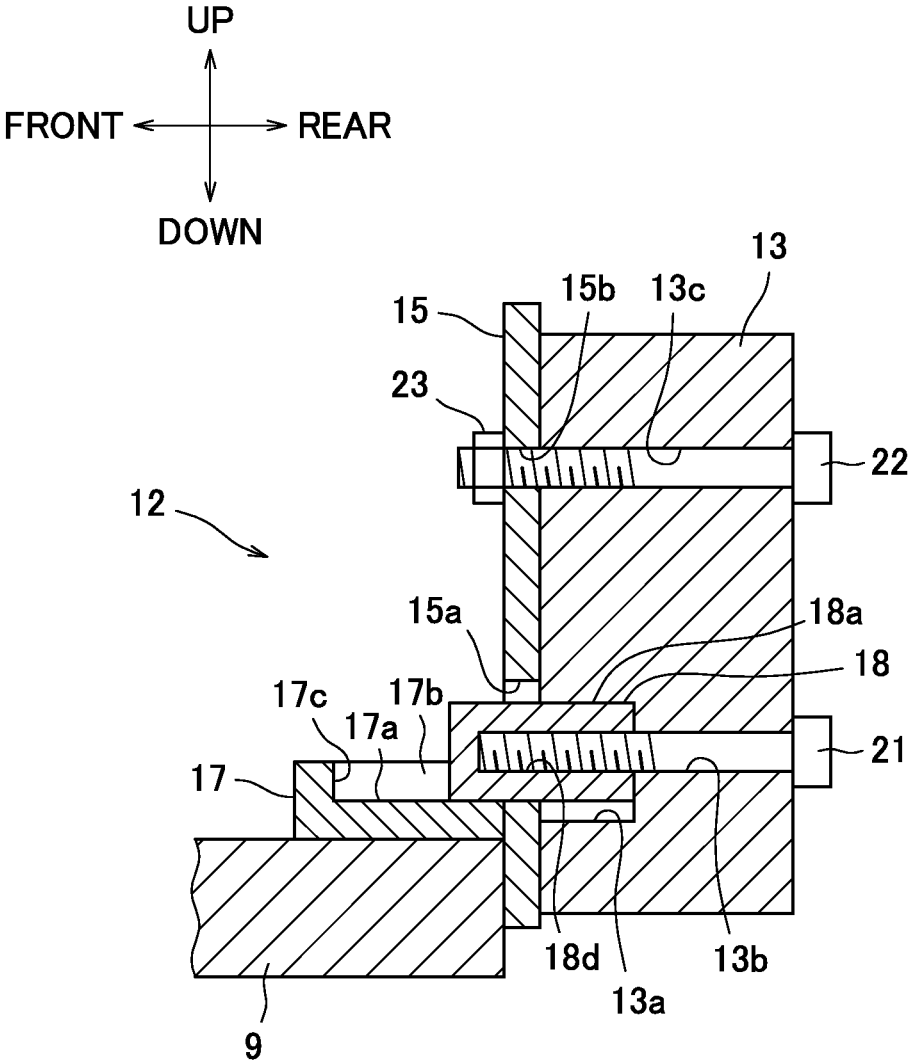


FIG. 9



**WORK MACHINE**

## TECHNICAL FIELD

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

## BACKGROUND ART

[0002] For example, a hydraulic excavator includes an upper turning body turnably provided on an undercarriage traveling by crawlers and includes an articulated work front provided at a front portion of the upper turning body. In order to keep a balance with a weight of the work front, a counterweight is detachably attached to a rear portion of the upper turning body.

[0003] As illustrated in FIG. 8, for example, an attachment base **115** is provided at a rear portion of a frame **109** of the upper turning body, and a counterweight **113** is disposed on a rear side. A boss portion **113a** provided to project from a front surface of the counterweight **113** is inserted into a boss hole **115a** of the attachment base **115**. A bolt **122** is inserted from the front side into bolt holes **113b** and **115b** provided to penetrate through the counterweight **113** and the attachment base **115** and is screwed into a nut **123**, and the counterweight **113** is thereby fastened to the attachment base **115**. Although not illustrated, a plate is fastened to the boss portion **113a** exposed forward via the boss hole **115a** with a bolt to prevent the boss portion **113a** from coming off backward from the boss hole **115a**.

[0004] A shear force due to the weight of the counterweight **113** is received by the firm boss portion **113a**, the weight of the counterweight **113** is supported by the attachment base **115** via the boss portion **113a**, and the shear force acting on the bolt **122** is thus reduced. Hereinafter, the attachment structure of the counterweight **113** will be referred to as a related art.

[0005] Such a counterweight **113** is detached from the attachment base **115** at the time of transport or the like of the hydraulic excavator, and a counterweight attachment/detachment device is used for the attachment/detachment work. As described in Patent Document 1, for example, the counterweight attachment/detachment device is included at the rear portion of the upper turning body of the hydraulic excavator. Proximal ends of a pair of left and right rotating arms are axially supported by coupling pins at a rear portion of the frame of the upper turning body, and a coupling tool that can lock at a suspension ring of each counterweight is provided at a distal end of each rotating arm. Each rotating arm is driven by an elevating cylinder and can rotate about the coupling pin between an attachment position at which the distal end is directed upward and a detachment position at which the distal end is directed backward.

[0006] In a case where the counterweight **113** illustrated in FIG. 8 placed on a ground surface is attached to the hydraulic excavator, the rotating arms of the counterweight attachment/detachment device are brought into removal positions, a suspension height of the counterweight **113** is roughly adjusted by an adjustment bolt of each coupling tool, and the counterweight **113** is locked at the suspension ring. Once the rotating arms are caused to rotate to attachment positions, the counterweight **113** is suspended and moves to the attachment base **115**. In a case where the suspension height has been appropriately adjusted, the boss portion **113a** is inserted into the boss hole **115a** of the attachment base **115**, the bolt hole **113b** of the counterweight

**113** coincides with the bolt hole **115b** of the attachment base **115** in an up-down direction at this time, fastening with the bolt **122** is thus achieved, and the bolt and the plate prevent the boss portion **113a** from falling out.

[0007] Also, in a case where the suspension height is not appropriate, the boss **113a** causes deviation with respect to the attachment base **115** in the up-down direction and cannot be inserted. Therefore, the deviation state is checked, the counterweight **113** is then put down on the ground surface once, the suspension height is adjusted again with the adjustment bolt of the coupling tool, and attachment of the counterweight **113** is tried again.

[0008] On the other hand, in a case where the counterweight **113** is detached from the attachment base **115**, the rotating arms of the counterweight attachment/detachment device are brought into the attachment positions, each coupling tool is locked at the suspension ring of the counterweight **113**, and the counterweight **113** is suspended. Once the bolt **122** and the plate are removed and the rotating arms are caused to rotate to the removal positions, the counterweight **113** is moved to and placed on the ground surface.

## PRIOR ART DOCUMENT

## Patent Document

[0009] Patent Document 1: Japanese Patent Laid-Open No. 7-268908

## SUMMARY OF THE INVENTION

## Problems to be Solved by the Invention

[0010] However, the attachment structure of the counterweight **113** in the related art has a problem that a work of attachment to the hydraulic excavator is complicated.

[0011] In the example illustrated in FIG. 8, the work of attachment should be able to be completed since it is possible to insert the boss portion **113a** of the counterweight **113** into the boss hole **115a** in the attachment base **115** at the suspension height as illustrated by the two-dotted chain line. However, since the counterweight **113** moves along an arc-shaped trajectory L around the coupling pins along with the coupling tools, the boss portion **113a** provided to project forward interferes with the attachment base **115** before being inserted into the boss hole **115a** and prevents movement of the counterweight **113**.

[0012] In this case, although it is possible to insert the boss portion **113a** into the boss hole **115a** if the suspension height of the counterweight **113** is adjusted upward by a dimension A corresponding to a height difference between the position of a lower end of the boss portion **113a** and the position of a lower end of the boss hole **115a** in FIG. 8, the state means that an adjustment margin (an attachable up-down width) of the suspension height has decreased by the amount corresponding to the dimension A. As a result, it is not possible to attach the counterweight **113** regardless of the boss portion **113a** having originally been adjusted to the suspension height at which the boss portion **113a** can be inserted into the boss hole **115a**, and a complicated work of putting down the counterweight **113** on the ground once and adjusting the suspension height again is thus needed.

[0013] The present invention was made to solve such a problem, and an object thereof is to provide a work machine capable of enlarging an adjustment margin of a suspension

height at the time of attachment of a counterweight to the work machine and facilitating an attachment work.

#### Means for Solving the Problems

**[0014]** In order to achieve the above object, a work machine according to the present invention is a work machine capable of detachably attaching a counterweight to an attachment base provided at a rear portion of a vehicle body, the work machine including: a boss hole that is provided to penetrate through the attachment base; a boss recessed portion that is formed in a front surface of the counterweight; a boss member that is inserted into the boss recessed portion in the counterweight from a front side via the boss hole in the attachment base, is fastened to the counterweight with a first fastening member, and has a lower surface abutting a lower wall inside the boss hole and an upper surface abutting an upper wall inside the boss recessed portion; and a second fastening member that fastens the counterweight to the attachment base.

#### Advantageous Effects of the Invention

**[0015]** According to the work machine of the present invention, it is possible to enlarge an adjustment margin of a suspension height at the time of attachment of a counterweight to the work machine and facilitate an attachment work.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** FIG. 1 is a side view illustrating a hydraulic excavator to which an attachment structure of a counterweight according to an embodiment is applied.

**[0017]** FIG. 2 is a schematic view illustrating, in a lateral view, a state where attachment of the counterweight has been completed.

**[0018]** FIG. 3 is a perspective view illustrating a boss member, a pedestal, and a fixation metal fitting.

**[0019]** FIG. 4 is an exploded perspective view illustrating the boss member, the pedestal, and the fixation metal fitting.

**[0020]** FIG. 5 is a schematic view illustrating, in a lateral view, a state where a bolt hole of the counterweight is caused to coincide with a female screw hole in the boss member.

**[0021]** FIG. 6 is a schematic view illustrating, in a lateral view, a state where a bolt is screwed into the female screw hole in the boss member via the bolt hole of the counterweight.

**[0022]** FIG. 7 is a schematic view illustrating, in a lateral view, a state where the bolt is tightened and the boss member is withdrawn into a boss recessed portion of the counterweight.

**[0023]** FIG. 8 is a schematic view illustrating, in a lateral view, a state where a boss portion of a counterweight interferes with a support frame and re-adjustment is needed according to a related art.

**[0024]** FIG. 9 is a schematic view corresponding to FIG. 7 illustrating a boss member in another example with a flange portion omitted.

#### MODE FOR CARRYING OUT THE INVENTION

**[0025]** Hereinafter, an embodiment that implements the present invention as an attachment structure of a counterweight of a hydraulic excavator will be described. FIG. 1 is a side view illustrating the hydraulic excavator according to the present embodiment, and a schematic configuration of

the hydraulic excavator will be described first on the basis of the drawing. Note that in the following description, front-rear, left-right, and up-down directions will be expressed from a viewpoint of an operator sitting in the hydraulic excavator.

**[0026]** A pair of left and right crawlers 3 are included in an undercarriage 2 of a hydraulic excavator 1, and the crawlers 3 are driven by a hydraulic motor for traveling, which is not illustrated, and cause the hydraulic excavator 1 to travel. An upper turning body 4 (corresponding to the "vehicle body" of the present invention) is provided on the undercarriage 2, and the upper turning body 4 is driven and turned by a hydraulic motor for turning, which is not illustrated. An articulated work front 5 is provided at a front portion of the upper turning body 4, and the work front 5 is configured of a boom 6, an arm 7, and a bucket 8. An angle of the boom 6 is changed by a boom cylinder 6a, an angle of the arm 7 is changed by an arm cylinder 7a, and an angle of the bucket 8 is changed by a bucket cylinder 8a.

**[0027]** A driver's cabin 10 is provided at a front portion on a frame 9 of the upper turning body 4, and various operation devices, which are provided in the driver's cabin 10 and are not illustrated, are operated by the operator. A fuel tank 11, a machine room 12, a counterweight 13, and the like are provided behind the driver's cabin 10 on the frame 9, and although not illustrated, various devices such as an engine, a hydraulic pump driven by the engine, and a hydraulic circuit that switches an operating oil ejected from the hydraulic pump are mounted in the machine room 12. The operating oil from the hydraulic pump is switched by the hydraulic circuit in response to operations of the operation devices and is supplied to the aforementioned hydraulic motors for traveling and for turning and each of cylinders 6c to 8c of the work front 5. In this manner, traveling of the hydraulic excavator 1, turning of the upper turning body 4, operating of the work front 5, and the like are performed.

**[0028]** A pair of attachment bases 15 (one of the pair is illustrated in FIGS. 2 and 3) are provided at a rear end of the frame 9 of the upper turning body 4 at intervals in the left-right direction, and the counterweight 13 is attached to the hydraulic excavator 1 via the attachment bases 15. A counterweight attachment/detachment device 16 for attaching and detaching the counterweight 13 is included between the attachment bases 15. A configuration of the counterweight attachment/detachment device 16 is similar to the configuration described in Patent Document 1, for example, proximal ends of a pair of left and right rotating arms are axially supported by the attachment bases 15 at the rear portion of the frame 9 of the upper turning body 4 of the hydraulic excavator 1 with coupling pins, a coupling tool that can be locked at a suspension ring of the counterweight is provided at a distal end of each rotating arm, and each rotating arm is driven by an elevating cylinder and is configured to be rotatable about the coupling pin between an attachment position at which the distal end is directed upward and a detachment position at which the distal end is directed backward.

**[0029]** Therefore, in a case where the counterweight 13 is attached by the counterweight attachment/detachment device 16 with such a configuration, the counterweight 13 moves along an arc-shaped trajectory L (illustrated in FIG. 5) around the coupling pins and is attached to the attachment bases 15. At this time, the attachment structure of the counterweight 113 in the related art illustrated in FIG. 8 has

a problem that there may be a case where the boss portion **113a** provided to project from the front surface of the counterweight **113** interferes with the attachment bases **115** and attachment cannot be achieved and re-adjustment of the suspension height may be needed.

[0030] In view of the aforementioned defect, the present inventor discovered a measure of preparing a boss member **18**, which is a component different from the counterweight **13**, instead of the boss portion **113a** and disposing the boss member **18** between the counterweight **13** and the attachment bases **15** after disposing the counterweight **13** at the attachment bases **15**. Details will be described below.

[0031] FIG. 2 is a schematic view illustrating, in a lateral view, a state where attachment of the counterweight **13** has been completed, FIG. 3 is a perspective view illustrating the boss member **18**, a pedestal, and a fixation metal fitting, and FIG. 4 is an exploded perspective view illustrating the boss member **18**, the pedestal, and the fixation metal fitting. Note that although each drawing shows one of the left and right attachment bases **15** and the boss member **18**, the pedestal **17**, and the like related to the attachment base **15**, the other attachment base **15** and the like also have the same configurations.

[0032] The attachment base **15** has a plate shape facing the front side and the rear side and is provided to extend upward with a lower end thereof fixed to a rear end of the frame **9** of the upper turning body **4**. The pedestal **17** is fixed on the front side of the attachment base **15** on the frame **9**, the pedestal **17** includes a guide surface **17a** that is parallel with an axis of a boss hole **15a**, which will be described later, faces the upper side, and has a quadrangular shape in a plan view and side walls **17b** and a front wall **17c** formed on both the left and right sides and the front side of the guide surface **17a**, and a rear end of the pedestal **17** abuts the attachment base **15**.

[0033] The boss member **18** is disposed on the guide surface **17a** of the pedestal **17**, and the boss member **18** includes a fitting insertion portion **18a** that extends in the front-rear direction and has a rectangular parallelepiped shape and a flange portion **18b** that is integrally formed at a front end of the fitting insertion portion **18a** and has a quadrangular plate shape. As a result, the fitting insertion portion **18a** has a quadrangular shape (corresponding to the “square shape” of the present invention) seen from the rear side. The entire lower surface of the boss member **18** abuts the guide surface **17a**, and the boss member **18** is movable in the front-rear direction by being guided by the guide surface **17a**. A left-right width of the fitting insertion portion **18a** is set to be smaller than a left-right width of the flange portion **18b**, and an up-down width of the fitting insertion portion **18a** is set to be smaller than an up-down width of the flange portion **18b**. For this reason, both the left and right sides and the upper side of the fitting insertion portion **18a** are surrounded by the flange portion **18b** in a view from the rear side, and the surrounding region of the flange portion **18b** will be referred to as an abutment surface **18c** below.

[0034] A fixation metal fitting **19** produced by folding and shaping a steel plate is disposed at the fitting insertion portion **18a** of the boss member **18**, has a recessed shape opened downward in a manner corresponding to a sectional shape of the fitting insertion portion **18a**, and is fitted into the fitting insertion portion **18a** from the upper side. Both ends of the fixation metal fitting **19** are fastened to the guide surface **17a** with bolts **20**, and the boss member **18** is fixed

to the guide surface **17a** with the fixation metal fitting **19**. At the time of transport during which the counterweight **13** is detached from the hydraulic excavator **1**, the fixation metal fitting **19** is fastened to the pedestal **17** and serves to prevent the boss member **18** from falling out.

[0035] Various structures can be employed as the fixation metal fitting **19** as long as it is possible to restrict movement of the boss member **18**. For example, movement in all of the front-rear direction, the left-right direction, and to the upper side may be restricted by pushing the boss member **18** against the guide surface **17a** with the fixation metal fitting **19**. Alternatively, movement in the left-right direction and to the upper side may be restricted with the fixation metal fitting **19**, movement to the front side may be restricted by the front wall **17c**, and movement to the rear side may be restricted by causing the abutment surface **18c** of the flange portion **18b** to abut the fixation metal fitting **19**.

[0036] On the other hand, when the counterweight **13** is attached to the hydraulic excavator **1**, the fixation metal fitting **19** is detached from the pedestal **17**. Therefore, movement of the boss member **18** is allowed, and the weight of the counterweight **13** is supported by the attachment base **15** via the boss member **18** as will be described later.

[0037] FIG. 5 is a schematic view illustrating, in a lateral view, a state where a bolt hole **13b** in the counterweight **13** is caused to coincide with a female screw **18d** hole in the boss member **18**, FIG. 6 is a schematic view illustrating, in a lateral view, a state where a bolt is screwed into the female screw **18d** hole in the boss member **18** via the bolt hole **13b** in the counterweight **13**, and FIG. 7 is a schematic view illustrating, in a lateral view, a state where the bolt is tightened and the boss member **18** is withdrawn into a boss recessed portion **13a** of the counterweight **13**.

[0038] As illustrated in FIGS. 2 and 3, the boss hole **15a** with a quadrangular shape (corresponding to the “square shape” in the present invention) corresponding to the fitting insertion portion **18a** of the boss member **18** is provided to penetrate through the attachment base **15**, and a lower wall inside the boss hole **15a** is on the same plane as the guide surface **17a** of the pedestal **17**. As illustrated in FIG. 5, a distal end of the fitting insertion portion **18a** does not project backward from the inside of the boss hole **15a** and stays within the boss hole **15a** at a position of the boss member **18** caused to move to the frontmost side on the guide surface **17a** of the pedestal **17** (hereinafter, referred to as a front position). If the boss member **18** moves backward from the position, the fitting insertion portion **18a** projects backward from the inside of the boss hole **15a** in the attachment base **15** as illustrated in FIG. 6. If the boss member **18** further moves backward, the abutment surface **18c** of the flange portion **18b** abuts the front surface of the attachment base **15** as illustrated in FIG. 7, and movement of the boss member **18** is restricted (hereinafter, referred to as a rear position).

[0039] As illustrated in FIG. 2, the counterweight **13** is disposed behind the attachment base **15**, and the boss recessed portion **13a** with a quadrangular shape (corresponding to the “square shape” in the present invention) corresponding to the fitting insertion portion **18a** of the boss member **18** is formed in the front surface of the counterweight **13**. Hereinafter, the configuration will be described on the assumption that the counterweight **13** has been attached to the attachment base **15** as illustrated in FIG. 2 for convenience of explanation.

[0040] In this case, the boss member 18 is at the rear position, the abutment surface 18c abuts the front surface of the attachment base 15, and the fitting insertion portion 18a is inserted into the boss recessed portion 13a from the front side via the boss hole 15a in the attachment base 15. A female screw 18d is formed from the rear side at the fitting insertion portion 18a of the boss member 18, and the bolt hole 13b is provided to penetrate through the counterweight 13 in the front-rear direction such that the bolt hole 13b coincides with the female screw 18d. A bolt 21 (corresponding to the “first fastening member” in the present invention) is inserted into the bolt hole 13b from the rear side, and a distal end thereof is screwed into the female screw 18d of the boss member 18.

[0041] The fitting insertion portion 18a of the boss member 18 receives a fastening force of the bolt 21 and is withdrawn into and fastened to the boss recessed portion 13a of the counterweight 13. As a result, the attachment base 15 is sandwiched between the abutment surface 18c of the boss member 18 and the front surface of the counterweight 13, and the counterweight 13 is attached to the attachment base 15.

[0042] In this state, the lower surface of the boss member 18 abuts the lower wall inside the boss hole 15a, and the upper surface of the boss member 18 abuts the upper wall inside the boss recessed portion 13a. Therefore, a shear force due to the weight of the counterweight 13 is received by the boss member 18, and the weight of the counterweight 13 is supported by the attachment base 15 via the boss member 18.

[0043] In the present embodiment, the up-down width of the boss hole 15a in the attachment base 15 and the up-down width of the boss recessed portion 13a of the counterweight 13 are set to be slightly larger as compared with the up-down width of the fitting insertion portion 18a of the boss member 18, and clearances in the up-down direction are formed therebetween, as illustrated in FIG. 2. Although not illustrated, the left-right width of the boss hole 15a in the attachment base 15 and the left-right width of the boss recessed portion 13a of the counterweight 13 are also set to be slightly larger as compared with the left-right width of the fitting insertion portion 18a. However, the present invention is not limited thereto, and the up-down width of each of the members 18a, 15a, and 13a may be caused to coincide with each other, or the left-right width thereof may be caused to coincide with each other.

[0044] On the other hand, bolt holes 13c and 15b are provided to penetrate in the front-rear direction through the counterweight 13 and the attachment base 15, respectively, at positions above the boss member 18, and a bolt 22 (corresponding to the “second fastening member” in the present invention) is inserted into the bolt holes 13c and 15b from the rear side and are then screwed into a nut 23 welded on the front surface of the attachment base 15. As a result, the attachment base 15 and the counterweight 13 are fastened at this position as well.

[0045] The counterweight 13 configured as described above is attached and detached by the counterweight attachment/detachment device 16. In a case where the counterweight 13 is detached from the state of attachment to the hydraulic excavator 1 illustrated in FIG. 2, the rotating arms of the counterweight attachment/detachment device 16 is brought into an attachment position, each coupling tool is

locked at and suspended from the suspension ring, which is not illustrated, and fastening of the bolt 21 and the bolt 22 is then released.

[0046] Since the counterweight 13 is detached along the arc-shaped trajectory L around the coupling pins, movement thereof may be prevented by the boss member 18 at the rear position. Thus, the removed bolt 21 is inserted into the bolt hole 13b in the counterweight 13, and the boss member 18 is pushed with the distal end of the bolt hole 13b and is caused to move to the front position, for example. If the rotating arms of the counterweight attachment/detachment device 16 is caused to rotate to a detachment position, then the counterweight 13 is moved to and placed on the ground surface.

[0047] Note that in a case where the hydraulic excavator 1 is transported after the detachment of the counterweight 13, the fixation metal fitting 19 is fastened to the pedestal 17 to fix the boss member 18. Although vibration at the time of the transport acts on the boss member 18, it is possible to prevent such a situation in which the boss member 18 falls out from the pedestal 17 before it happens.

[0048] On the other hand, in a case where the counterweight 13 placed on the ground surface is attached to the hydraulic excavator 1, the work is performed by the following procedure. Note that it is assumed that the boss member 18 is maintained at the front position in advance before the attachment work.

[0049] First, the rotating arms of the counterweight attachment/detachment device 16 are brought into a removal position, the suspension height of the counterweight 13 is roughly adjusted by an adjustment bolt of each coupling tool, and locked at the suspension ring. If the rotating arms are caused to rotate to the attachment position, the counterweight 13 is suspended and moves to the attachment base 15 along the arc-shaped trajectory L as illustrated in FIG. 5. A positional relationship in the up-down direction between the fitting insertion portion 18a of the boss member 18 and the boss recessed portion 13a of the counterweight 13 (and thus a positional relationship in the up-down direction between the female screw 18d and the bolt hole 13b) gradually changes with movement of the counterweight 13.

[0050] In a case where the suspension height has been appropriately adjusted, the fitting insertion portion 18a and the boss recessed portion 13a coincide with each other in the up-down direction at some point before the front surface of the counterweight 13 abuts the rear surface of the attachment base 15. For example, a worker looks into the bolt hole 13b in the counterweight 13 from the rear side, checks the positional relationship between the bolt hole 13b and the female screw 18d of the boss member 18, and stops the movement of the counterweight 13 at the point when the bolt hole 13b and the female screw 18d coincide with each other.

[0051] Then, the bolt 21 is inserted into the bolt hole 13b in the counterweight 13 from the rear side, and the distal end thereof is screwed into and temporarily fastened to the female screw 18d of the boss member 18 as illustrated in FIG. 6. The boss member 18 at the front position moves to the rear position while being guided by the guide surface 17a with the tightening of the bolt 21, and the fitting insertion portion 18a of the boss member 18 is withdrawn into the boss recessed portion 13a of the counterweight 13 as illustrated in FIG. 7. In this manner, the abutment surface 18c of the boss member 18 abuts the front surface of the attachment

base 15, and the front surface of the counterweight 13 abuts the rear surface of the attachment base 15.

[0052] In parallel with this, the bolt 22 is inserted into the bolt holes 13c and 15b in the counterweight 13 and the attachment base 15 from the rear side, and the distal end thereof is screwed into and temporarily fastened to the nut 23. Then, once the suspension of the counterweight 13 by the counterweight attachment/detachment device 16 is stopped, the weight of the counterweight 13 acts on the boss member 18 and is supported by the attachment base 15 via the boss member 18. If the bolt 21 and the bolt 22 are actually fastened in this state, the counterweight 13 is attached to the attachment base 15, and the series of attachment work is completed.

[0053] As described above, according to the attachment structure for the counterweight 13 in the present embodiment, the boss member 18 is a component separated from the counterweight 13, and the front surface thereof does not include the boss portion 113a provided to project therefrom like the counterweight 113 in the related art illustrated in FIG. 8, for example, and has a flat shape. FIGS. 5 and 8 illustrate cases where the respective counterweights 13 and 113 are adjusted to the same suspension height. According to the related art in FIG. 8, the boss portion 113a provided to project forward interferes with the attachment base 115 before insertion into the boss hole 115a and prevents movement of the counterweight 113 when the counterweight 113 is caused to move along the arc-shaped trajectory L for attachment to the attachment base 115. Therefore, re-adjustment to adjust the suspension height upward is needed.

[0054] On the contrary, according to the present embodiment illustrated in FIG. 5, a site corresponding to the boss member 18 is not present, and it is thus possible to cause the counterweight 13 to move with any problem along the arc-shaped trajectory L to the up-down position at which the boss recessed portion 13a coincides with the fitting insertion portion 18a of the boss member 18. Also, if the fitting insertion portion 18a of the boss member 18 is withdrawn into the boss recessed portion 13a through screwing of the bolt 21 after the fitting insertion portion 18a and the boss recessed portion 13a are caused to coincide with each other, it is possible to cause the attachment base 15 to support the weight of the counterweight 13 via the boss member 18. As a result, it is possible to expand downward an adjustment margin of the suspension height by the amount corresponding to the dimension A in FIG. 8, to reduce opportunities in which re-adjustment is needed, and thereby to facilitate the attachment work of the counterweight 13.

[0055] Also, the up-down width of the boss recessed portion 13a of the counterweight 13 is set to be larger than the up-down width of the fitting insertion portion 18a of the boss member 18, and clearances in the up-down direction are formed therebetween in the present embodiment. Therefore, it is possible to insert the fitting insertion portion 18a into the boss recessed portion 13a even in a case where the suspension height slightly deviates upward. As a result, it is not necessary to perform re-adjustment to adjust the suspension height downward again in this case, and this point also significantly contributes to the facilitating of the attachment work.

[0056] Also, the bolt 21 is screwed into the female screw 18d of the boss member 18 from the rear side via the bolt hole 13b in the counterweight 13. In this manner, the fitting insertion portion 18a of the boss member 18 is withdrawn

into the boss recessed portion 13a of the counterweight 13, and the attachment base 15 is sandwiched between the abutment surface of the boss member 18 and the front surface of the counterweight 13. As a result, it is possible to fasten the counterweight 13 to the attachment base 15 merely by causing the bolt 21 to be screwed into the boss member 18 from the rear side.

[0057] Also, the pedestal 17 is fixed to the front side of the attachment base 15 on the frame 9, and the boss member 18 is disposed on the guide surface 17a formed on the pedestal 17 and facing the upper side, to thereby guide the movement in the front-rear direction. In a case of a configuration that does not include the pedestal 17, it is necessary for the worker to grip the boss member 18 that is heavy and to manually insert the fitting insertion portion 18a into the boss recessed portion 13a of the counterweight 13 via the boss hole 15a from the front side of the attachment base 15. However, since the boss member 18 is guided on the guide surface 17a, it is possible to significantly reduce a work requiring such a large effort. Additionally, it is possible to withdraw the boss member 18 into the boss recessed portion 13a of the counterweight 13 merely by screwing the bolt 21 into the boss member 18 and tightening the bolt 21 thereto from the rear side.

[0058] As for the bolt 22, it is only necessary to screw the bolt 22 into the nut 23 via the bolt holes 13c and 15b in the counterweight 13 and the attachment base 15 from the rear side, and fastening of the counterweight 13 to the attachment base 15 is completed only by such a simple operation.

[0059] Also, according to the attachment structure of the present embodiment, it is possible to complete all the works at the time of attaching the counterweight 13 at the rear position of the upper turning body 4 as is obvious from the above description. In other words, it is a matter of course that the work of disposing the counterweight 13 at a prescribed position on the attachment base 15 by using the counterweight attachment/detachment device 16 can be performed at the rear position of the upper turning body 4, the fastening operation of the bolt 21 and the bolt 22 can also be performed at the rear position of the upper turning body 4. Also, it is possible to fasten the counterweight 13 to the attachment base 15 through the tightening of the bolt 21, and together, it is possible to withdraw the boss member 18 into the boss recessed portion 13a of the counterweight 13.

[0060] In a case of a configuration where the bolt 21 is screwed from the front side, it is necessary for the worker to insert the bolt 122 into the bolt holes 115b and 113b in the attachment base 115 and the counterweight 113 from the front side of the attachment base 115 and to screw the distal end thereof into the nut 123 as illustrated in FIG. 8, for example. Also in a case of a configuration that does not include the pedestal 17, it is necessary for the worker to insert the boss member 18 into the boss recessed portion 13a of the counterweight 13 from the front side of the attachment base 15 as described above.

[0061] The machine room 12 is defined on the front side of the attachment base 15 on the frame 9, and a maintenance opening portion, which is not illustrated, is formed in the frame 9 to open downward for maintenance of the machine room 12. Therefore, the worker performs the operation of fastening the bolt 122 (illustrated in FIG. 8) or the operation of inserting the boss member 18 (illustrated in FIG. 7) as described above with his/her upper body placed in the machine room 12 from the maintenance opening portion.

However, since the worker keeps a half-sitting posture at this time and performs the works while avoiding various devices that may be obstacles inside the machine room 12, the works are very complicated.

[0062] On the contrary, according to the present embodiment, it is only necessary for the worker to fasten the bolt 21 and the bolt 22 at the rear position of the upper turning body 4, the work can be performed in a natural standing posture, and there are no obstacles and the like that may disturb the works in the surroundings of the counterweight 13. This makes the work very simple and thus significantly contributes to facilitating of the entire attachment work of the counterweight 13.

[0063] Also, since the fitting insertion portion 18a of the boss member 18 has a quadrangular shape in a view from the rear side, and the boss hole 15a of the attachment base 15 and the boss recessed portion 13a of the counterweight 13 have quadrangular shapes corresponding to the shape of the boss member 18, relative rotation is restricted. Although a rotation force acts on the boss member 18 at the time of fastening of the bolt 21, the rotation of the boss member 18 at this time is restricted by the boss hole 15a in the attachment base 15 and the boss recessed portion 13a of the counterweight 13, it is possible to easily fasten the bolt 21, and this point also significantly contributes to the facilitating of the attachment work.

[0064] Note that it is not necessary that both the boss hole 15a in the attachment base 15 and the boss recessed portion 13a of the counterweight 13 be formed into quadrangular shapes. Since the rotation of the boss member 18 can be restricted if any one of the members 15a and 13a is formed into a quadrangular shape, the other member may be formed into another shape into which the fitting insertion portion 18a can be inserted. Also, the shape of each of the members 18a, 15a, and 13a is not necessarily quadrangular shape in a view from the rear side and may be changed to another shape that enables rotation to be restricted. Furthermore, rotation is not necessarily restricted, the shapes may be circular shapes, for example, and such cases are also included in the present invention.

[0065] Although the description of the embodiment ends here, aspects of the present invention are not limited to the embodiment. Although the present invention is implemented as the attachment structure for the counterweight 13 of the hydraulic excavator 1 in the above embodiment, for example, the present invention is not limited thereto. The present invention can be applied to various work machines to which a counterweight is detachably attached and may be implemented as an attachment structure for a counterweight of a hydraulic crane, for example.

[0066] Also, although the bolt 21 is inserted into the bolt hole 13b in the counterweight 13 from the rear side to fasten the boss member 18 to the inside of the boss recessed portion 13a in the above embodiment, the present invention is not limited thereto. For example, a bolt hole may be provided to penetrate through the boss member 18 in the front-rear direction, a female screw may be formed inside the boss recessed portion 13a of the counterweight 13 in a manner corresponding to the bolt hole, and a bolt may be screwed into the female screw inside the boss recessed portion 13a from the front side via the bolt hole of the boss member 18.

[0067] Also, although the flange portion 18b is formed at the boss member 18 in the above embodiment, the flange portion 18b may be omitted as illustrated in FIG. 9, for

example. Although the bolt 21 in this case does not play a role in fastening the counterweight 13 to the attachment base 15, the fastening function is achieved by the bolt 22 and the nut 23, and no problems will occur.

[0068] Also, although the movement of the boss member 18 is guided with the pedestal 17 fixed on the frame 9 in the above embodiment, the pedestal 17 may be omitted. Although the lower surface of the boss member 18 is formed to be flat on the assumption of disposition on the guide surface 17a in the above embodiment, there is no need thereof, and the flange portion 18b may be formed to extend on the lower side as well in addition to both the left and right sides and the upper sides and may be caused to function as the abutment surface 18c.

#### EXPLANATION OF REFERENCE SIGNS

[0069]	1	Hydraulic excavator (work machine)
[0070]	4	Upper turning body (vehicle body)
[0071]	13	Counterweight
[0072]	13a	Boss recessed portion
[0073]	13b	Bolt hole
[0074]	15	Attachment base
[0075]	15a	Boss hole
[0076]	16	Counterweight attachment/detachment device
[0077]	17	Pedestal
[0078]	17a	Guide surface
[0079]	18	Boss member
[0080]	18b	Flange portion
[0081]	18c	Abutment surface
[0082]	19	Fixation metal fitting
[0083]	21	Bolt (first fastening member)
[0084]	22	Bolt (second fastening member)

1. A work machine capable of detachably attaching a counterweight to an attachment base provided at a rear portion of a vehicle body, the work machine comprising:

- a boss hole that is provided to penetrate through the attachment base;
- a boss recessed portion that is formed in a front surface of the counterweight;
- a boss member that is inserted into the boss recessed portion in the counterweight from a front side via the boss hole in the attachment base, is fastened to the counterweight with a first fastening member, and has a lower surface abutting a lower wall inside the boss hole and an upper surface abutting an upper wall inside the boss recessed portion; and
- a second fastening member that fastens the counterweight to the attachment base.

2. The work machine according to claim 1,

- wherein the first fastening member is screwed into the boss member via a bolt hole in the counterweight from a rear side, and draws the boss member into the boss recessed portion, and fastens the boss member, and
- a flange portion abutting the attachment base from the front side is integrally formed with the boss member, and the attachment base is sandwiched between an abutment surface of the flange portion and the front surface of the counterweight by a fastening force of the fastening member.

3. The work machine according to claim 1, further comprising:

a pedestal that has a guide surface facing upward in parallel with an axis of the boss hole and provided on a front side of the attachment base, wherein the boss member is disposed on the guide surface and is movable in a front-rear direction by being guided by the guide surface.

4. The work machine according to claim 1, wherein the second fastening member is inserted into a bolt hole in the counterweight from a rear side, and fastens the attachment base to the counterweight.

5. The work machine according to claim 1, wherein the boss member has a square shape, and at least one of the boss hole in the attachment base and the boss recessed portion in the counterweight has a square shape corresponding to a sectional shape of the boss member and has restricted relative rotation.

6. The work machine according to claim 3, wherein the boss member is fixed on the guide surface of the pedestal with a detachable fixation metal fitting.

7. The work machine according to claim 1, wherein the boss recessed portion forms a clearance in an up-down direction with respect to the boss member.

8. The work machine according to claim 1, wherein the boss hole in the attachment base, the boss recessed portion in the counterweight, and the boss member are each provided in pairs at intervals in a left-right direction.

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