



(11) **EP 4 458 596 A1**

(12) **EUROPEAN PATENT APPLICATION**  
published in accordance with Art. 153(4) EPC

(43) Date of publication:  
**06.11.2024 Bulletin 2024/45**

(51) International Patent Classification (IPC):  
**B60K 1/00** <sup>(2006.01)</sup> **B60K 1/04** <sup>(2019.01)</sup>  
**B60L 50/60** <sup>(2019.01)</sup> **B62D 21/18** <sup>(2006.01)</sup>  
**B62D 49/00** <sup>(2006.01)</sup>

(21) Application number: **22915464.6**

(22) Date of filing: **17.10.2022**

(52) Cooperative Patent Classification (CPC):  
**B60K 1/00; B60K 1/04; B60L 9/18; B60L 50/60;**  
**B62D 21/18; B62D 49/00**

(86) International application number:  
**PCT/JP2022/038590**

(87) International publication number:  
**WO 2023/127229 (06.07.2023 Gazette 2023/27)**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR**

Designated Extension States:  
**BA**

Designated Validation States:  
**KH MA MD TN**

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(30) Priority: **27.12.2021 JP 2021213186**

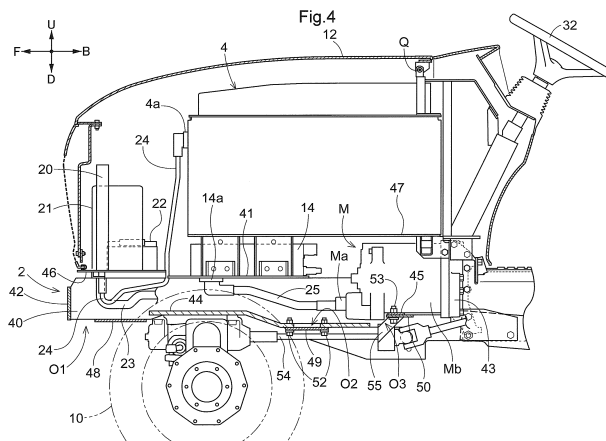
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(54) **ELECTRIC WORK VEHICLE**

(57) An electric work vehicle includes a first cover member (48) configured to cover a portion of a first harness (24) exposed downward through a first opening (O1) and configured to be removable, a second cover member (49) configured to cover a portion of a second

harness (25) exposed downward through a second opening (O2) and configured to be removable, and a third cover member (50) configured to cover a portion of a motor (M) exposed downward through a third opening (O3) and configured to be removable.



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**Description**

## Technical Field

**[0001]** The present invention relates to an electric work vehicle.

## Background Art

**[0002]** A known example of an electric work vehicle is disclosed in Patent Document 1. The electric work vehicle disclosed in Patent Document 1 includes a battery ("travel battery (4)" in the document), an inverter ("inverter (14)" in the document) configured to convert DC power from the battery to AC power, a motor ("motor (M)" in the document) driven by electric power supplied from the inverter, a travel device ("front wheels (10) and rear wheels (11)" in the document) driven by the motor, and a DC-DC converter ("voltage converter (19)" in the document) configured to step down electric power from the battery.

## Prior Art Document

## Patent Document

**[0003]** Patent Document 1: JP 2021-953A

## Disclosure of the Invention

## Problem to be Solved by the Invention

**[0004]** In an electric work vehicle such as that as described above, usually, the battery and the DC-DC converter are connected to each other by a harness, and the inverter and the motor are connected to each other by a harness. For such an electric work vehicle, it is desired to facilitate the maintenance of the harnesses and the motor and to prevent the harnesses and the motor from being damaged by a flying stone from the ground.

**[0005]** Under these circumstances, there is demand for an electric work vehicle that provides enhanced ease of maintenance of the harnesses and the motor and is configured to prevent the harnesses and the motor from being damaged by a flying stone from the ground.

## Means for Solving Problem

**[0006]** A feature of the present invention lies in a configuration including: a battery; an inverter configured to convert DC power from the battery to AC power; a motor drivable by electric power supplied from the inverter; a travel device drivable by the motor; a DC-DC converter configured to step down electric power from the battery; a first harness connecting the battery and the DC-DC converter; a second harness connecting the inverter and the motor; a body frame having a first opening through which the first harness is exposed downward, a second opening through which the second harness is exposed

downward, and a third opening through which the motor is exposed downward, and supporting the battery, the inverter, the motor, and the DC-DC converter; a first cover member configured to cover a portion of the first harness exposed downward through the first opening and configured to be removable; a second cover member configured to cover a portion of the second harness exposed downward through the second opening and configured to be removable; and a third cover member configured to cover a portion of the motor exposed downward through the third opening and configured to be removable.

**[0007]** With this characteristic configuration, even when a stone flies from the ground toward the first harness, the second harness, or the motor, the stone is blocked by the first cover member, the second cover member, or the third cover member. Thus, the first harness, the second harness, and the motor can be prevented from being damaged by a flying stone from the ground.

**[0008]** In addition, during maintenance, the first cover member, the second cover member, and the third cover member are removed, and the first harness, the second harness, and the motor are thus exposed downward. As a result, it is easy to perform the maintenance of the first harness, the second harness, and the motor by accessing the first harness, the second harness, and the motor from below.

**[0009]** Furthermore, in the present invention, it is preferable that the motor is configured as a water-cooled type, and the third cover member is configured to cover a water-cooled portion of the motor.

**[0010]** With this characteristic configuration, the water-cooled portion of the motor can be protected by the third cover member.

**[0011]** Furthermore, in the present invention, it is preferable that at least any of the first cover member, the second cover member, or the third cover member has a drain hole.

**[0012]** With this characteristic configuration, at least any of the first cover member, the second cover member, or the second cover member allows water accumulating inside to be discharged through the drain hole.

**[0013]** Furthermore, in the present invention, it is preferable that a transmission shaft configured to transmit motive power from the motor to the travel device is provided, and the transmission shaft is held by at least any of the first cover member, the second cover member, or the third cover member.

**[0014]** With this characteristic configuration, at least any of the first cover member, the second cover member, or the second cover member can be used as a support for the transmission shaft.

## Brief Description of the Drawings

**[0015]**

FIG. 1 is a left side view of a tractor.

FIG. 2 is a left side view showing arrangement of an inverter and the like.

FIG. 3 is a diagram showing a flow of motive power transmission.

FIG. 4 is a left side sectional view showing a configuration of a front portion of a body of the tractor.

FIG. 5 is a plan view showing the configuration of the front portion of the body of the tractor.

FIG. 6 is a bottom view showing the configuration of the front portion of the body of the tractor.

#### Best Mode for Carrying out the Invention

**[0016]** An embodiment of the present invention will be described based on the drawings. In the following description, unless otherwise stated, the direction of an arrow F and the direction of an arrow B in the drawings will be respectively referred to as "the front side" and "the rear side", and the direction of an arrow L and the direction of an arrow R in the drawings will be respectively referred to as "the left side" and "the right side". Also, the direction of an arrow U and the direction of an arrow D in the drawings will be respectively referred to as "the upper side" and "the lower side".

#### Overall Configuration of Tractor

**[0017]** The following describes a tractor according to the present embodiment. As shown in FIG. 1, the tractor includes left and right front wheels 10, left and right rear wheels 11, and a cover member 12.

**[0018]** The tractor also includes a body frame 2 and a driving section 3. The body frame 2 is supported by the left and right front wheels 10 and the left and right rear wheels 11.

**[0019]** The cover member 12 is disposed in a front portion of the body of the tractor. The driving section 3 is behind the cover member 12. In other words, the cover member 12 is in front of the driving section 3.

**[0020]** The driving section 3 includes a protective frame 30, a driver's seat 31, and a steering wheel 32. An operator can sit on the driver's seat 31. Accordingly, the operator can get on the driving section 3. The operator steers the left and right front wheels 10 by operating the steering wheel 32. The operator can perform various driving operations in the driving section 3.

**[0021]** The tractor includes a battery 4 for driving. The cover member 12 is configured to be pivotable about an opening/closing axis Q extending in the left-right direction of the body. Accordingly, the cover member 12 is configured to be openable and closable. When the cover member 12 is closed, the battery 4 for driving is covered by the cover member 12.

**[0022]** As shown in FIG. 2, the tractor includes an inverter 14 and a motor M. The battery 4 for driving supplies electric power to the inverter 14. The inverter 14 converts DC power supplied from the battery 4 for driving to AC power, and supplies the AC power to the motor M. The

motor M is driven by the AC power supplied from the inverter 14.

**[0023]** As shown in FIGS. 2 and 3, the tractor includes a hydraulic continuously variable transmission 15 and a transmission 16. As shown in FIG. 3, the hydraulic continuously variable transmission 15 includes a hydraulic pump 15a and a hydraulic motor 15b.

**[0024]** The hydraulic pump 15a is driven by rotational motive power transmitted from the motor M. As a result of the hydraulic pump 15a being driven, rotational motive power is output from the hydraulic motor 15b. The hydraulic continuously variable transmission 15 is configured to change the speed of rotational motive power between the hydraulic pump 15a and the hydraulic motor 15b. Also, the hydraulic continuously variable transmission 15 is configured to be capable of changing the transmission ratio in a stepless manner.

**[0025]** The rotational motive power output from the hydraulic motor 15b is transmitted to the transmission 16. The speed of the rotational motive power transmitted to the transmission 16 is changed by a gear transmission mechanism included in the transmission 16, and the rotational motive power is distributed to the left and right front wheels 10 and the left and right rear wheels 11. Thus, the left and right front wheels 10 and the left and right rear wheels 11 are driven.

**[0026]** As shown in FIGS. 2 and 3, the tractor also includes a middle PTO shaft 17 and a rear PTO shaft 18. Rotational motive power output from the motor M is distributed to the hydraulic pump 15a, the middle PTO shaft 17, and the rear PTO shaft 18. The middle PTO shaft 17 and the rear PTO shaft 18 are rotated by the distributed rotational motive power.

**[0027]** If a work device is connected to the middle PTO shaft 17 or the rear PTO shaft 18, the work device is driven by rotational motive power transmitted by the middle PTO shaft 17 or the rear PTO shaft 18. For example, in the present embodiment, a grass cutting device 19 is connected to the middle PTO shaft 17 as shown in FIG. 2. The grass cutting device 19 is driven by rotational motive power transmitted by the middle PTO shaft 17.

**[0028]** As shown in FIGS. 4 to 6, the motor M is behind the inverter 14. The motor M and the inverter 14 are below the battery 4 for driving. The motor M and the inverter 14 are aligned in the front-rear direction of the body. Specifically, the motor M and the inverter 14 are aligned in the front-rear direction of the body such that the inverter 14 is on the front side and the motor M is on the rear side.

**[0029]** The tractor includes a radiator 20, a DC (direct current)-DC converter 21, and a battery 22. The radiator 20, the DC-DC converter 21, and the battery 22 are in front of the battery 4 for driving. The DC-DC converter 21 is to the immediate right of the radiator 20. The battery 22 is to the immediate right of the DC-DC converter 21.

**[0030]** Here, all the inverter 14, the motor M, and the DC-DC converter 21 are water-cooled types. The radiator 20 cools cooling water for cooling the inverter 14, the motor M, and the DC-DC converter 21. A cooling hose

23 is connected to a lower portion of the radiator 20 and extends toward the inverter 14. The DC-DC converter 21 steps down electric power supplied from the battery 4 for driving. The battery 22 is for supplying electric power to various electric components. The electric power (high voltage) supplied from the battery 4 for driving is stepped down by the DC-DC converter 21 before being used to charge the battery 22 as low-voltage electric power.

#### Harnesses

**[0031]** As shown in FIGS. 4 to 6, a first harness 24 connecting the battery 4 for driving and the DC-DC converter 21 extends from the battery 4 for driving to the DC-DC converter 21. The first harness 24 is for supplying electric power from the battery 4 for driving to the DC-DC converter 21. An output section 4a to which the first harness 24 is connected is provided at an upper portion of a front surface of the battery 4 for driving. An input section 21a to which the first harness 24 is connected is provided at a front portion of a lower surface of the DC-DC converter 21. The first harness 24 is routed in such a manner as to extend downward from the output section 4a and forward toward the input section 21a.

**[0032]** A second harness 25 connecting the inverter 14 and the motor M extends from the inverter 14 to the motor M. The second harness 25 is for supplying electric power from the inverter 14 to the motor M. An output section 14a to which the second harness 25 is connected is provided at a front portion of a lower surface of the inverter 14. An input section Ma to which the second harness 25 is connected is provided at a front end of the motor M. The second harness 25 is routed in such a manner as to extend rearward from the output section 14a toward the input section Ma.

#### Body Frame

**[0033]** As shown in FIGS. 4 to 6, the body frame 2 includes left and right side plates 40, left and right bases 41, a front plate 42, a rear plate 43, a bottom plate 44, and a lateral plate 45. The left and right side plates 40 are spaced apart from each other in the left-right direction of the body. A space between the left side plate 40 and the right side plate 40 is used as a space in which the motor M is disposed. The radiator 20, the DC-DC converter 21, and the battery 22 are supported on a base 46. The base 46 is supported on front portions of the left and right side plates 40.

**[0034]** The left base 41 extends leftward from an upper edge of the left side plate 40. The right base 41 extends rightward from an upper edge of the right side plate 40. The inverter 14 is supported on the left and right bases 41. The battery 4 for driving is supported on a support stand 47. The support stand 47 is supported on the left and right bases 41 and the rear plate 43.

**[0035]** The front plate 42 extends from a front end of the left side plate 40 to a front end of the right side plate

40. The rear plate 43 extends from a rear end of the left side plate 40 to a rear end of the right side plate 40. The motor M is supported by the rear plate 43. The bottom plate 44 extends from a lower edge of the left side plate 40 to a lower edge of the right side plate 40. The lateral plate 45 is behind the bottom plate 44 and extends from the left side plate 40 to the right side plate 40.

**[0036]** A first opening O1 is formed in a portion of the body frame 2 surrounded by the front plate 42, a front edge of the bottom plate 44, and the left and right side plates 40. A second opening O2 is formed in a portion of the bottom plate 44 below a rear portion of the second harness 25. A third opening O3 is formed in a portion of the body frame 2 surrounded by the rear plate 43, a rear edge of the bottom plate 44, and the left and right side plates 40. That is, the body frame 2 has the first opening O1, the second opening O2, and the third opening O3.

**[0037]** The first opening O1 is configured to expose the first harness 24 and the cooling hose 23 in the downward direction. The second opening O2 is configured to expose the second harness 25 in the downward direction. The third opening O3 is configured to expose the motor M (specifically, a portion (water-cooled portion) Mb of the motor M in which cooling water flows) in the downward direction.

#### Cover Members

**[0038]** As shown in FIGS. 4 to 6, a first cover member 48, a second cover member 49, and a third cover member 50 are attached to the body frame 2. The first cover member 48 is configured to cover the first opening O1. More specifically, the first cover member 48 is configured to cover a portion of the first harness 24 exposed downward through the first opening O1 and a portion of the cooling hose 23 exposed downward through the first opening O1. The portion of the first harness 24 exposed downward through the first opening O1 and the portion of the cooling hose 23 exposed downward through the first opening O1 are covered by the first cover member 48 from below.

**[0039]** The first cover member 48 includes a horizontal surface portion 48a, left and right bent portions 48b, and recessed portions 48c. The bent portions 48b have shapes that are bent upward relative to the horizontal surface portion 48a in such a manner as to extend along the respective side plates 40. The recessed portions 48c are configured to accommodate therein members (e.g., a member supporting a front portion of the grass cutting device 19) around the first cover member 48, and thus, the first cover member 48 does not obstruct the members around the first cover member 48. The first cover member 48 is fixed to the left and right side plates 40 by a plurality of bolts 51. Specifically, each bent portion 48b is pressed against the corresponding side plate 40 from the lateral outer side and is fixed to the side plate 40 by a plurality of (two in the present embodiment) bolts 51.

**[0040]** The second cover member 49 is configured to

cover the second opening O2. More specifically, the second cover member 49 is configured to cover a portion of the second harness 25 exposed downward through the second opening O2. The portion of the second harness 25 exposed downward through the second opening O2 is covered by the second cover member 49 from below.

**[0041]** The second cover member 49 has a plurality of (four in the present embodiment) drain holes 49a. The drain holes 49a are formed in a portion of the second cover member 49 that faces the second opening O2. The second cover member 49 is pressed against the bottom plate 44 from below and is fixed to the bottom plate 44 by a plurality of (four in the present embodiment) bolts 52.

**[0042]** The third cover member 50 is configured to cover the third opening O3. More specifically, the third cover member 50 is configured to cover a portion of the motor M exposed downward through the third opening O3. In the present embodiment, the third cover member 50 is configured to cover the water-cooled portion Mb of the motor M. The portion (water-cooled portion Mb) of the motor M exposed downward through the third opening O3 is covered by the third cover member 50 from below.

**[0043]** In the present embodiment, the third cover member 50 is configured to partially cover the third opening O3. A portion of the third opening O3 between a front edge of the third cover member 50 and the rear edge of the bottom plate 44 and a portion of the third opening O3 between a rear edge of the third cover member 50 and the rear plate 43 are not covered by the third cover member 50. The third cover member 50 is pressed against the lateral plate 45 from below and is fixed to the lateral plate 45 by a plurality of (two in the present embodiment) bolts 53.

**[0044]** Here, a transmission shaft 54 for transmitting motive power from the motor M (motive power from the transmission 16) to the left and right front wheels 10 is provided below the bottom plate 44. The transmission shaft 54 is held by the third cover member 50 via a stay 55.

#### Other Embodiments

#### **[0045]**

(1) In the above-described embodiment, the first cover member 48 is configured to partially cover the first opening O1. However, the first cover member 48 may be configured to cover the entire first opening O1.

(2) In the above-described embodiment, the second cover member 49 is configured to cover the entire second opening O2. However, the second cover member 49 may be configured to partially cover the second opening O2.

(3) In the present embodiment, the third cover member 50 is configured to partially cover the third opening O3. However, the third cover member 50 may be configured to cover the entire third opening O3.

(4) In the above-described embodiment, the third

cover member 50 is configured to cover the water-cooled portion Mb of the motor M. However, the third cover member 50 may be configured to cover a portion other than the water-cooled portion Mb of the motor M, in addition to the water-cooled portion Mb of the motor M.

(5) In the above-described embodiment, the second cover member 49 has the four drain holes 49a. However, the first cover member 48 may have one to three, or five or more, drain holes 49a.

(6) In the above-described embodiment, the transmission shaft 54 is held by the third cover member 50. However, the transmission shaft 54 may be held by the second cover member 49 instead of the third cover member 50 or together with the third cover member 50.

#### Industrial Applicability

**[0046]** The present invention is applicable to not only a tractor but also a combine harvester, a rice transplanter, and a utility vehicle (multipurpose vehicle).

#### Description of Reference Signs

#### **[0047]**

2: Body frame  
 4: Battery for driving (battery)  
 10: Front wheel (travel device)  
 11: Rear wheel (travel device)  
 14: Inverter  
 21: DC-DC converter  
 24: First harness  
 25: Second harness  
 48: First cover member  
 49: Second cover member  
 49a: Drain hole  
 50: Third cover member  
 54: Transmission shaft  
 M: Motor  
 Mb: Water-cooled portion  
 O1: First opening  
 O2: Second opening  
 O3: Third opening

#### Claims

1. An electric work vehicle comprising:
  - a battery (4);
  - an inverter (14) configured to convert DC power from the battery (4) to AC power;
  - a motor (M) drivable by electric power supplied from the inverter (14);
  - a travel device (10, 11) drivable by the motor (M);
  - a DC-DC converter (21) configured to step down

electric power from the battery (4);  
 a first harness (24) connecting the battery (4)  
 and the DC-DC converter (21);  
 a second harness (25) connecting the inverter  
 (14) and the motor (M); 5  
 a body frame (2) having a first opening (O1)  
 through which the first harness (24) is exposed  
 downward, a second opening (O2) through  
 which the second harness (25) is exposed  
 downward, and a third opening (O3) through 10  
 which the motor (M) is exposed downward, and  
 supporting the battery (4), the inverter (14), the  
 motor (M), and the DC-DC converter (21);  
 a first cover member (48) configured to cover a 15  
 portion of the first harness (24) exposed down-  
 ward through the first opening (O1) and config-  
 ured to be removable;  
 a second cover member (49) configured to cover  
 a portion of the second harness (25) exposed 20  
 downward through the second opening (O2) and  
 configured to be removable; and  
 a third cover member (50) configured to cover  
 a portion of the motor (M) exposed downward  
 through the third opening (O3) and configured 25  
 to be removable.

2. The electric work vehicle according to claim 1,  
 wherein the motor (M) is configured as a water-  
 cooled type, and 30  
 the third cover member (50) is configured to cov-  
 er a water-cooled portion (Mb) of the motor (M).

3. The electric work vehicle according to claim 1 or 2,  
 wherein at least any of the first cover member (48), 35  
 the second cover member (49), or the third cover  
 member (50) has a drain hole (49a).

4. The electric work vehicle according to any one of  
 claims 1 to 3, comprising: 40  
 a transmission shaft (54) configured to transmit  
 motive power from the motor (M) to the travel  
 device (10, 11),  
 wherein the transmission shaft (54) is held by at 45  
 least any of the first cover member (48), the sec-  
 ond cover member (49), or the third cover mem-  
 ber (50).

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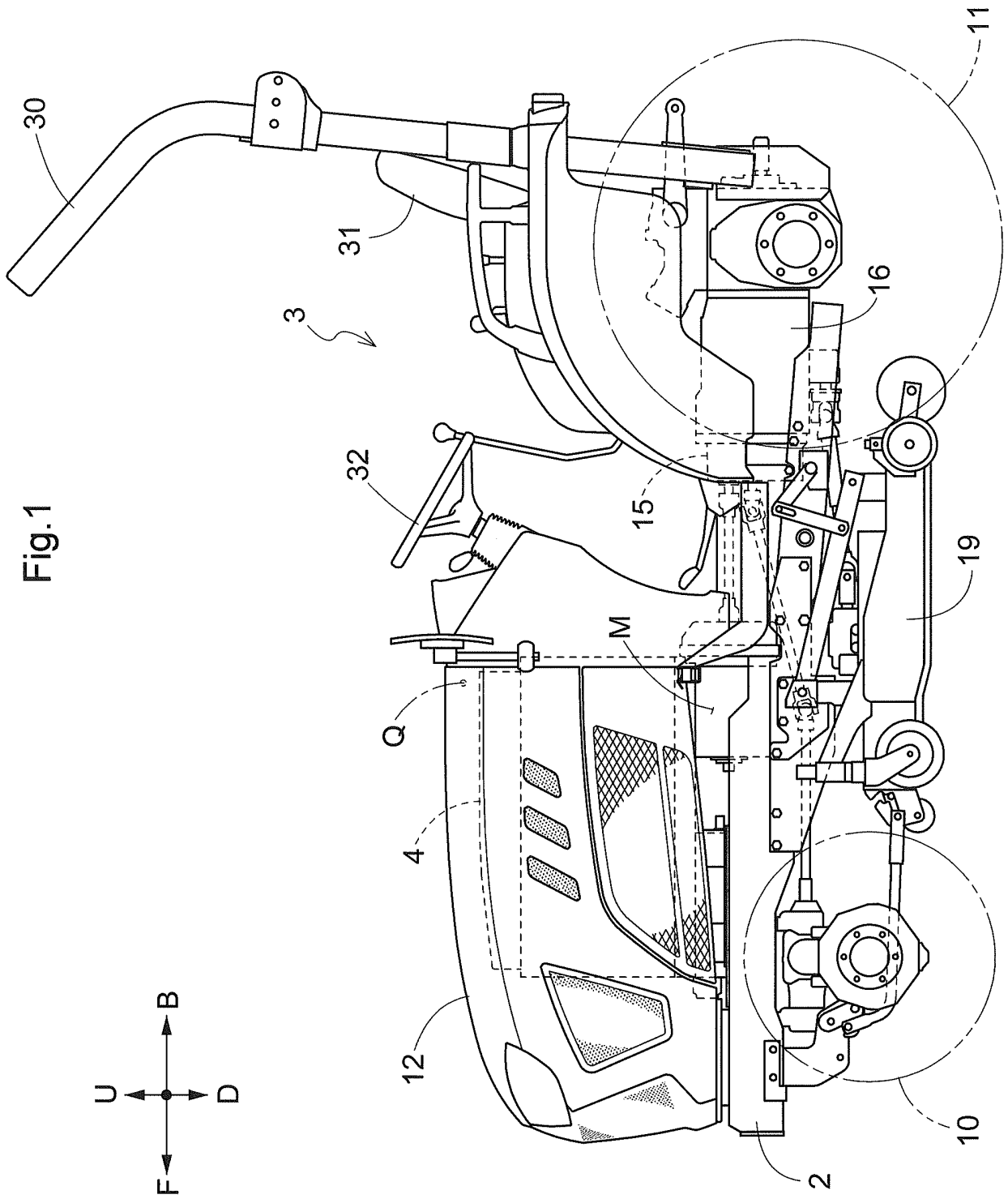


Fig.2

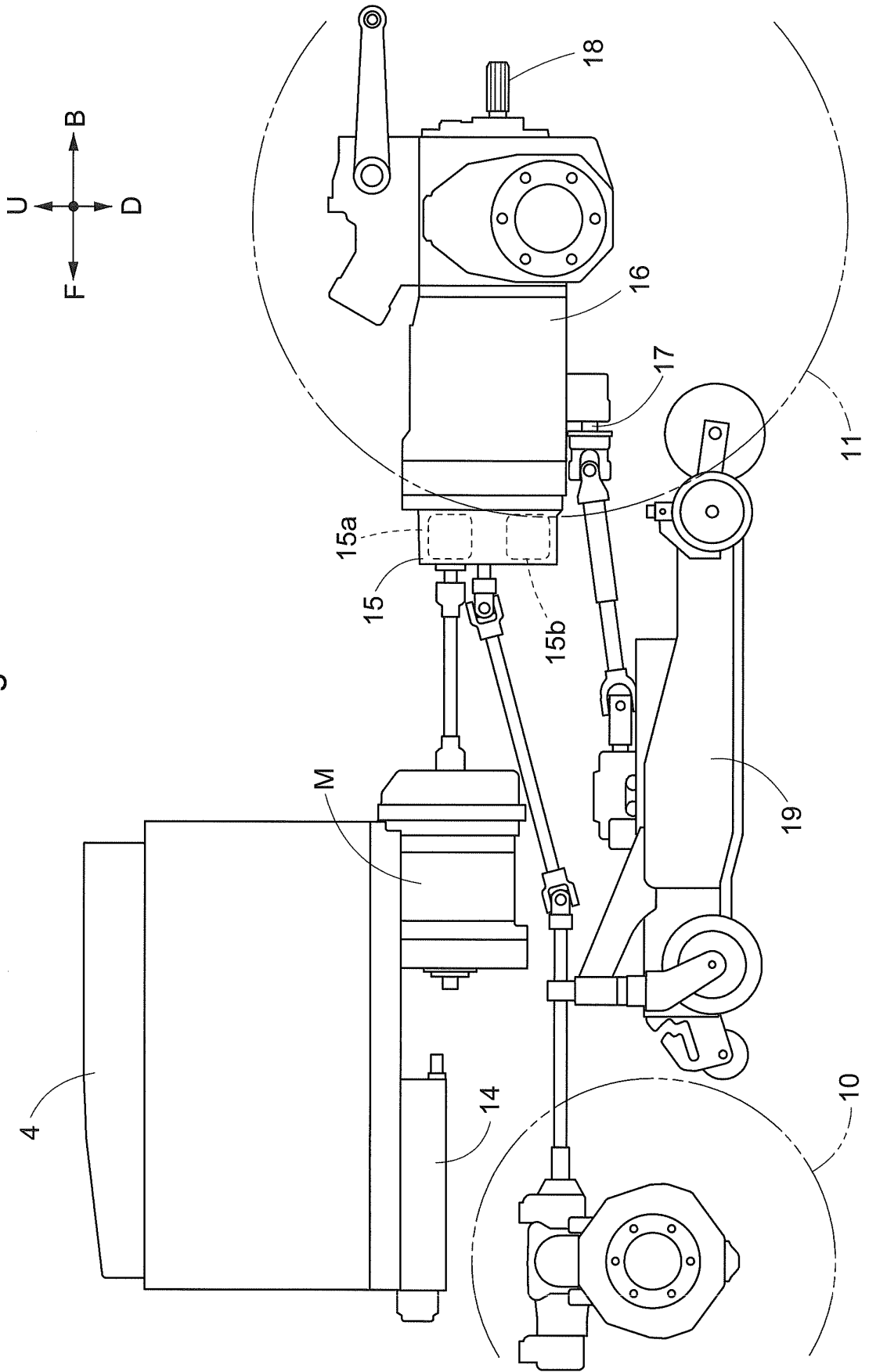
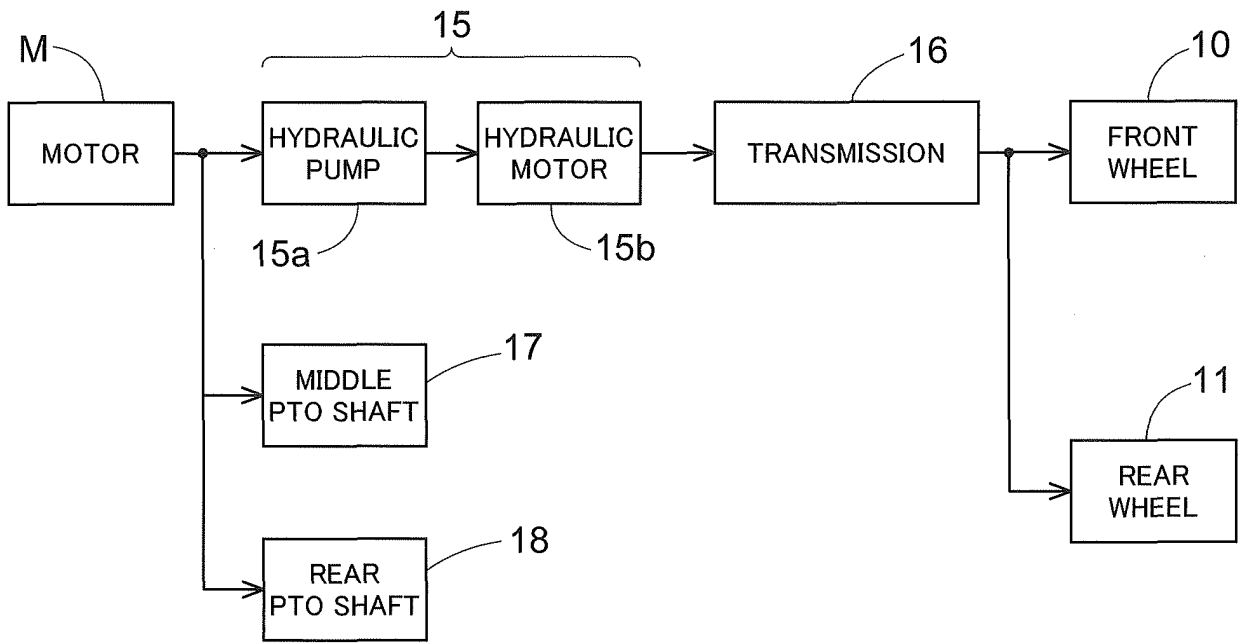




Fig.3



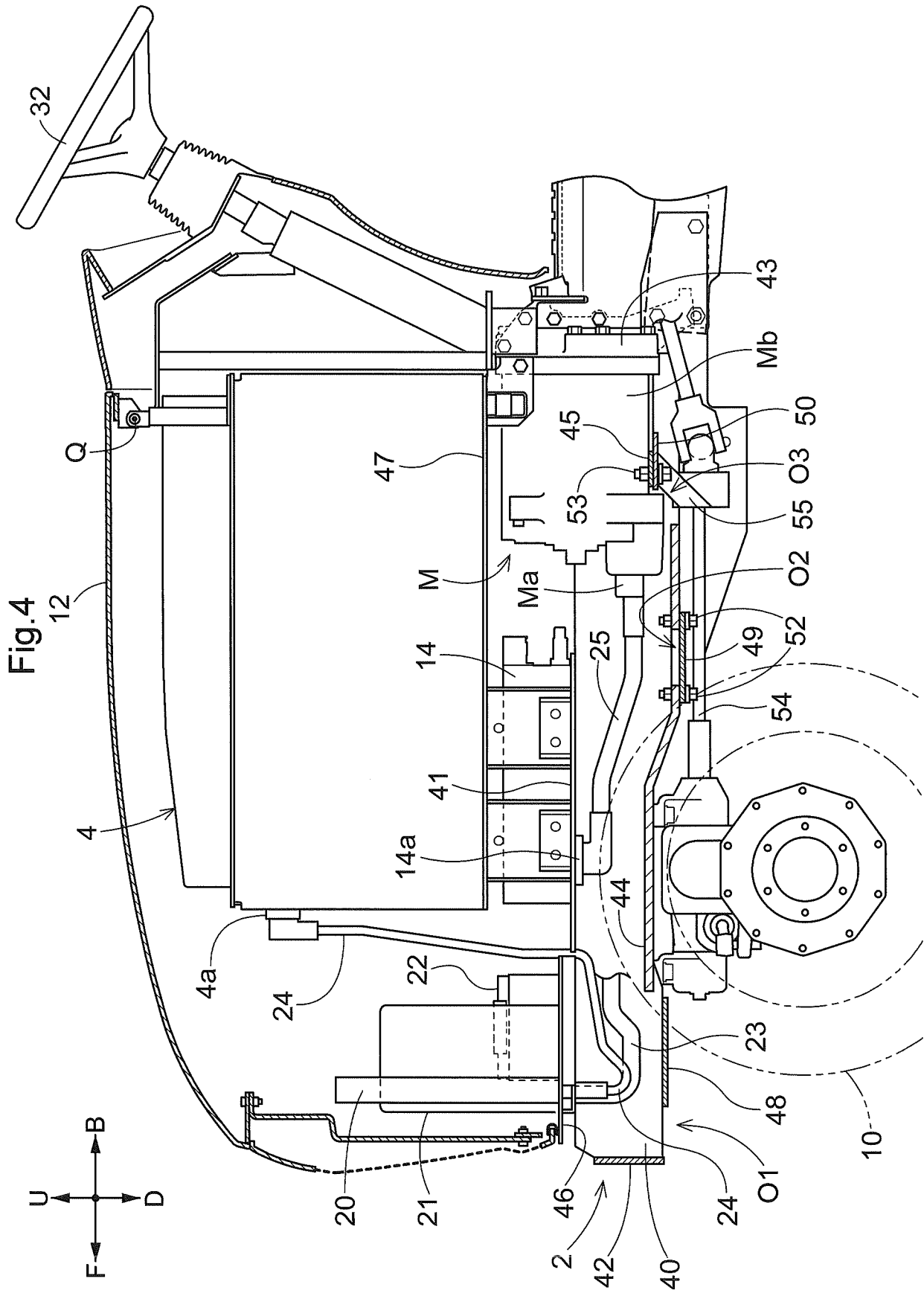
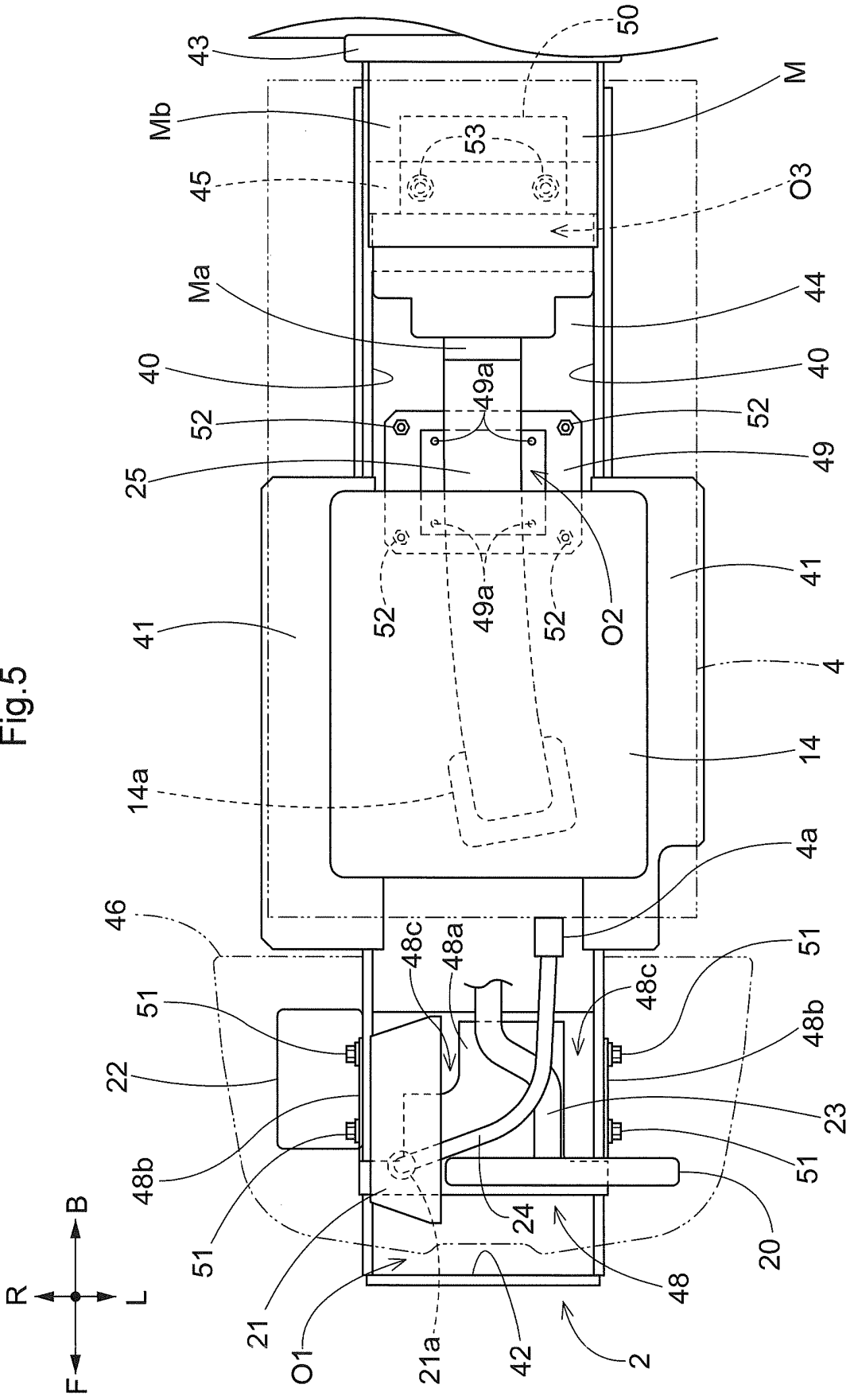
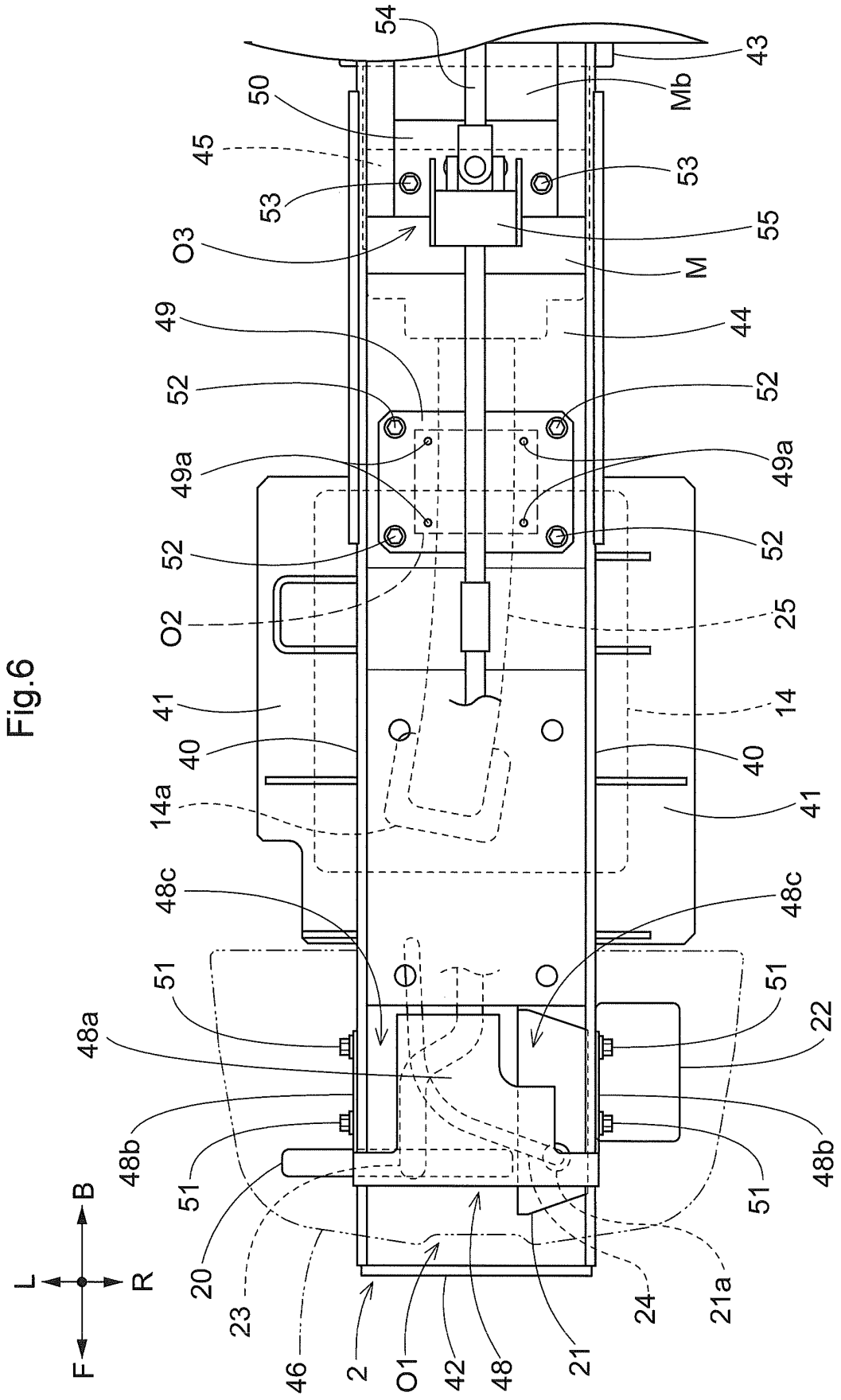


Fig.5





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/038590

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>	
<p><i>B60K 1/00</i>(2006.01)i; <i>B60K 1/04</i>(2019.01)i; <i>B60L 50/60</i>(2019.01)i; <i>B62D 21/18</i>(2006.01)i; <i>B62D 49/00</i>(2006.01)i            FI: B60K1/00; B60K1/04 Z; B60L50/60; B62D21/18 C; B62D49/00 B; B62D49/00 N</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>	
<b>B. FIELDS SEARCHED</b>	
<p>Minimum documentation searched (classification system followed by classification symbols)            B60K1/00-1/04; B60L50/60-50/64; B62D21/18-21/20; B62D49/00-49/08; B60L9/18-9/32; H01M10/625</p> <p>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 1971-2022            Registered utility model specifications of Japan 1996-2022            Published registered utility model applications of Japan 1994-2022</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>	
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>	
Category*	Citation of document, with indication, where appropriate, of the relevant passages
A	WO 2020/261845 A1 (KUBOTA CORP.) 30 December 2020 (2020-12-30) entire text, all drawings
A	JP 2018-176798 A (SOMIC ISHIKAWA INC.) 15 November 2018 (2018-11-15) entire text, all drawings
A	JP 2020-82983 A (MAZDA MOTOR CORP.) 04 June 2020 (2020-06-04) entire text, all drawings
A	JP 2017-137003 A (HONDA MOTOR CO., LTD.) 10 August 2017 (2017-08-10) entire text, all drawings
A	JP 2014-24485 A (KUBOTA CORP.) 06 February 2014 (2014-02-06) entire text, all drawings
A	JP 9-2080 A (TOYOTA AUTOM. LOOM WORKS, LTD.) 07 January 1997 (1997-01-07) entire text, all drawings
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.	
* Special categories of cited documents:	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"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</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search	Date of mailing of the international search report
<b>05 December 2022</b>	<b>20 December 2022</b>
Name and mailing address of the ISA/JP	Authorized officer
<b>Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan</b>	
	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.  
**PCT/JP2022/038590**

5  
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				CN	113840750	A	
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