



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**21.10.2020 Bulletin 2020/43**

(51) Int Cl.:  
**E02F 3/43** (2006.01) *E02F 3/34* (2006.01)

(21) Application number: **20169559.0**

(22) Date of filing: **15.04.2020**

(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 MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**  
Designated Validation States:  
**KH MA MD TN**

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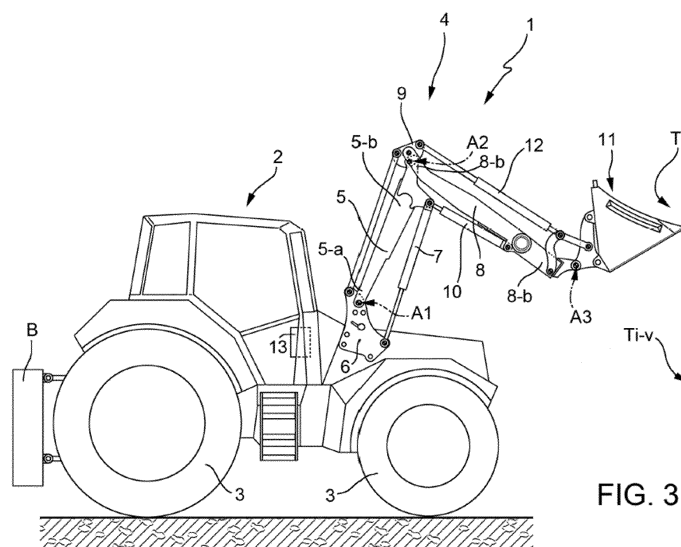
(30) Priority: **15.04.2019 IT 201900005800**

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(54) **INDUSTRIAL VEHICLE PROVIDED WITH A FRONT TOOL**

(57) Industrial vehicle (1) wherein a vehicle body (2) provided with wheels (3) or tracks has a front loading device (4) comprising: a rear boom (5) having a first end (5-a) rotably connected with a loader connection frame (6) carried by the vehicle body (2) and angularly movable ( $\alpha$ ) around a first axis (A1) under the thrust of a first actuator (7); a front boom (8) having a first end (8-a) rotably connected with a second end (5-b) of the rear boom (5) and angularly movable ( $\beta$ ) around a second axis (A2) under the thrust of a second actuator (10); a tool designed to load and move material (11) carried by a second end (8-b) of the front boom (8) and rotably connected with respect said second end and angularly movable ( $\omega$ )

around a third axis (A3) under the thrust of a third actuator (12). A control unit (13) is designed to control the movement of first actuator (7), the movement of the second actuator (10) and the movement of the third actuator (13) so that the angular movement of the rear boom (5) with respect to the connection frame (6) around the first axis (A1), the angular movement of the front boom (8) with respect to the rear boom (5) around the second axis (A2) and the angular movement the tool (11) with respect of the front boom (8) around the third axis (A3) produces predetermined selectable trajectory of the tool (11). (figures 2-4)



**FIG. 3**

## Description

### TECHNICAL FIELD

5 [0001] The present invention relates to an industrial vehicle provided with a front tool.

### BACKGROUND OF THE INVENTION

[0002] Industrial vehicles provided with a front tool to grip, hold and move any kind of material are known in the art.  
 10 [0003] An example of such a vehicle is a front loader that is a machine for holding and moving material, for instance earth, sand, rocks, pallets, wood, logs, etc.) by means of a front tool (a scoop or bucket, a pallet handler, a log handler, etc.) onto trucks that transport the material to its final location.  
 [0004] Another example of such a vehicle is an excavator.  
 [0005] The tool is generally movable around a semi-circular trajectory under the thrust of actuators (for instance  
 15 hydraulic cylinders) between a lower position and an upper position.  
 [0006] Due to the above trajectory, the load on the front axle increases during lifting process since the distance between front axle and load increases when lifting. Due to this effect, machines are equipped with upsized front axle. In addition, the front loader needs a heavier counterweight in the back (B) to raise the load due to dynamic inertia change.  
 [0007] For instance, patent application WO2018070922 (A1) describes an agricultural device for semi-automatic move-  
 20 ment of a holding tool, for holding an object, between two positions at different heights. The device comprises a holding tool for holding the object, a load sensor means for determining if the holding tool holds an object, a driver for moving the holding tool up and down, a control unit for controlling the driver and a user interface for receiving user input for the control unit. The device can be used in two modes of operations, wherein the holding tool in a first mode of operation is  
 25 freely movably, and in a second mode of operation is semi-automatically movable between a plurality of determined positions (URP, UPP, LRP, LPP) depending on if the holding tool is holding an object or not, and which command is given to the user interface.  
 [0008] The aim of the present invention is to provide a front loader with optional parallelism kinematics in which the user may choose one or more moving strategy of the front tool to grip bucket other than semi-circular.

### 30 SUMMARY OF THE INVENTION

[0009] The above aim is obtained by the present invention that relates to an industrial vehicle provided with a front tool as described in claim 1.

### 35 BRIEF DESCRIPTION OF DRAWINGS

[0010] For a better understanding of the present invention, a preferred embodiment is described in the following, by way of a non-limiting example, with reference to the attached drawings wherein:

40 Figure 1 shows schematically an industrial vehicle provided with a front tool and having an optional parallelism kinematics according to the present invention;  
 Figures 2-4 show an example of an operation of the industrial vehicle.

### DETAILED DESCRIPTION OF THE INVENTION

45 [0011] In figure 1, numeral 1 indicates an industrial vehicle provided with a front tool and having an optional parallelism kinematics.

[0012] As not limiting example a front loader is shown.

50 [0013] The industrial vehicle 1 has a vehicle body 2 provided with wheels 3 or tracks with a front loading device 4 comprising:

a rear boom 5 having a first end 5-a rotably connected with a loader connection frame 6 carried by the vehicle body 2 and angularly movable ( $\alpha$ ) around a first axis A1 under the thrust of a first actuator 7;  
 a front boom 8 having a first end 8-a rotably connected with a second end 5-b of the rear boom 5 and angularly  
 55 movable ( $\beta$ ) around a second axis A2 under the thrust of a second actuator 10;  
 a tool 11 (in the example a scoop or bucket even if different tools may be used such as a pallet handler, a log handler, etc) carried by a second end 8-b of the front boom 8 and rotably connected with respect the second end 8-b and angularly movable ( $\omega$ ) around a third axis A3 under the thrust of a third actuator 12.

**[0014]** More specifically according one example, the first actuator 7 (for example an hydraulic cylinder) having one end rotably connected with the front loader connection frame 6 and another end rotably connected with the second end 5-b of the rear boom 5; the second actuator 10 (for instance a second hydraulic cylinder) having one end rotably connected with the second end 5-b of the rear boom -and another end rotably connected with the second 8-b end of the front boom 8; the third actuator 12 (for instance third hydraulic cylinder) having one end rotably connected with an upper portion of a joint element 9 and another end rotably connected with the tool 11 (in the example the scoop or the bucket) . The joint element 9 protrudes with said upper portion from the area of connection of the rear boom 5 with the front boom 8. The rear boom 5 and the first actuator 7 are both connected to the front loader connection frame 6 at different locations. It is however clear that the actuators 7, 10 and 12 may be of any kind of actuators i.e. a mechanic, hydraulic, electrohydraulic, etc.

**[0015]** According to the present invention a control unit 13 is provided to control the movement of first actuator 7, the movement of the second actuator 10 and the movement of the third actuator 12 so that the angular movement of the rear boom 5 with respect to the connection frame 6 around the first axis (A1), the angular movement of the front boom 8 with respect to the rear boom 5 around the second axis (A2) and the angular movement of the tool 11 with respect to the front boom 8 around the third axis (A3) produces predetermined selectable trajectory profile **Ti** of the tool 11.

**[0016]** More specifically, the control unit 13 is so designed as to establish a straight vertical trajectory profile **Ti-v** of the tool 11 between a lower position (figure 2) and an upper position (figure 4) and vice versa.

**[0017]** The use of a straight vertical trajectory profile **Ti-v** has a lot of advantages:

- Load can be kept closer to the front axle of the industrial vehicle;
- Less/no counter ballast B needed in the back of the industrial vehicle; and
- Front Axle can be smaller by keeping the same loader capacity.

**[0018]** Generally speaking, more than one trajectory profiles **Ti** are available to the user of the industrial vehicle 1 that may choose among different profiles such as:

- Standard profile, the tool 11 moves along a semi-circular path;
- Vertical lift, the tool 11 moves along the above straight vertical trajectory profile **Ti-v**;
- Special profile, the tool 11 moves along a non rectilinear or non circular path, for example a vertical S-shaped path.
- Profile with increased lift height

**[0019]** The control unit 13 is an electronic unit and is designed to establish successive pre-set angular positions of the front boom 8 with respect to the connection frame 6 around the first axis (A1), of the front boom 8 with respect to the rear boom 5 around the second axis (A2) and of the tool 11 with respect of the front boom 8 around the third axis (A3) in order to establish the selected trajectory **Ti**.

Time	Angular position	Angular position	Angular position
T1	$\alpha 1$	$\beta 1$	$\omega 1$
T2	$\alpha 2$	$\beta 2$	$\omega 2$
..	..	..	
Ti	$\alpha i$	Bi	$\omega i$
Tn	$\alpha n$	Bn	$\omega n$

Angles may be measured by means of know techniques (for instance using encoders) and may be compared with preset target values set in a memorized table utilizing a closed loop control system of know kind.

**[0020]** However, the control of the front loader is not mandatory to be electronic.

The control strategy can be mechanical (for example by mechanic controlled hydraulic valve) or electro hydraulic (as described).

Mechanical control strategy (e.g. vertical lift): Dependent on the position of rear boom, a mechanical controlled valve (which is connected with the rear boom) controls the position of the front boom.

## Claims

1. Industrial vehicle wherein a vehicle body (2) provided with wheels (3) or tracks has a front loading device (4)

comprising:

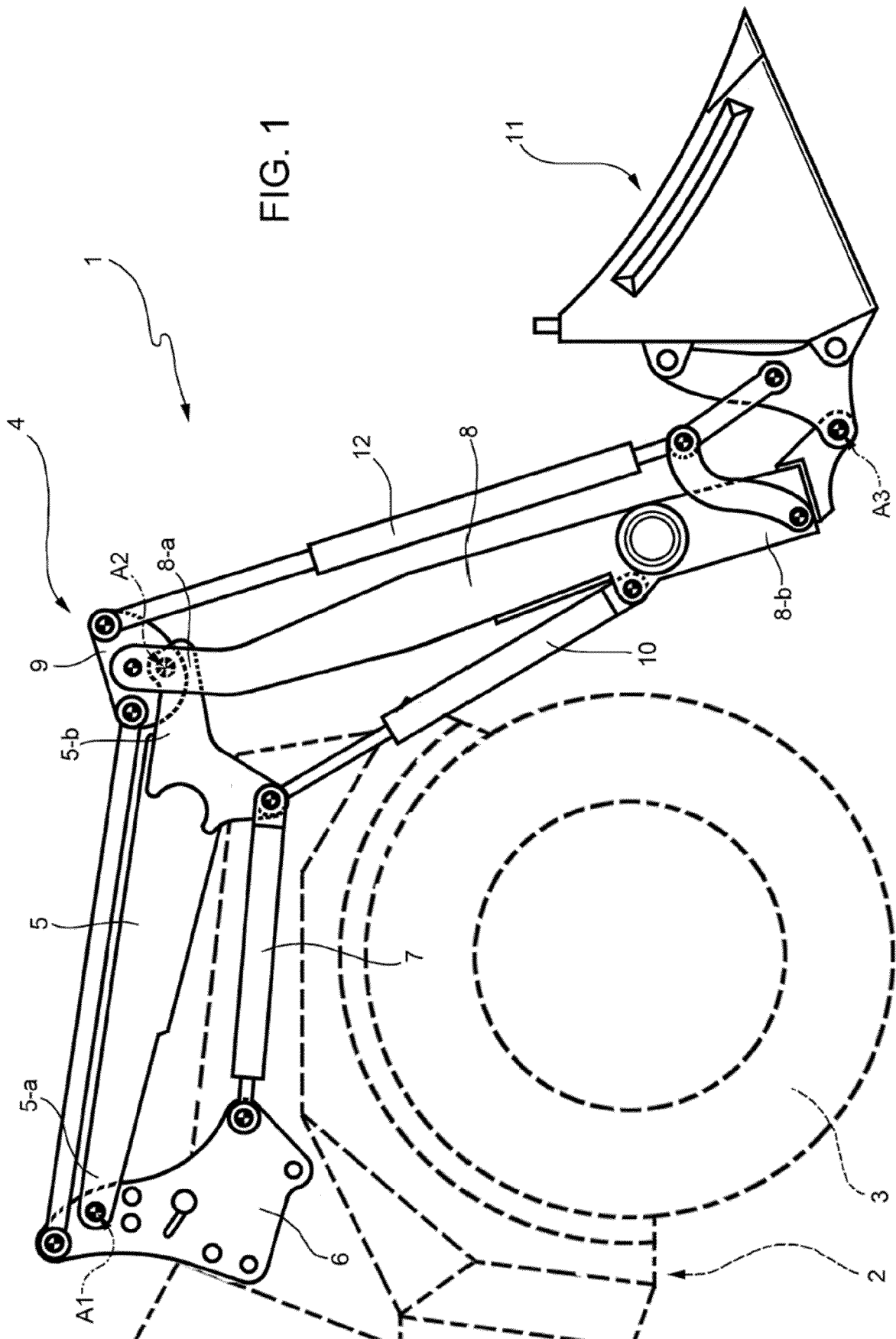
a rear boom (5) having a first end (5-a) rotably connected with a loader connection frame (6) carried by the vehicle body (2) and angularly movable ( $\alpha$ ) around a first axis (A1) under the thrust of a first actuator (7);

a front boom (8) having a first end (8-a) rotably connected with a second end (5-b) of the rear boom (5) and angularly movable ( $\beta$ ) around a second axis (A2) under the thrust of a second actuator (10);

a tool (11) designed to load and move material carried by a second end (8-b) of the front boom (8) and rotably connected with respect said second end and angularly movable ( $\omega$ ) around a third axis (A3) under the thrust of a third actuator (12);

**characterized by** comprising a control unit (13) designed to control the movement of first actuator (7), the movement of the second actuator (10) and the movement of the third actuator (12) so that the angular movement of the rear boom (5) with respect to the loader connection frame (6) around the first axis (A1), the angular movement of the front boom (8) with respect to the rear boom (5) around the second axis (A2) and the angular movement of the tool (11) with respect to the front boom (8) around the third axis (A3) produces predetermined selectable vertical trajectory of the tool (11).

2. Industrial vehicle as defined in claim 1, wherein the control unit (13) is so designed as to establish a straight vertical trajectory (Ti-v) of the tool (11) between a lower position and an upper position and/or vice versa.
3. Industrial vehicle as defined in claim 1, wherein the control unit (13) is an electronic unit and is designed to establish successive pre-set angular positions of the front boom (8) with respect to the loader connection frame (6) around the first axis (A1), of the front boom (8) with respect to the rear boom (5) around the second axis (A2) and of the tool (11) with respect of the front boom (8) around the third axis (A3) in order to establish the selected vertical trajectory.
4. Industrial vehicle as defined in claim 1, wherein the control means have table means where said pre-set angular position are memorized.
5. Industrial vehicle as defined in any of the preceding claims, wherein the first actuator (7) is a first hydraulic cylinder having one end rotably connected with the front loader connection frame (6) and another end rotably connected with the second end (5-b) of the rear boom (5); the second actuator (10) is a second hydraulic cylinder having one end rotably connected with the second end (5-b) of the rear boom (5) and another end rotably connected with said second (8-b) end of the front boom (8); said third actuator (12) is a third hydraulic cylinder having one end rotably connected with a joint element (9) and another end rotably connected with said tool (11); the joint element (9) protrudes from the area of connection of the rear boom (5) with the front boom (8).



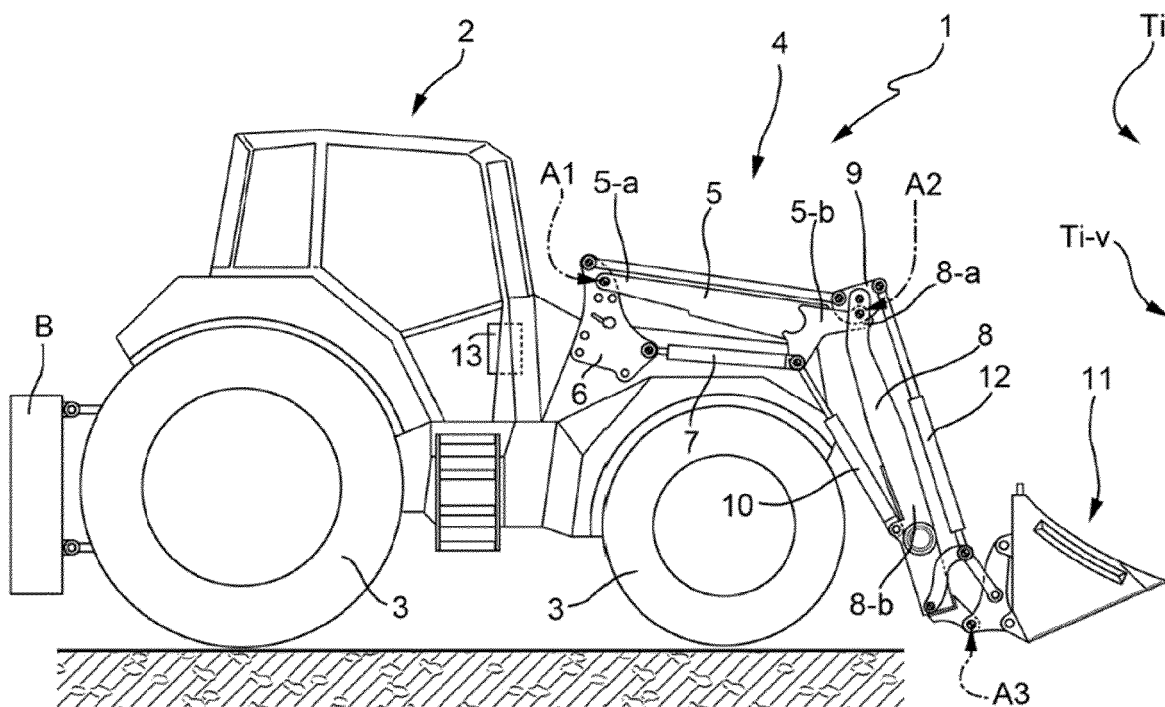


FIG. 2

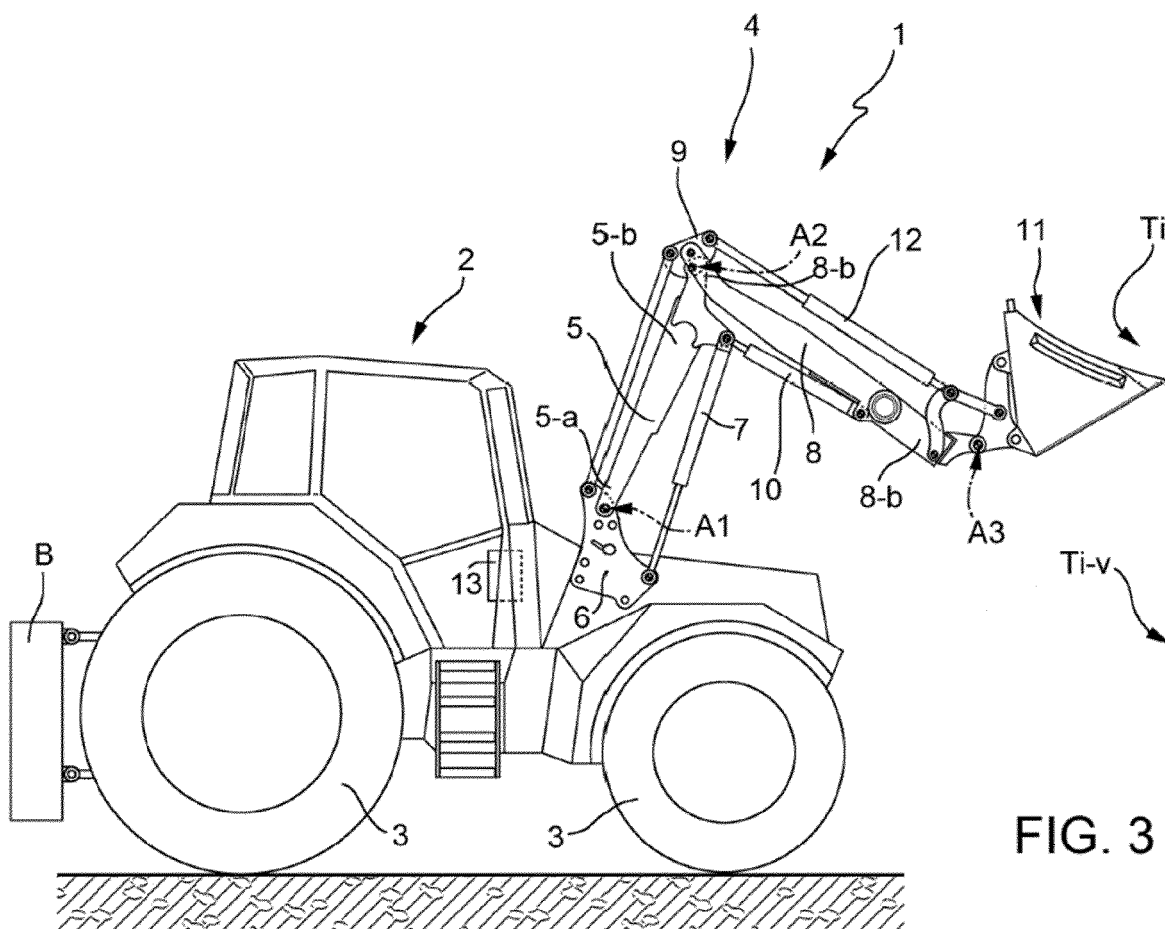
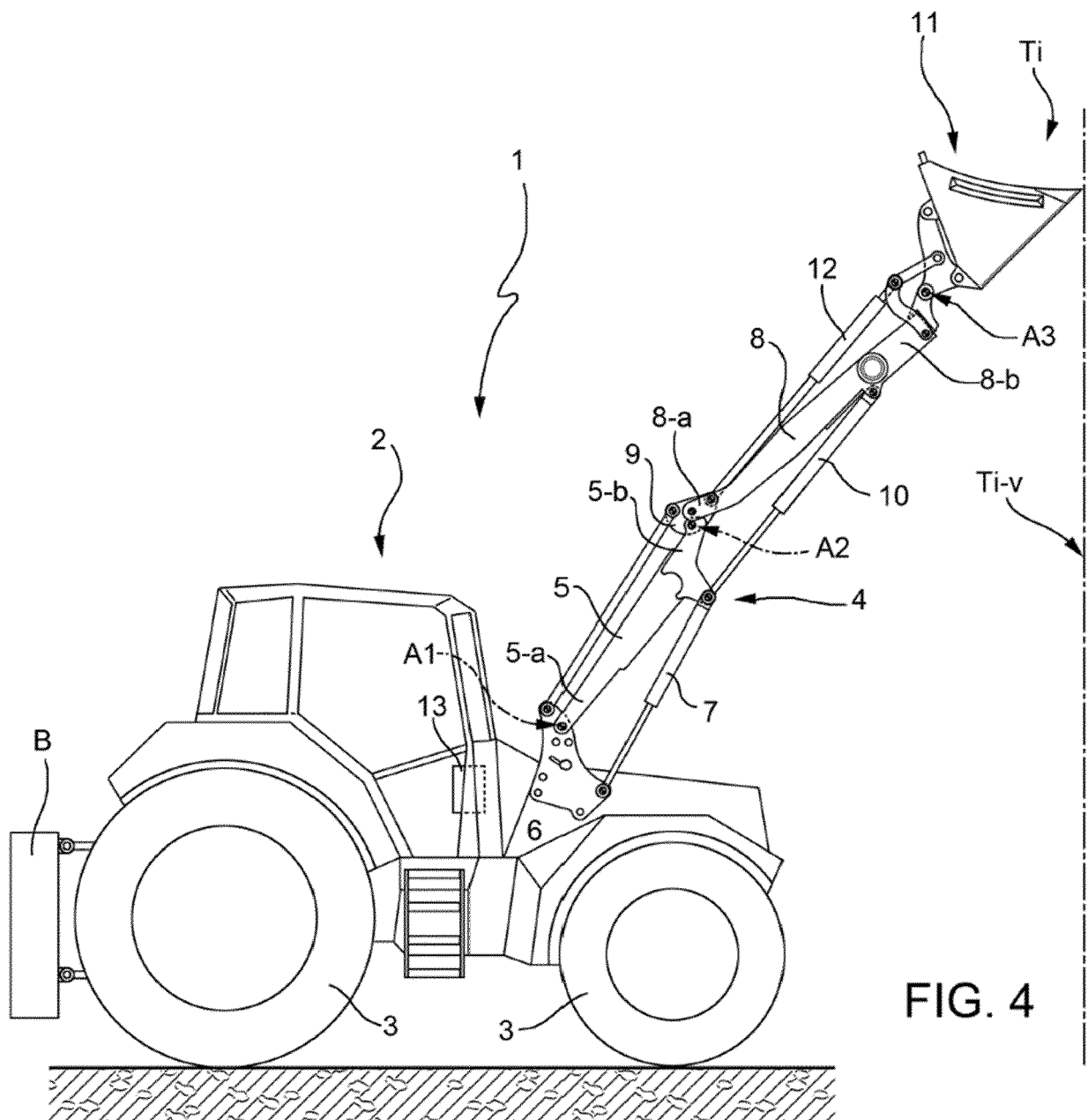


FIG. 3





## EUROPEAN SEARCH REPORT

Application Number  
EP 20 16 9559

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>14 August 2020</b>	Examiner <b>Autran, Adrien</b>
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.02 (P04C01)



**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 16 9559

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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