(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
01 August 2019 (01.08.2019)

WIPO | PCT

(10) **International Publication Number**
WO 2019/144687 A1

(51) **International Patent Classification:**
E02F 3/28 (2006.01) *E02F 3/42* (2006.01)
E02F 3/36 (2006.01)

(21) **International Application Number:** PCT/CN2018/117223

(22) **International Filing Date:** 23 November 2018 (23.11.2018)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
201810076343.4 26 January 2018 (26.01.2018) CN

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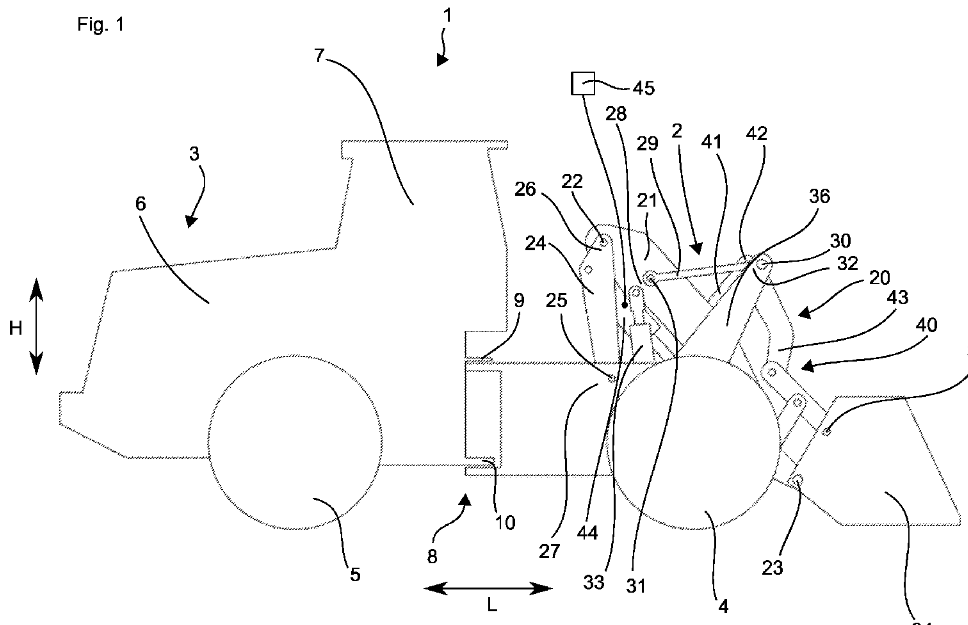
(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

WO 2019/144687 A1

(54) **Title:** VERTICAL LIFT LOADER

Fig. 1



(57) **Abstract:** A loader (1) with a frame arrangement (2, 3) and a lifting arrangement (20, 50), the lifting arrangement (20, 50) being mounted to the frame arrangement (2, 3) and comprising a main arm (21), which is provided with a pivot connector (22) at a proximate end thereof and an equipment connector (23) at a distal end thereof, and a main arm actuating element (33) for moving said main arm (21) between a lowered position and a lifted position, wherein the lifting arrangement (20, 50) is configured to move the equipment connector (23) between the lowered position and the lifted position along a substantially J-shaped path in order to move the equipment connector (23) forward in the front-rear direction of the loader upon lifting.

[Continued on next page]

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

VERTICAL LIFT LOADER

Technical Field

The present invention to a loader having a frame arrangement and lifting arrangement for lifting an equipment between lowered position and lifted position. The lifting arrangement is mounted to the frame arrangement. The lifting arrangement comprises a main arm and a main arm actuating element for pivotably supporting the main arm.

Background of the invention

Loaders usually comprise a front-mounted bucket to scoop up loose material from the ground, such as dirt, sand or gravel, and move it from one place to another without pushing the material across the ground. Loaders may be used to move a stockpiled material from ground level and deposit it into an awaiting dump truck.

Said loaders usually comprise a lifting arrangement for moving the bucket from a lowered position to a lifted position. Conventional lifting arrangements comprise a main arm with a pivot connector, which is mounted to the loader frame, and an equipment connector for mounting a bucket thereto. Upon moving the main arm between a lowered position and a lifted position, the equipment connector follows a substantially arcuate path, as the main arm is rotated around a point, which is fixed in space relative to the frame arrangement of the loader. Such lifting arrangements are known as radial lifting arrangements.

Recently, vertical lifting arrangements for loaders have been proposed. Said vertical lifting arrangements comprise a main arm support means, which is pivotably mounted to the machine frame of the loader, and a main arm with a pivot connector, which is mounted to the main arm support means. The main arm support means allows for an adjustment of the point of rotation of the main arm to provide movement paths of the equipment connector between lowered and lifted positions that deviate from an arcuate path. Such vertical lifting arrangements are known from WO 2016/123732 A1 and WO 2016/123735 A1.

Summary of the invention

The present invention relates to a loader having a frame arrangement and a lifting arrangement. The lifting arrangement is mounted to the frame arrangement. The lifting arrangement may be detachable or non-detachable from the frame arrangement during normal operation of the loader. The lifting arrangement is configured to lift an equipment, which is mounted to the lifting arrangement, between a lowered position and a lifted position. The frame arrangement may be a base structure of the loader, to which different equipment groups, e.g. an engine compartment, an operator's cap, the above-noted lifting arrangement, ground engaging elements, e.g. wheels or tracks, and/or further equipment, is attached. The frame arrangement may be composed of a singular or multiple different parts.

The loader may be a construction machine suitable for moving aside or loading materials, such as asphalt, demolition debris, dirt, snow, gravel, raw minerals, recycled material, rock, sand, woodchips, etc., into or onto another type of machinery, e.g. a dump truck, a conveyor belt and/or a rail road car. The loader may be any type of loader, e.g. a wheel loader or a skid-steer loader. The loader may be a tracked loader. On each side of the loader, only one track may be provided. Alternatively, on each side of the loader, two or more tracks, e.g. a front track and a rear track, which are separated from each other, may be provided.

The lifting arrangement comprises a main arm, which is provided with a pivot connector at a proximate end thereof and an equipment connector at a distal end thereof. The equipment connector is configured such that an equipment, e.g. a bucket or a lifting fork, may be mounted thereto. Furthermore, the lifting arrangement comprises a main arm actuating element for moving the main arm between a lowered position and a lifted position. The main arm actuating element may be mounted to the main arm or any other part of the lifting arrangement at one end, and to the frame arrangement at the other end thereof. The main arm actuating element is provided to lift the main arm, i.e. the equipment connector provided at the distal end of the main arm, between a lowered position and a lifted position. The main arm actuating element may be a hydraulic and/or pneumatic cylinder. Alternatively, the main arm actuating element may be driven by an electric motor and/or a spindle drive.

The lifting arrangement is configured to move the equipment connector between the lowered position and the lifted position along a substantially J-shaped path. The J-shaped path is oriented with respect to the loader such that the equipment connector is moved forward in the front-rear direction of the loader upon lifting. The J-shaped path is oriented such that the arc-shaped portion of the J is situated close to the lowered position and bulges outwards away from the loader before passing over in the substantially line portion of the J, which extends upwards towards the lifted position. The path may deviate from an exact J-shape, as long as the path is of J-shaped nature in view of the present technical field. However, preferably, for being of J-shaped nature, the equipment connector must be moved forward in the initial arc-shaped portion of the J, before being moved more or less straight upwards.

The front-rear direction of the loader extends from the front of the loader to the rear of the loader when the loader is moved straight forward and is situated centrally of the loader in a top view thereon. A width direction of the loader is situated perpendicular to the front-rear direction in a top view of the loader. A height direction of the loader is situated perpendicular to the front-rear direction and to the width direction of the loader. A lowered position of the lifting arrangement may be the lowest position of the lifting arrangement, which may be provided during normal operation of the loader. The lifted position may be the highest position of the lifting arrangement, which may be provided during normal operation of the loader.

The loader of the present invention allows for an easy loading of the equipment mounted to the equipment connector, e.g. filling of a bucket, due to a forward movement of the equipment close to the lowered position of the lifting arrangement. For example, to move the bucket into a pile of sand, the lifting arrangement only must be lifted. In other words, the loader as a whole does not have to be moved, at least not as much, forward to move the equipment into the sand pile. This simplifies operation of the loader. At the same time, the substantially straight-line portion of the J-shaped lifting path ensures that the distance of the equipment's centroid to the machine's center of gravity remains relatively small, thereby increasing the loader's tipping load.

According to an embodiment, the frame arrangement comprises a front frame portion and a rear frame portion, which are articulatingly interconnected for providing an articulating steering, the lifting arrangement being supported by the front frame portion. The front frame portion is situated forward of the rear frame portion in the front-rear direction of the loader. The front frame portion may support front wheels, and the rear frame portion may support rear wheels. Alternatively, the loader may be a tracked loader. The front frame portion may support front tracks, and/or the rear frame portion may support rear tracks. The articulating steering arrangement may be actuated via hydraulic cylinders, an electric motor and/or differently. The front frame portion may be specifically designed and adapted to accommodate the lifting arrangement. In particular, the front frame portion may exhibit a structure, which deviates, preferably significantly, from existing front frame portions of loaders to be able to accommodate the lifting arrangement allowing for a J-shaped lifting path between the lowered and the lifted positions.

According to an embodiment, the lifting arrangement comprises a main arm support means with a proximal end and a distal end, wherein the proximal end is pivotably mounted to a first portion of the frame arrangement. The distal end is pivotably supporting the pivot connector of the main arm, wherein the main arm support means is movable in a direction, which includes at least a component in the front-rear direction of the loader. Via the main arm support means, the point of rotation of the main arm may be adapted to provide a movement path of the equipment connector between the lowered position and the lifted position, which deviates from a strictly arcuate path, namely a J-shaped path. The loader may be configured such that the extension direction of the main arm support means from the proximal end to the distal end, in the lowered position of the lifting arrangement, is oriented upwards in the height direction and backwards in the front-rear direction of the loader. In the lifted position of the lifting arrangement, the extension direction of the main arm support means from the proximal end to the distal end may be oriented upwards in the height direction and forward in the front-rear direction of the loader. In other words, during movement of the lifting arrangement between the lowered position and the lifted position, the main arm support means is turned to cross over the height direction of the loader. Preferably, the main arm support means encloses an angle with the height direction, which is smaller than |45°|, more preferably |40°| or |30°|, even more preferably |25°| in all operating conditions of the lifting arrangement. This embodiment allows for high dump heights, as the movement regime of the main arm support means around the height direction of the loader implies relatively low influence thereof on the loader's dump height.

According to an embodiment, the lifting arrangement further comprises a guiding means with a proximal end and a distal end, wherein the proximal end is pivotably mounted to a second support portion of the frame arrangement, and wherein the distal end is engaged to the main arm at a guided portion of said main arm, which is positioned between the pivot connector and the equipment connector. The lifting arrangement according to this embodiment is configured such that the guiding means guides the main arm between the lowered and the lifted position such that the equipment connector of the main arm follows the J-shaped path. According to this embodiment, the J-shaped lifting path may be realized with only one actuating element and a respectively configured mechanical link structure. This provides a loader with a lifting arrangement having high reliability.

The main arm, the main arm support means and/or the guiding means may be formed as rigid link, whose structure is not adaptable during normal operation of the loader. Alternatively, the structure of the main arm, the main arm support means and/or the guiding means, e.g. the distance between the proximal end and the distal end, is adaptable during operation, e.g. by being formed as linear actuator. The proximal end of the main arm, the main arm support means and/or the guiding means may be that end of the respective part, which is situated closer to the frame arrangement than the distal end of the respective part in the kinematic chain of the lifting arrangement.

According to an embodiment, the second support portion of the frame arrangement, to which the proximal end of the guiding means is mounted, is provided above a ground engaging element of the loader, e.g. a wheel or a track. Preferably, the entire guiding means is provided above the ground engaging element of the loader, e.g. above the entire ground engagement element of the loader, in all operating conditions of the lifting arrangement. By removing the guiding means from the narrow and difficult to reach region around the ground engaging element, this embodiment enhances accessibility of the lifting arrangement, thereby reducing maintenance effort.

The front frame portion may comprise a protruding portion, which extends upwards in the height direction and forward in the front-rear direction of the loader. The second support portion may be provided at the distal end of the protruding portion. Preferably, the second support portion is the highest portion of a front frame portion in the height direction and/or the most forward portion of the front portion in the front-rear direction of the loader. This embodiment allows for good accessibility of the second support portion, at the same time providing a second support portion, which is moved to a significant degree towards the front of the loader so as to allow for a J-shaped movement path of the equipment connector, as described above. Preferably, in the present embodiment, the second support portion is provided backwards of the most forward portion of the front ground engaging element of the loader, e.g. the front wheel, in the front-rear direction of the loader. This ensures that, when approaching an obstacle, the ground engaging element and not the frame arrangement firstly hits the obstacle, thereby increasing reliability of the loader.

According to an embodiment, in the lowered position of the lifting arrangement, the extension direction of the guiding means from the proximal end to the distal end exhibits an angle with respect to the front-rear direction of the loader, which is smaller than |30°|, preferably smaller than |20°|, even more preferably smaller than |10°|. This configuration implies that for small lifting heights, the guiding means is extending substantially parallel to the front-rear direction of the loader. Accordingly, for small lifting angles, the pivot connector of the main arm is not moved significantly in the front-rear direction via the main arm support means. As a result, for small lifting angles, the equipment connector is substantially moved along an arc portion, i.e. the arc-shaped portion of the J-shaped path. For increasing lifting angles, the angle of the guiding means with respect to the front-rear direction increases, thereby increasing the shifting of the pivot connector of the main arm via the main arm support means in the front-rear direction of the loader. As a consequence, for larger lifting angles, the present configuration allows for lifting paths, significantly deviating from an arc-shaped path, i.e. for the substantially straight part of the J-shaped lifting path.

Preferably, in the lowered position of the lifting arrangement, the guiding means extends from the proximal end to the distal end backwards in the front-rear direction of the loader and downwards in the height direction of the loader. This configuration increases the movement region of the guiding means, which exhibits relatively small angles with respect to the front-rear direction of the loader, as, in this embodiment, positive and negative angles with respect to the front-rear direction are traversed by the guiding means during the lifting operation.

According to an embodiment, the lifting arrangement further comprises an auxiliary actuating element engaged to said main arm and said main arm support means for adjusting an angle therebetween. The loader according to this embodiment further comprises a control means configured to control an operation of said main arm actuating element and said auxiliary element such that said equipment connector follows the J-shaped path. A control means configured to perform a certain function is not only suitable but specifically arranged, i.e. programmed, to perform said function. Concerning the configuration of the auxiliary actuating element, it is referred to the above-described configuration of the main arm actuation element. This embodiment allows for the provision of a variety of non-arcuate lifting path with a single machine.

According to an embodiment, the main arm of the lifting arrangement comprises an adjustment mechanism for adjusting a distance between the pivot connector and the equipment connector. The adjustment mechanism may allow for a linear displacement of the pivot connector and the equipment connector with respect to each other. The adjustment mechanism may comprise a linear bearing. Furthermore, in this embodiment, the loader comprises an auxiliary actuating element for actuating the adjustment mechanism. Concerning the configuration of the auxiliary actuating element, it is referred to the above-described configuration of the main arm actuation element. The loader according to this embodiment further comprises a control means configured to control an operation of said main arm actuating element and said auxiliary actuating elements such that said equipment connector follows the J-shaped path between the lowered position and the lifted position. In other words, the control means is configured to coordinate the control of the main arm actuating element and the auxiliary actuating element with respect to each other such that their combined movement implies the J-shaped lifting path of the equipment connector.

According to an embodiment, the loader further comprises a tilting arrangement for tilting an equipment, e.g. a bucket, mounted to the equipment connector. The tilting arrangement is configured to rotate the equipment backwards, i.e. towards the rear of the loader in the front-rear direction thereof, while moving the lifting arrangement from the lowered position to the lifted position. Specifically, the tilting arrangement is configured to tilt the equipment backwards such that the equipment's centroid, i.e. the bucket's centroid, is not moved forward in the front-rear direction of the loader as much as the equipment connector during lifting. Preferably, the tilting arrangement is configured to tilt the equipment backwards when the equipment connector is moved through the arc-shaped portion of the J-shaped lifting path. By tilting the equipment backwards, the distance between the equipment’s centroid and the center of gravity of the overall loader may be decreased compared to a situation where the equipment is not rotated backwards. Accordingly, tilting the equipment backwards may compensate any forward movement of the equipment connector, thereby not decreasing the machine’s tipping load despite of the forward movement of the equipment connector during lifting. According to an embodiment, the tilting arrangement comprises a tilting actuating element, e.g. a hydraulic cylinder, for tilting the equipment, and a control means. The control means is configured to tilt the equipment via the tilting actuation element backwards upon moving the lifting arrangement from the lowered position to the lifted position, as described above.

According to an embodiment, the loader is a wheel loader and the equipment is a bucket, which is pivotably mounted to the equipment connector of the main arm.

Brief description of the drawings

Fig. 1 illustrates a side view of a loader with a lifting arrangement according to an embodiment of the invention in a lowered position.

Figs. 2a-2c schematically illustrate the lifting arrangement of the loader of Fig. 1 in a lifted, in an intermediate and in a lowered position.

Figs. 3a-3c schematically illustrate an alternative configuration of the lifting arrangement of the loader of Fig. 1 in a lifted, in an intermediate and in a lowered position.

Detailed description of embodiments

Fig. 1 shows a loader 1 according to an embodiment of the present invention in a simplified side view. Elements which are not essential for the invention are omitted. The loader 1 of the present embodiment is a wheel loader. The loader 1 comprises a front frame portion 2 and a rear frame portion 3. A pair of front wheels 4 is mounted to the front frame portion 2 and a pair of rear wheels 5 is mounted to the rear frame portion 3. An engine compartment 6 is provided at the rear frame portion 3. The engine compartment 6 houses one or multiple power sources for providing power required to operate the loader 1. The power sources can include but are not limited to an internal combustion engine, such as a Diesel engine, which can be coupled to further equipment such as hydraulic pumps, generators and the like. Alternatively or additionally, the power sources can include a battery and an electric engine. The power source is used to provide power for driving the front wheels 4 and/or the rear wheels 5 as well as for providing power for actuators of the construction machine 1. The actuators may be actuators of a lifting arrangement and/or a steering arrangement, for example. Furthermore, the loader 1 comprises an operator's cab 7, which is mounted to the rear frame portion 3. Inside the operator's cab 7, space for an operator of the loader 1 is provided.

The front frame portion 2 is mounted to the rear frame portion 3 with an articulating steering arrangement 8. The articulating steering arrangement 8 comprises multiple, optionally two bearings 9, 10, which are situated above each other, for providing an articulating mount between the front frame portion 2 and the rear frame portion 3. A pivoting axis of the articulating mount, i.e. of the bearings 9, 10, is arranged substantially parallel to the height direction H of the loader 1. The steering arrangement 8 can be provided below the operator’s cab 7. The articulating steering arrangement 8 can be driven by one or multiple not illustrated actuator(s), such as hydraulic actuators. Said hydraulic actuators can be driven by a power source of the engine compartment 6. Upon a steering operation, the front frame portion 2 tilts with respect to the rear frame portion 3 and thus to the operator's cab 7 and the engine compartment 6, which are provided at the rear frame portion 3.

In addition, the loader 1 comprises a lifting arrangement 20. The lifting arrangement 20 comprises a main arm 21 having a pivot connector 22 at a proximate end and an equipment connector 23 at a distal end thereof. The pivot connector 22 is pivotably supported by a main arm support means 24, which is formed as main arm support link in the present embodiment. The main arm support link 24 has a proximal end 25 and a distal end 26, the proximal end 25 being pivotably mounted to a first supporting portion 27 of the front frame portion 2. The distal end 26 of the main arm support link is pivotably supporting the pivot connector 22 of the main arm 21. The main arm support link 24 is arranged such that a rotation or pivoting movement of the main arm support link 24 around the proximal end 25 provides a movement of the distal end 26 in a direction, which at least includes a component in the front-rear direction L of the loader 1.

The main arm 21 comprises a guided portion 28, which is provided between the pivot connector 22 and the equipment connector 23. In the present embodiment, the guided portion 28 may be offset below by a predetermined amount from a line connecting the pivot connector 22 and the equipment connector 23. Preferably, the guided portion is offset towards the bottom side of the main arm (not shown). The lifting arrangement 20 further includes a guiding means 29, which is formed as a guiding arm having a proximal end 30 and a distal end 31. The proximal end 30 is pivotably mounted to a first support portion 32 of the front frame portion 2. The distal end 31 is pivotably mounted to the guided portion 28 of the main arm 21.

The lifting arrangement 20 comprises an actuator 33. The actuator 33 has a first end, which is pivotably mounted to the front frame portion 2, and a second end, which is pivotably mounted to the main arm 21. The actuator 33 is embodied as a linear actuator such as a hydraulic actuator in the present embodiment but not limited thereto. Upon operating the actuator 33, the distance between the first end and the second end can be changed, e.g. by introducing pressurized fluid into pressure chambers of the actuator 33.

Furthermore, at the equipment connector 23 of the main arm 21, a bucket 34 is provided. The bucket 34 comprises a main arm connector for connection to the equipment connector 23 of the main arm 21 and a tilt connector 35 for connecting the bucket 34 to a tilting arrangement 40. The tilt connector 35 may be provided above the main arm connector in the height direction H of the loader 1. The tilting arrangement 40 comprises a lever 41 that is pivotably supported at approximately its centre at the main arm 21. The top end 42 of the lever 41 is connected via a link chain 43, which, in the present embodiment, comprises two links and runs above the main arm 21, to the tilt connector 35 of the bucket 34. The bottom end of the lever 41, which is not shown in Fig. 1, is connected via a tilting actuation element 44, which is formed as a hydraulic cylinder in the present embodiment, to the main arm support means 23, preferably in proximity to the distal end 26 thereof. By operating the tilting actuation element 44, the bucket 34 may be tilted around the equipment connector 23 via the tilting arrangement 40. However, also other configurations of tilting arrangements are conceivable.

In the following, an operation of the lifting arrangement 20 is explained under reference to the illustrations of Figs. 2a-2c. In Fig. 2c, the lifting arrangement 20 is illustrated in a lowered position. In this situation, the main arm 21 is rotated downwards. This is achieved by retracting the actuator 33, which is provided for operating the main arm 21. The position of the main arm 21 is determined by the linkage between the guiding arm 29 and the main arm support link 24. In other words, the position of the pivot connector 22 of the main arm 21 can be changed by changing the rotational position of the main arm support link 24, whereas the guiding arm 29 determines, due to its rotational connection between the front frame portion 2 and the guided portion 28 of the main arm 21, the position of the pivot connector 22 depending on the rotational position of the main arm 21. As such, the lifting arrangement 20 provides a link-based transmission which uniquely determines the position of the main arm 21.

In the present embodiment, in the lowered position shown in Fig. 2c, the guiding arm 29 extends from the proximal end to the distal end rearwards in the front-rear direction L and downwards in the height direction H of the loader 1. Furthermore, the extension direction of the guiding arm 29 from the proximal end to the distal end encloses an angle α with the front-rear direction L of the loader 1, which is than smaller 10°, in particular approximately 8°. The main arm support link 24 extends, in the lowered position shown in Fig. 2c, from the proximal to the distal end upwards in the height direction H and rearwards in the front-rear direction L of the loader 1.

Upon actuating the actuator 33, the main arm 21 is rotated in the counter clockwise direction in Fig. 2c to move it to a position shown in Fig. 2b. With this rotation, the main arm 21 is rotated with respect to the main arm support link 24. At the same time, the guiding arm 29 is rotated in the clockwise direction in Fig. 2c. When the guiding arm 29 rotates in the clockwise direction, the guided portion 28 of the main arm 21 is forced along a circular path due to the constant distance between the proximal end 30 and the distal end 31 of the guiding arm 29. As can be seen, the position of the distal end 31 of the guiding arm 29 has moved slightly rearwards in the front-rear direction L of the loader 1. In the same context, the main arm 21 has rotated in the counter clockwise direction and the equipment connector 23 has lifted by a predetermined amount. Because of the fact that the guided portion 28 of the main arm 21 is forced in the rearward direction by the predetermined movement path of the distal end of the guiding arm 29, the main arm support link 24 is rotated in the counter clockwise direction about its proximal end 25, which is mounted to the first support portion 27 of the front frame portion 2. Therefore, the position of the distal end 26 of the main arm support link 24 is moved together with the pivot connector 22 of the main arm 21 rearwards in the front-rear direction L of the loader 1.

In the intermediate position shown in Fig. 2b, the guiding arm 29 extends from the proximal end 30 to the distal end 31 rearwards in the front-rear direction L and upwards in the height direction H of the loader 1. The main arm support link 24 extends from the proximal end 25 to the distal end 26 rearwards in the front-rear direction L and upwards in the height direction H of the loader 1 to enclose an angle β with the height direction H of the loader 1.

Upon a further operation of the actuator 33, the main arm 21 is further rotated in the counter clockwise direction in the figures and reaches a lifted position shown in Fig. 2a. In this position, the equipment connector 23 of the main arm 21 has reached a position, which is higher than the position shown in Fig. 2b. Upon further rotating the main arm 21 in the counter clockwise direction from the position shown in Fig. 2b, the guiding arm 29 is further rotated in the clockwise direction and forces the guided portion 28 of the main arm 21 further along the circular path. As the distal end 31 of the guiding arm 29 has moved forward with respect to the position shown in Fig. 2b, the main arm support link 24 is rotated in the clockwise direction from the position shown in Fig. 2b. Therefore, the position of the distal end 26 of the main arm support link 24, which supports the pivot connector 22 of the main arm 21, is positioned further forward compared to the position shown in Fig. 2b.

In the lifted position shown in Fig. 2a, the guiding arm 29 extends from the proximal end 30 the distal end 31 rearwards in the front-rear direction L and upwards in the height direction H of the loader 1, enclosing the angle α with the front-rear direction L. The main arm support link 24 extends from the proximal end 25 to the distal end 26 upwards in height direction H and forward in front-rear direction L of the loader 1, enclosing the angle β with the height direction H.

Based on the above operation, a bucket 34 can be moved from the lowered position shown in Fig. 2c to the lifted position shown in Fig. 2a through the position shown in Fig. 2b along a substantially J-shaped path. In particular, the path deviates from an arcuate or circular path, which is achievable with radial lifting arrangements in which the pivot connector of the main arm is immovably and stationary with respect to the front frame portion 2 of the loader 1. Specifically, the lifting arrangement 20 of the present embodiment is configured to move the equipment connector 23 upwards in the height direction H and forwards in the front-rear direction L of the loader 1 during a first phase of the lifting action to move the equipment connector 23 along the arc-shaped portion of the J-shaped lifting path. In a subsequent second phase of the lifting action, the lifting arrangement 20 is configured to move the equipment connector 23 substantially upward in the height direction H and neither forward nor backward in the front-rear direction L of the loader 1 to move it along the straight-line-shaped portion of the J-shaped lifting path.

This is achieved by designing the lifting arrangement 20 such that the guiding arm 29 encloses a rather small angle with the front-rear direction L, preferably an angle smaller than 10°, in the lowered position of the lifting arrangement 20 shown in Fig. 2c. Preferably, the guiding arm 29 extends rearwards in the front-rear direction L and downwards in the height direction H of the loader 1, as described above. This configuration ensures that for relatively small rotation angels α of the guiding arm 29, the effect of the guiding arm 29 forcing the pivot connector 22 in the front-rear direction L of the loader 1, is relatively small. Thus, for relatively small rotation angels α of the guiding arm 29, the equipment connector 23 is approximately moved along an arc-shaped path. For increasing rotation angles α of the guiding arm 29, the influence of the guiding arm 29 forcing the pivot connector 22 in the front-rear direction increases. The lifting arrangement is configured, e.g. by providing suitable dimensional relationships and attachment positions of the individual components, such that for said larger rotational angels α of the guiding arm 29, the equipment connector 23 is moved along a substantially vertical path portion. Accordingly, overall, the lifting arrangement 20 is configured to move the equipment connector 23 along a substantially J-shaped path between the lowered position shown in Fig. 2c and the lifted position shown in Fig. 2a.

Furthermore, as derivable from Figs.1 and 2a-2c, the front frame portion 2 of the loader 1 of the present embodiment comprises a protruding portion 36, which protrudes upwards in the height direction H and forward in the front-rear direction L of the loader 1. At the distal end of the protruding portion 36, the first support portion 32 of the front frame portion 2 is formed. In the present embodiment, the first support portion 32 is provided slightly behind a most forward portion of the front wheel 4 in the front-rear direction L of the loader 1. Furthermore, in height direction H, the first support portion 32 is formed above the entire front wheel 4. Specifically, the lifting arrangement 20, in particular the protruding portion 36, is formed such that the entire guiding arm 29, whose proximal end is mounted to the first support portion 32, stays above the entire front wheel 4 in all operating conditions of the lifting arrangement 20.

The lifting arrangement 20 attached to the front frame portion 2 of the loader 1 can also be configured differently. In the following, a second configuration 50 of the lifting arrangement is explained under reference to Figs. 3a-3c. Except for the differences outlined below, the lifting arrangement 50 according to this second configuration is configured as that of the first configuration described above. Alike elements are denoted by the same reference signs.

The second configuration of the lifting arrangement 50 does not comprise a guiding arm 29 but instead an auxiliary actuating element 51 embodied as a linear actuator. The auxiliary actuating element 51 has a first end and second end, the first end being pivotably mounted to the main arm support link 24. The second end of the auxiliary actuating element 51 is pivotably mounted to the main arm 21. Accordingly, the auxiliary actuating element 51 operates in order to vary the angle of inclination between the main arm support link 24 and the main arm 21. In other words, by operating the auxiliary actuating element 51, the angle enclosed by the main arm support link 24 and the main arm 21 is increased or decreased.

The second configuration of the lifting arrangement 50 further comprises a control system 52 and a determining means 53 determining a lifting related quantity reflecting a position of said equipment connector 23 with respect to the front frame portion 2. The determining means can include sensors, which provide information on the extension position of the linear actuators used for the main arm actuating element 33 and the auxiliary actuating element 51. The type of sensors can be selected as needed as long as it is possible to provide information on the relative position of the main arm 21 with respect to the main arm support link 24 as well as the relative position of the main arm support link 24 with respect to the front frame portion 2, for example. The control system 52 communicates with an output section, which is provided for controlling the actuating system of the lifting arrangement 50, in particular, the main arm actuating element 33 and the auxiliary actuating element 51.

According to the present embodiment, the control system 52 is configured to provide a relationship between the movement of the main arm actuating element 33 and the movement of the auxiliary actuating element 51. In other words, a function or pattern included in the control system 52 includes a relationship between the operating position of the main arm actuating element 33 and the operating position of the auxiliary actuating element 51. The relationship can be continuous.

The operation of the control based lifting arrangement is explained in the following. Starting out from the situation in Fig 3c, the operator manipulates a not illustrated operating element in order to initiate a lifting operation for lifting the equipment connector 23 from a lowered position shown in Fig. 3c to a lifted position shown in Fig. 3a through a position shown in Fig. 3b. With the lifting arrangement 50 shown in Fig. 3c, the main arm actuating element 33 is extended in order to initially rotate the main arm 21 together with the main arm support link 24 in the counter clockwise direction in the drawing. In the course of operation of the main arm actuating element 33, the auxiliary actuating element 51 is initially not significantly actuated such that an angle enclosed by the main arm 21 and the main arm support means 24 stays substantially constant. Thus, the position of the pivot connector 22 is not shifted significantly in the front-rear direction L of the loader 1 in the initial operation phase. Accordingly, the lifting arrangement 50 of this second configuration is configured to move the equipment connector 23 initially along an arc-shaped portion, namely the arc-shaped portion of the J-shaped lifting path, as described above.

Upon further performing the lifting operation from the position shown in Figure 3b, the main arm actuating element 33 is further extended in order to further rotate the main arm 21 in the counter clockwise direction in the drawing. In the course of the lifting operation between the position shown in Fig. 3b towards the lifted position shown in Fig. 3a, the auxiliary actuating element 51 is extended in order to increase the angle enclosed between the main arm 21 and the main arm support link 24. By this, the pivot connector 22 is moved forward in the front-rear direction of the loader 1. Thus, following the arc-shaped portion, the lifting arrangement 50 according to this second configuration is configured to move the equipment connector 23 subsequently along a substantially vertical-line portion, as described above in combination with the embodiment of Figs. 2a-2c.

Based on the above cooperation of the main arm actuating element 33 and the auxiliary actuating element 51, a movement pattern of the equipment connector 23 can be provided, which deviates from an arcuate or circular path having a constant radius. Based on the above operation, the equipment connector 23 can be moved from the lowered position shown in Fig. 3c to the lifted position shown in Fig. 3a through the position shown in Fig. 3b along a substantially J-shaped path. A closed loop control utilizing the information received from the determining means 53 can be performed by the control system 52, preferably continuously, such that there is always a unique relationship between the extension position of the main arm actuating element 33 and the extension position of the auxiliary actuation element 51.

A lifting arrangement (not shown) according to a third configuration, which may be provided on the loader 1 of Fig. 1 instead of the lifting arrangement 20, is configured as the lifting arrangement 50 according to the second configuration besides the below described differences. However, the lifting arrangement according to this third configuration does not comprise a main arm support means 24. Instead, the pivot connector 22 of the main arm 21 is directly mounted to front frame portion 2 of the loader 1. Furthermore, the main arm comprises an adjustment mechanism for adjusting the distance between the pivot connector 22 and the equipment connector 23. The auxiliary actuating element of this third configuration is arranged and configured to adjust a distance between the pivot connector 22 and the equipment connector 23. The control system 52 and the determining means 53 of this third configuration are configured to control the main arm actuation element and the auxiliary actuation element such that the equipment connector 23 follows a substantially J-shaped path between the lowered position and the lifted position. Besides the lifting arrangements described above, also alternative lifting arrangements can be provided.

Furthermore, as described above, the loader 1 comprises a tilting arrangement 40 for tilting an equipment, e.g. a bucket 34, mounted to the equipment connector 23 of the main arm 21. The tilting arrangement 40 of the present embodiment comprises the above-described tilting cylinder 44 and a control means 45 for controlling the tilting cylinder 44. As described above, upon moving the equipment connector 23 from the lowered position to the lifted position with one of the above-described lifting arrangement configurations, i.e. the first 20, second 50 or third configuration, the equipment connector 23 is moved forward in the front-rear direction L of the loader 1. The control means 45 of the tilting arrangement 40 is configured to tilt the equipment, e.g. the bucket 34, backwards via the tilting cylinder 44 when the equipment connector 23 is moved forward so as to compensate any forward movement of the equipment connector 23 via the back-turning of the bucket 34. The tilting arrangement 40 is configured to turn the bucket 34 backwards such that the bucket's centroid is essentially not moved in the front-rear direction L of the loader upon moving the lifting arrangement from the lowered position to the lifted position. For this purpose, the control means 45 of the tilting arrangement 40 can be coupled with a control system of the lifting arrangement, e.g. with the control system 52 of the lifting arrangement 50 according to the second configuration.

Claims

1. Loader (1) with a frame arrangement (2, 3) and a lifting arrangement (20; 50), the lifting arrangement (20; 50) being mounted to the frame arrangement (2, 3) and comprising

a main arm (21), which is provided with a pivot connector (22) at a proximate end thereof and an equipment connector (23) at a distal end thereof; and

a main arm actuating element (33) for moving said main arm (21) between a lowered position and a lifted position;

wherein the lifting arrangement (20; 50) is configured to move the equipment connector (23) between the lowered position and the lifted position along a substantially J-shaped path in order to move the equipment connector (23) forward in the front-rear direction (L) of the loader (1) upon lifting.

2. Loader (1) according to Claim 1, the frame arrangement comprising a front frame portion (2) and a rear frame portion (3), which are articulatingly interconnected for providing an articulating steering, the lifting arrangement (20; 50) being supported by the front frame portion (2).

3. Loader (1) according to Claim 1 or 2, wherein the lifting arrangement (20; 50) further comprises

a main arm support means (24) with a proximal end (25) and a distal end (26), wherein the proximal end (25) is pivotably mounted to a first support portion (27) of the frame arrangement, the distal end (26) is pivotably supporting the pivot connector (22) of the main arm (21), and said main arm support means (24) is movable in a direction, which includes at least a component in the front-rear direction (L) of the loader (1).

4. Loader (1) according to Claim 3, wherein the extension direction of the main arm support means (24) from the proximal end (25) to the distal end (26), in the lowered position, is oriented upwards in the height direction (H) and backwards in the front-rear direction (L) of the loader (1), and, in the lifted position, upwards in the height direction (H) and forward in the front-rear direction (L) of the loader (1).

5. Loader (1) according to Claim 3 or 4, wherein the lifting arrangement (20) further comprises

a guiding means (29) with a proximal end (30) and a distal end (31), wherein the proximal end (30) is pivotably mounted to a second support portion (32) of the frame arrangement and wherein the distal end (31) is engaged to said main arm (21) at a guided portion (28) of said main arm (21), which is positioned between said pivot connector (22) and said equipment connector (23),

wherein the lifting arrangement (20) is configured such that the guiding means (29) guides the main arm (21) between said lowered and said lifted position such that the equipment connector (23) of the main arm (21) follows the J-shaped path.

6. Loader (1) according to Claims 2 and 5, wherein the second support portion (32) of the frame arrangement is provided above a ground engaging element (4), preferably a wheel, of the loader (1), preferably the guiding means (29) being provided above the ground engaging element (4) of the loader (1) in all operating conditions of the lifting arrangement (20).

7. Loader (1) according to Claim 6, wherein the front frame portion (2) comprises a protruding portion (36), which extends upwards in the height direction (H) and forward in the front-rear direction (L) of the loader (1), the second support portion (32) being formed at a distal end of the protruding portion (36), wherein the second support portion (32) is preferably the highest portion of the front frame portion (2) in the height direction (H) and/or the most forward portion of the front frame portion (2) in the front-rear direction (L) of the loader (1).

8. Loader (1) according to Claim 5, 6 or 7, wherein, in the lowered position of the lifting arrangement (20), the extension direction of the guiding means (29) from the proximal end (30) to the distal end (31) exhibits an angle (α) with respect to the front-rear direction (L) of the loader (1), which is smaller than |15°|, preferably smaller than |10°|.

9. Loader (1) according to Claim 8, wherein, in the lowered position of the lifting arrangement (20), the extension direction of the guiding means (29) from the proximal end (30) to the distal end (31) is oriented backwards in the front-rear direction (L) of the loader (1) and downwards in the height direction (H) of the loader (1).

10. Loader (1) according to Claim 3 or 4, the lifting arrangement (50) further comprising

an auxiliary actuating element (51) engaged to said main arm (21) and said main arm support means (24) for adjusting an angle therebetween; and

a control means (52) configured to control an operation of said main arm actuating element (33) and said auxiliary actuating element (51) such that said equipment connector (23) follows the J-shaped path.

11. Loader (1) according to Claim 1 or 2, wherein the main arm (21) of the lifting arrangement comprises an adjustment mechanism for adjusting a distance between the pivot connector (22) and the equipment connector (23) and the lifting arrangement further comprises

an auxiliary actuating element for actuating the adjustment mechanism; and

a control means configured to control an operation of said main arm actuating element and said auxiliary actuating element such that said equipment connector (23) follows the J-shaped path.

12. Loader (1) according to one of the preceding claims, further comprising a tiling arrangement (40) for tiling an equipment (34), preferably a bucket, mounted to the equipment connector (23), the tiling arrangement (40) being configured to rotate the equipment (34) backwards upon moving the lifting arrangement (20; 50) from the lowered position to the lifted position such that the equipment's centroid is not moved forwards in the front-rear direction (L) of the loader (1) as much as the equipment connector (23).

13. Loader (1) according to Claim 12, the tilting arrangement (40) comprising a tilting actuation element (44) for tilting the equipment (34) and a control means (45), the control means (45) being configured to tilt the equipment (34) via the tilting actuation element (44) backwards upon moving the lifting arrangement (20; 50) from the lowered position to the lifted position.

14. Loader (1) according to one of the preceding claims, wherein the loader (1) is a wheel loader.

15. Loader (1) according to one of the preceding claims, wherein an equipment (34), preferably a bucket, is pivotably mounted to the equipment connector (23).

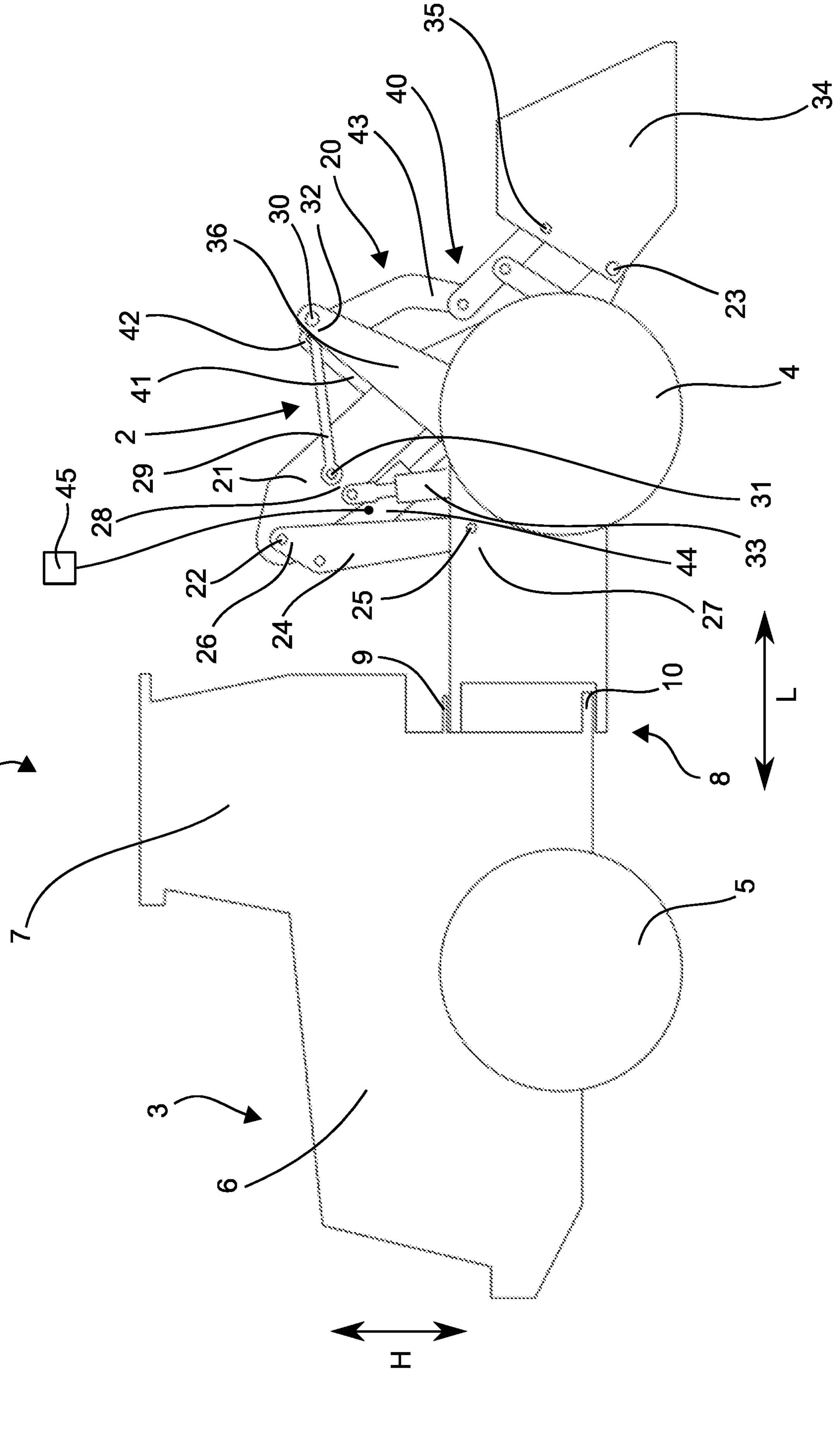

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Fig. 1

Fig. 2a

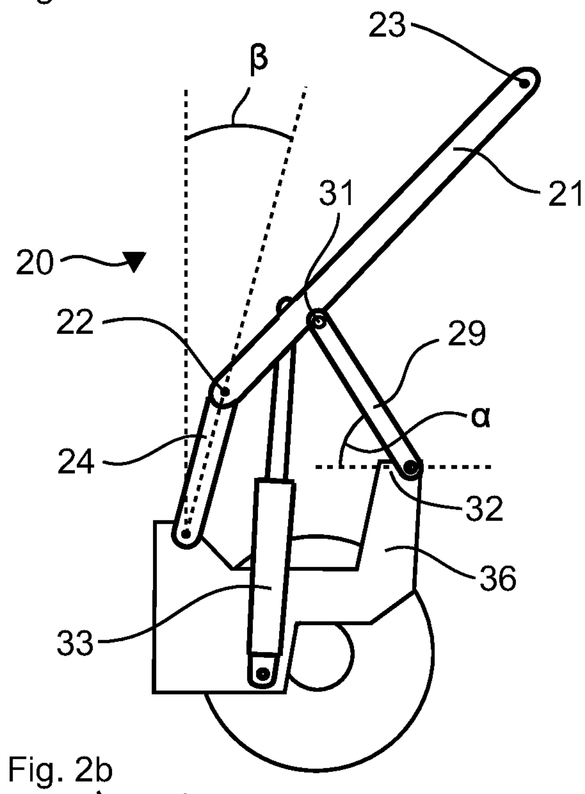


Fig. 3a

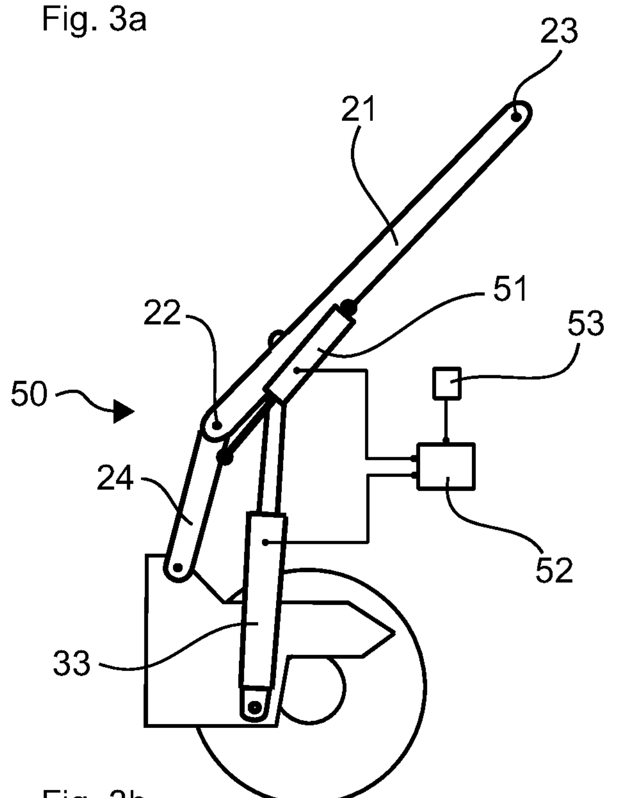


Fig. 2b

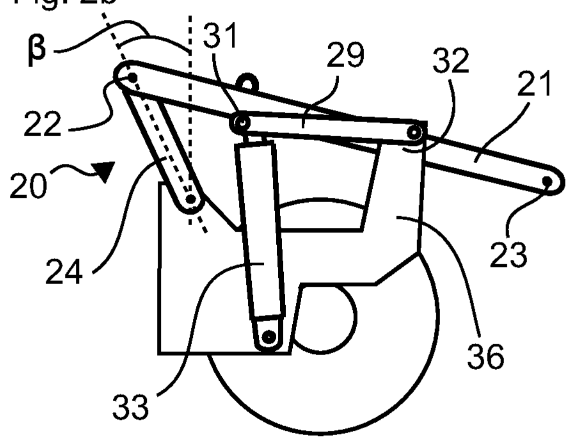


Fig. 3b

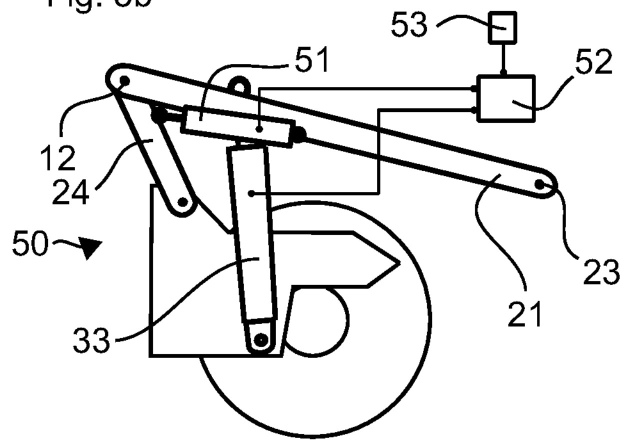


Fig. 2c

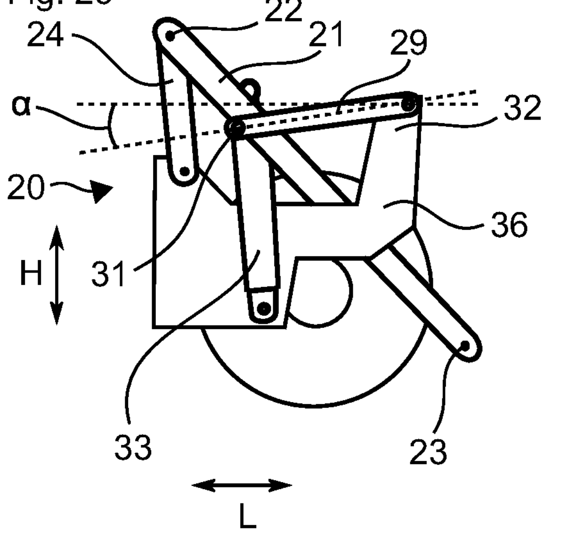
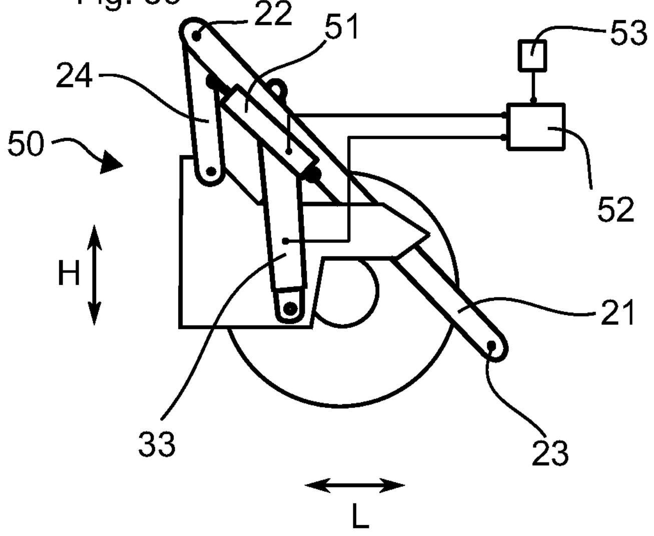


Fig. 3c



INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/117223

A. CLASSIFICATION OF SUBJECT MATTER

E02F 3/28(2006.01)i; E02F 3/36(2006.01)i; E02F 3/42(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNABS,CNTXT,DWPI,SIPOABS,CNKI: loader?, cylinder?, lift+, mov+, lower+, bottom, front+, forward, rear, arm?, pivot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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PX	CN 108301448 A (GUANGXI LIUGONG MACHINERY CO., LTD.) 20 July 2018 (2018-07-20) description, paragraphs [0003]-[0022], figures1-3	1-15
PX	CN 108678044 A (XCMG CONSTR MACHINERY CO., LTD. SCIENCE & TECHNOLOGY BRANCH) 19 October 2018 (2018-10-19) description, paragraphs [0005]-[0018], figures1-2	1-15
PX	CN 207109890 U (GUANGXI LIUGONG MACHINERY CO., LTD.) 16 March 2018 (2018-03-16) description, paragraphs [0003]-[0013], figures1-3	1-15
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A	CN 106168040 A (LIUGONG MACHINERY CO., LTD.) 30 November 2016 (2016-11-30) the whole document	1-15

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "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
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 June 2019	**17 June 2019**

Name and mailing address of the ISA/CN	Authorized officer
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Facsimile No. **(86-10)62019451**	Telephone No. **86-(10)-53962833**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/117223

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