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(54) Title: METHOD FOR IMPROVING TILT STABILITY OF A VEHICLE AND VEHICLE WITH AN IMPROVED TILT STABILITY

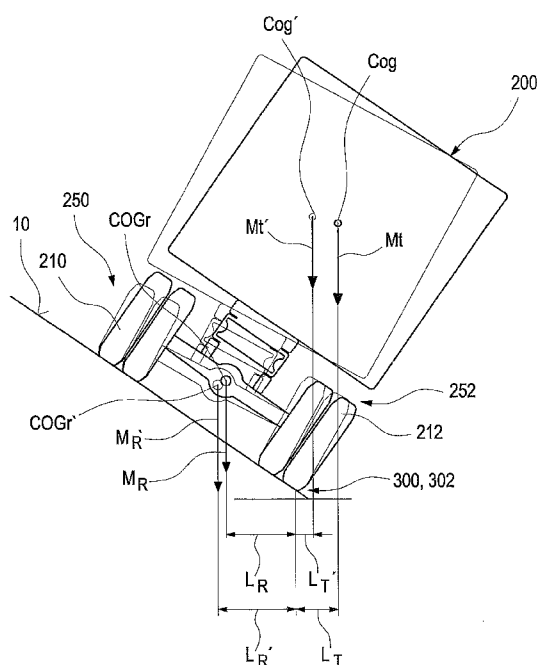


Fig. 3b

(57) Abstract: The invention relates to a method for improving tilt stability of a vehicle (100, 200, 500, 600, 700), particularly a work machine, wherein the vehicle (100, 200) comprises inflatable tires (110, 112, 114; 210, 212; 510, 512, 514; 610, 612; 710, 712, 714) for ground engagement, wherein at least temporarily a pressure difference (Δp) is established between one or more first tires (110; 210; 510; 610; 710) and one or more second tires (112, 114; 212; 512, 514; 612; 712, 714). At least temporarily the pressure in the one or more first tires (110; 210; 510; 610; 710) is lower than in the one or more second tires (112, 114; 212; 512, 514; 612; 712, 714) wherein the one or more second tires (112, 114; 212; 512, 514; 612; 712, 714) are closer to an actual probable tilt axis (300) than the one or more first tires (110; 210; 510; 610; 710).



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DESCRIPTION

Method for Improving Tilt Stability of a Vehicle and Vehicle with an Improved Tilt
Stability

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TECHNICAL FIELD

10 The invention relates to a method for improving tilt stability of a vehicle and a
vehicle with improved tilt stability according to the preambles of the independent
claims.

BACKGROUND OF THE INVENTION

15 It is known in the art that the volume of tires of vehicles can be adapted according
to operation conditions of the vehicle. US 6,290,019 B1 discloses a method to
avert vehicle side rollover that has inflated tires during driving. A sensor senses a
parameter indicative of an immanent threat of vehicle rollover to one side of the
vehicle. A tire deflator device reduces an inflation pressure of one of the vehicle
20 tires on one side of the vehicle to avert vehicle rollover in response to the
imminent threat of vehicle rollover. For instance, if the vehicle is driving on the left
side tires only while the right side tires have lost ground contact, the vehicle may
rollover to the left side. The rollover is prevented by deflating the tires on the left
hand side of the vehicle until the tires on the right hand side of the vehicle are
25 engaging the ground again.

Work machines, also known as construction equipment or more generally as load
handling equipment carried by inflatable tires, are vehicles designed for and used
in rough and slippery conditions off-road surroundings where normal trucks or
30 passenger cars are inoperative and would be damaged when exposed to these
rough conditions. Such vehicles can comprise articulated haulers, tipper trucks or
dumpers, digging machines and the like, equipped with trailers or without. Work
machines are often operated on uneven and soft or slippery ground. Under such
operation ambient overturning of the vehicle can occur under unfavourable

conditions, particularly during load handling or when e.g. a tipper truck has raised its through body during tilting and/or when moving or standing on uneven ground.

5 SUMMARY OF THE INVENTION

It is an object of the invention to provide a method for improving the tilt stability of a vehicle, particularly a work machine. Another object is to provide a vehicle with an improved tilt stability.

10

The objects are achieved by the features of the independent claims. The other claims and the description disclose advantageous embodiments of the invention.

15

A method is proposed for improving tilt stability of a vehicle, particularly a work machine, wherein the vehicle comprises inflatable tires for ground engagement, wherein a pressure difference is established between one or more first tires and one or more second tires. At least temporarily a pressure difference is established between the one or more first tires and the one or more second tires, wherein the pressure in the one or more first tires is lower than in the one or more second tires, and wherein the one or more second tires are closer to an actual probable tilt axis than the one or more first tires.

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Favourably it is possible to use already existing tools in the vehicle to provide improved tilt stability. It is not necessary to adapt body and/or chassis or provide special installations for the axles, spring or stabilizers of the vehicle. Preferably, a central tire inflation system can be used to establish an advantageous pressure difference between the one or more first and the one or more second tires, e.g. by deflating and/or inflating the respective tires accordingly during the discharging of a load in case of a tipper truck and/or when the vehicle stands on inclined ground.

25

The pressure difference can be easily adapted to an actual vehicle, requirements for minimum and/or maximum pressure in the tires and operation conditions of the vehicle. Of course, parameters like wheel base, type of wheel suspension, particularly rear wheel suspension in the case of tipper trucks, frame size, with or without inner liner, centre-of-gravity position in an X-, Y- and Z-direction relative to

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payload or without payload, rear frame length, the constructional design of the body itself, body with or without cross reinforcement and the like. For instance, with a tipper bucket raised to 45°, a possible requirement can be that the tipper truck must be able to handle – to fulfil legal requirements in some countries - be able to handle a ground slope angle of 5° or 7° depending on number of criteria as which category the truck will be classified on and the truck configuration.

According to the invention, the tilt stability can be improved in a way that the vehicle can handle a higher ground slope angle e.g. a ground slope angle higher by 1°, particularly higher by 2°.

The invention is particularly useful for tipper trucks which can be stabilized against tilting with raised tipper bucket even when standing on a sidewise inclined ground, for vehicles running on off-road conditions such as concrete mixers and even military trucks and the like.

According to a favourable embodiment of the invention, the one or more first tires can be deflated for reducing the pressure in the one or more first tires. The result is a shift of the centre of gravity of the vehicle to a more stable position of the vehicle.

Additionally or alternatively, the one or more second tires can be inflated for increasing the pressure in the one or more second tires. Even so, the result is a shift of the centre of gravity of the vehicle to a more stable position of the vehicle. A limit for the increase of the pressure is the vehicle's compressor, tires and air system. In a static condition, i.e. at standstill, most tires can easily bear a pressure increase of up to 50% of its operational pressure. Depending on the actual kind of tire this value can be less but also higher for other kinds of tires.

According to a further favourable embodiment of the invention, the one or more first and/or second tires can be deflated and/or inflated by a central tire inflation system. Besides a more stable position, probable requirements of a minimum pressure in the one or more first tires can be fulfilled more easily.

According to a further favourable embodiment of the invention, a valve can be provided for inflating the one or more second tires with air deflated from the one or more first tires. When the operation where establishing a pressure difference between the one or more first and second tires is finished, e.g. when a tipper truck
5 has discharged its load, the air flow can be reversed and the inflated one or more second tires can be deflated by supplying air to the deflated one or more first tires. Thus, the air system of the truck can be relieved and/or it can be used as a supplement only.

10 According to a further favourable embodiment of the invention, establishing a pressure difference in the one or more first and second tires can be performed according to an inclination signal of the vehicle in its longitudinal and/or transversal direction is sensed by a sensor. According to a sensor signal it can be decided if a pressure difference between the one or more first and second tires should to be
15 established or not. Moreover, it can be estimated how much pressure difference between the one or more first and second tires is necessary.

According to a further favourable embodiment of the invention, at least during a tipping operation, wherein a tipper bucket of the vehicle is raised about a tipping
20 axle, the pressure difference can be established so that the one or more first tires at a side of the vehicle distant from the tipping axle exhibit a lower pressure than the one or more second tires on a second side close to the tipping axle. Preferably, the one or more first tires can be front axle tires.

25 According to a further favourable embodiment of the invention, during at least a phase where the vehicle is on an inclined surface, wherein one side of the vehicle is positioned geodetic higher than the other side, the pressure difference can be established so that the one or more first tires on the higher side exhibit a lower pressure than the one or more second tires on the lower side of the vehicle.
30 Preferably, the one or more first tires are tires at one side of the vehicle mounted on different axles. Particularly the one or more first tires can be tires at the highest elevation and the one or more second tires can be tires at the lowest elevation of the ground under the vehicle.

According to a further favourable embodiment of the invention, the pressure difference between the one or more first and second tires can be equalised during a driving phase of the vehicle. In case of a tipper truck this is possible as the tipper truck has offloaded the load.

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According to a further aspect of the invention, a vehicle, particularly a work machine, is proposed, wherein the vehicle comprises pressurized tires for ground engagement, wherein a pressure difference is establishable between one or more first tires and one or more second tires. At least temporarily a pressure difference is establishable between the one or more first tires and the one or more second tires, wherein the pressure in the one or more first tires is lower than in the one or more second tires, and wherein the one or more second tires are closer to an actual probable tilt axis than the one or more first tires.

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15 According to a favourable embodiment of the invention, a central tire inflation system can be provided. Favourably, a common component can be used to perform the method described above without necessity to provide extra installations.

20 According to a further favourable embodiment of the invention, a sensor for determining a tilt angle of the vehicle can be arranged at a rear and/or bogie axle. The sensor signal can be used in an economic way to decide whether establishment of a pressure difference is necessary or not and how big the pressure difference must be.

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According to a further favourable embodiment of the invention, a valve can be provided for inflating the one or more second tires with air deflated from the one or more first tires. When the operation where establishing a pressure difference between the one or more first and second tires is finished the air flow can be reversed and the inflated one or more second tires can be deflated by supplying air to the deflated one or more first tires. This allows for relieving the air system of the vehicle or for using the air system economically only as a supplement.

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Favourably, the pressure difference in the one or more first and second tires can be combined with adjusting a suspension of the vehicle in the same direction accordingly.

5 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention together with the above-mentioned and other objects and advantages may best be understood from the following detailed description of the embodiments, but not restricted to the embodiments, wherein is shown
10 schematically:

- Fig. 1 a preferred vehicle embodied as tipper truck according to the invention;
- Fig. 2a-2c an illustration of a stable position (Fig. 2a), an unstable position (Fig.
15 2b) and a roll-over position of a vehicle; and
- Fig. 3a, 3b a vehicle on an inclined ground in an unstable position (Fig. 3a) and in a stable position with a pressure difference in the tires according to the invention in a more stable position (Fig. 3b);
- Fig. 4a, 4b (Fig. 4a), (Fig. 4b); and
- 20 Fig. 5a-5c (Fig. 5a), Fig. 5b), (Fig. 5c).

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

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In the drawings, equal or similar elements are referred to by equal reference numerals. The drawings are merely schematic representations, not intended to portray specific parameters of the invention. Moreover, the drawings are intended to depict only typical embodiments of the invention and therefore should not be
30 considered as limiting the scope of the invention.

Fig. 1 depicts schematically a preferred vehicle 100 embodied by way of example as tipper truck according to the invention. The vehicle 100 comprises pressurized tires 110, 112, 114 which are arranged pairwise on a respective axle, engaging the

ground surface 10. The tires 110, 112, 114 can be single tires or twin tires on each side of the respective axle. The rear tires 112, 114 can be arranged at a bogie axle 170. The tipper truck (vehicle 100) comprises a cab 122 in the front and a tipper bucket 120 in the rear of the vehicle 100. The tipper bucket 120 can be raised by a ram 118 to discharge payload from the tipper bucket 120. When the tipper bucket 120 is being raised, the tipper truck (vehicle 100) "leans" to the ground on the side of the second tires 112, 114.

A roll-over threshold is defined as the ground slope angle at which the vehicle 100 becomes unstable and continues to tip over, particularly over a tilt axle 300, in an uncontrolled way.

For a stable operation of rearward tipping the vehicle 100 should provide a minimum total weight on the front axle with the first tires 110 yielding a minimum total front-axle pressure on a single axle of double axle at even ground (0° ground slope angle). For a standard tipper truck (vehicle 100), such a minimum weight can be 1000 kg at a 50° tipping angle, i.e. the inclination of the tipper bucket 120 to the vehicle frame 116. The required minimum total front-axle pressure depends on the actual vehicle 100, particularly on vehicle parameters such as an effective distance WB between the axles of first tires 110 (the theoretical wheel basis would be the distance between the axle of first tires 110 and the centre of the bogie axles) and the most forward of the second tires 112, the rear overhang ROH, the mass m_b of the tipper bucket 120, the height H of the centre-of-gravity of the tipper bucket 120 over the frame 116, the mass m_c of the cab 122.

If the front-axle pressure is below the required minimum total front-axle pressure, the vehicle 100 can roll over in an uncontrolled way. In the case of the tipper truck, the axle of the most rearward second tires 114 then becomes a tilt axle 300.

According to the invention, a pressure difference Δp is establishable between the first tires 110 and the second tires 112, 114, wherein the first tires 110 at the vehicle side 150 distant from the side 152 where the vehicle 100 is leaning against the ground have a lower pressure than the second tires 112, 114. This can be achieved by deflating the first tires 110 or inflating the second tires 112, 114 or by

deflating the first tires 110 and inflating the second tires 112, 114 accordingly. This can most favourably be accomplished by using a central tire inflation system (not shown) installed in the vehicle 100. When the tipping operation is done and the tipper bucket 120 moved back to the frame position, the pressure difference Δp is equalized, e.g. by inflating the first tires 110 and/or by deflating the second tires 112, 114, which can take some seconds.

Optionally, a valve (not shown) can be installed in the central tire inflation system between the first and second tires 110, 112, 114 which allows inflating the second tires 112, 114 with air from the first tires 110. When the pressure difference Δp is equalized, the surplus air of the second tires 112, 114 can be used to inflate the first tires 110.

Favourably, the vehicle 100 can start to move while the pressure difference Δp is being equalized, as in this operational mode of the vehicle 100 the tipper bucket 120 is empty.

A sensor 20, preferably arranged at the frame 116 close to the second tires 112, 114 can sense the lean angle of the vehicle when the tipper bucket 120 is being risen and a decision can be made by an appropriate control unit if and how big a pressure difference Δp has to be established.

Figs. 2a-2c illustrate stable, unstable and roll-over positions of a body b on an inclined surface 50. In Fig. 2a, the inclination of the surface 50 is relatively small. The body is represented by its centre-of-gravity COG which points vertically to the ground with a vector m. The body b generally has two roll-over points 302 at the two extreme edges of the body b engaging the surface 50, wherein the body b could be vulnerable for roll over at the right roll-over point 302 in the drawing due to the inclination of the surface 50. As long as the vector m is inside the body b, the position of the body b is stable with respect to roll over.

In Fig. 2b, the inclination of the surface 50 is increased so that the vector m hits the right roll-over point 302 and the body becomes unstable. In Fig. 2c the

inclination of the surface 50 is increased further and the vector m points outside of the right roll-over point 302 of the body b ."

Fig. 3a, 3b illustrate a vehicle 200, shown in a cross cut, e.g. a concrete mixer or a tipper truck, on an inclined surface 10. The vehicle 200 is oriented in a way that the first and second sides 250, 252 of the vehicle 200 on both sides of the longitudinal extension of the vehicle 200 are on different elevations. The longitudinal extension of the vehicle 200 is perpendicular to the paper plane of the drawing. Particularly, the first tires 210 on the first side 250 are positioned at a higher elevation than the second tires 210 on the second side 252.

The horizontal vector M_t originating from the centre-of-gravity COG_1 of a body (e.g. a tipper bucket) the vehicle 200 is outside the vehicle 200 to the right side of the roll-over point 302. The roll-over point 302 corresponds to the extreme outside of the second tires 212.

L_t is the distance between the roll-over point 302 and the vector M_t , wherein L_r is the distance between the vector M_t and a horizontal vector M_r originating from the centre-of gravity $COGr$ of the axle 228.

In the example shown, the vehicle 200 is clearly in an unstable position. The smaller the distance L_r compared to distance L_t , the less stable is the vehicle 200 with respect to a sidewise roll over on the side slope.

Fig. 3b illustrates the effect of the invention. The first tires 210 on the first, geodetically higher side 250 of the vehicle 200 have a lower pressure than the second tires 212 on the lower second side 252. A limit for the stable position of the vehicle 200 is $L_t \cdot M_t = L_r \cdot M_r$. The vehicle 200 becomes unstable if the product $L_t \cdot M_t$ is larger than the product $L_r \cdot M_r$. The vehicle 200 is in a stable position if the product $L_t \cdot M_t$ is smaller than the product $L_r \cdot M_r$.

Due to the established pressure difference Δp in the first and second tires 210, 212, the centre-of-gravity COG shifts to COG' to the left side in the drawing, as the axle 228 shifts its centre-of-gravity $COGr$ to $COGr'$, as the diameter of the first tires

210 is reduced due to the lower pressure compared to the second tires 212. Consequently, the product $L_t \cdot M_t$ decreases compared to the situation in Fig. 3a.

Whereas in Fig. 3a the axle 228 was parallel to the inclined surface, the axle 228 is now inclined to the surface 10 when the pressure difference Δp is established, and the axle 228 inclined less than the surface 10. The pressure difference Δp can be established by a central tire inflation system (not shown).

As described, the first and second tires 210, 212 can be connected via a valve (not shown) for exchanging air for deflating the first tires 210 and inflating the second tires for establishing the pressure difference Δp and vice versa for equalizing the pressure difference Δp if not needed anymore. The amount of the pressure difference Δp required can be estimated by a sensor (not shown) which determines a sidewise inclination of the vehicle 200.

The distance L_t' between the roll-over point 302 and the vector M_t' is smaller than the distance L_t between the roll-over point 302 and the vector M_t , and the distance L_r' is larger than the distance L_r . The larger the distance L_r' compared to distance L_t' , the more stable is the vehicle 200 with respect to a sidewise roll over on the side slope. Thus, the vehicle 200 is in a more stable position than before.

Favourably, the vehicle 200 is capable of handling a transverse acceleration of at least 4 m/s^2 , which is a typical value for a truck, and which determines the maximum slope of the surface 10 for stable operation of the vehicle 200. The actual value for the transverse acceleration depends, of course, on parameters like the height of the centre of gravity above ground and the like.

Figs. 4a, 4b, 5 and 6 illustrate several preferred vehicles 500, 600, 700, 800.

Fig. 4a displays a vehicle 500 embodied as a lift dumper which can lift a bucket (not shown) by ways of a lift arrangement 520 behind a rear of the vehicle 500. A probable tilt axle 300 is located in the rear of the lift dumper. In an instable state, the lift dumper could tilt about the tilt axle 300. The stability of the vehicle 500 can be increased if the first tires 510 in the front of the vehicle 500 provide a lower

pressure (and diameter) than the second tires 512, 514 at the rear of the vehicle 500.

Fig. 4b displays a vehicle 600 embodied as a side lifter which can lift a bucket or container 622 over the side of the vehicle 600 by ways of a lift arrangement with front lift arm 620 and rear lift arm 630. A probable tilt axle 300 is located at the side of the side lifter where the bucket or container 622 is lifted (load side). In an instable state, the side lifter could tilt about the tilt axle 300. The stability of the vehicle 600 can be increased if the first tires 610 at the front and the rear of the vehicle 600 at the side opposite to the load side of the vehicle 600 provide a lower pressure (and diameter) than the second tires 612 at the rear and the front of the vehicle 600 at the load side of the vehicle 600.

Fig. 5a, 5b and 5c depict a vehicle 700 embodied as a load changer which can lift a bucket or container 724 over the rear of the vehicle 700 by ways of a lift arrangement 720 with a hook 722. The hook 722 is attached to a front face of a bucket or container 724 to pull the load onto the chassis over the rear of the load changer. A probable tilt axle 300 is located at the rear of the load changer where the bucket or container 724 is lifted (load side). In an instable state, the load changer could tilt about the tilt axle 300. The stability of the vehicle 700 can be increased if the first tires 710 at the front of the vehicle 700 provide a lower pressure (and diameter) than the second tires 712, 714 at the rear of the vehicle 700 at the load side of the vehicle 700.

Fig. 5a displays the load changer when seizing the bucket or container 724. Fig. 5b displays the load changer in the way of hauling the load onto the chassis of the load changer. Fig. 5c displays a vehicle 700 embodied as a load changer which can lift a bucket or container 724 over the rear of the vehicle 700 by ways of a lift arrangement 720 comprising a cable 722. A probable tilt axle 300 is located at the rear of the load changer where the bucket or container 724 is lifted (load side). In an instable state, the load changer could tilt about the tilt axle 300. The stability of the vehicle 700 can be increased if the first tires 710 at the front of the vehicle 700, i.e. at the side opposite to the load side of the vehicle 700, provide a lower

pressure (and diameter) than the second tires 712, 714 at the rear of the vehicle 700 at the load side of the vehicle 700.

5 The invention improves the handling of load-handling vehicles carried on inflatable tires. The invention is not only useful for vehicles on inclined surfaces but also e.g. for vehicles handling loads at least temporarily in a one-sided way, such as a side loader.

C L A I M S

1. A method for improving tilt stability of a vehicle (100, 200, 500, 600, 700),
5 particularly a work machine, wherein the vehicle (100, 200) comprises
inflatable tires (110, 112, 114; 210, 212; 510, 512, 514; 610, 612; 710, 712,
714) for ground engagement, wherein at least temporarily a pressure
difference (Δp) is established between one or more first tires (110; 210;
510; 610; 710) and one or more second tires (112, 114; 212; 512, 514; 612;
10 712, 714), characterized in that at least temporarily the pressure in the one
or more first tires (110; 210; 510; 610; 710) is lower than in the one or more
second tires (112, 114; 212; 512, 514; 612; 712, 714) wherein the one or
more second tires (112, 114; 212; 512, 514; 612; 712, 714) are closer to an
actual probable tilt axis (300) than the one or more first tires (110; 210; 510;
15 610; 710).
2. The method according to claim 1, characterized in that the one or more first
tires (110; 210; 510; 610; 710) are deflated for reducing the pressure in the
one or more first tires (110; 210; 510; 610; 710)
20
3. The method according to claim 1 or 2, characterized in that the one or more
second tires (112, 114; 212; 512, 514; 612; 712, 714) are inflated for
increasing the pressure in the one or more second tires (112, 114; 212;
512, 514; 612; 712, 714).
25
4. The method according to one of the preceding claims, characterized in that
the one or more first and/or second tires (112, 114; 212; 512, 514; 612;
712, 714) are deflated and/or inflated by a central tire inflation system (320).
- 30 5. The method according to one of the preceding claims, characterized in that
the one or more second tires (112, 114; 212; 512, 514; 612; 712, 714) are
inflated by air deflated from the one or more first tires (110; 210; 510; 610;
710).

6. The method according to one of the preceding claims, characterized in that establishing a pressure difference (Δp) in the one or more first and second tires (112, 114; 212; 512, 514; 612; 712, 714) is performed according to an inclination signal of the vehicle (100; 200; 500; 600; 700) in its longitudinal and/or transversal direction sensed by a sensor (20).
7. The method according to one of the preceding claims, characterized in that during at least during a tipping operation, wherein a tipper bucket (140) of the vehicle (100; 200; 500; 600; 700) is raised about a tipping axle (310), a pressure difference (Δp) is established so that the one or more first tires (110; 210; 510; 610; 710) at a side (150) of the vehicle (100, 200; 500; 600; 700) distant from the tipping axle (310) exhibit a lower pressure than the one or more second tires (112, 114; 212; 512, 514; 612; 712, 714) on a second side (152) close to the tipping axle (310).
8. The method according to one of the preceding claims, characterized in that during at least a phase where the vehicle (100; 200; 500; 600; 700) is on a tilted surface (10), wherein one side (250) of the vehicle (100; 200; 500; 600; 700) is positioned geodetic higher than the other side (252), the pressure difference (Δp) is established so that the one or more first tires (110; 210; 510; 610; 710) on the higher side (250) exhibit a lower pressure than the one or more second tires (112, 114; 212; 512, 514; 612; 712, 714) on the lower side (252) of the vehicle (100; 200; 500; 600; 700).
9. The method according to one of the preceding claims, characterized in that the pressure difference (Δp) between the one or more first and second tires (110, 112, 114; 210, 212; 510, 512, 514; 610, 612; 710, 712, 714) is equalised during a driving phase of the vehicle (100; 200; 500; 600; 700).
10. A vehicle (100; 200; 500; 600; 700), particularly a work machine, wherein the vehicle (100; 200; 500; 600; 700) comprises pressurized tires (110, 112, 114; 210, 212; 510, 512, 514; 610, 612; 710, 712, 714) for ground engagement, wherein at least temporarily a pressure difference (Δp) is establishable between one or more first tires (110; 210; 510; 610; 710) and

one or more second tires (112, 114; 212; 512, 514; 612; 712, 714),
characterized in that at least temporarily at least temporarily the pressure in
the one or more first tires (110; 210; 510; 610; 710) is lower than in the one
or more second tires (112, 114; 212; 512, 514; 612; 712, 714) wherein the
5 one or more second tires (112, 114; 212; 512, 514; 612; 712, 714) are
closer to an actual probable tilt axis (300) than the one or more first tires
(110; 210).

11. The vehicle according to claim 10, characterized in that a central tire
10 inflation system is provided.

12. The vehicle according to claim 10 or 11, characterized in that a sensor (20)
for determining a tilt angle of the vehicle (100; 200; 500; 600; 700) is
arranged at a rear and/or bogie axle (170).

13. The vehicle according to one of the claims 10 to 12, characterized in that a
valve (30) is provided for inflating the one or more second tires (112, 114;
212; 512, 514; 612; 712, 714) by air deflated from the one or more first tires
(110; 210; 510; 610; 710).

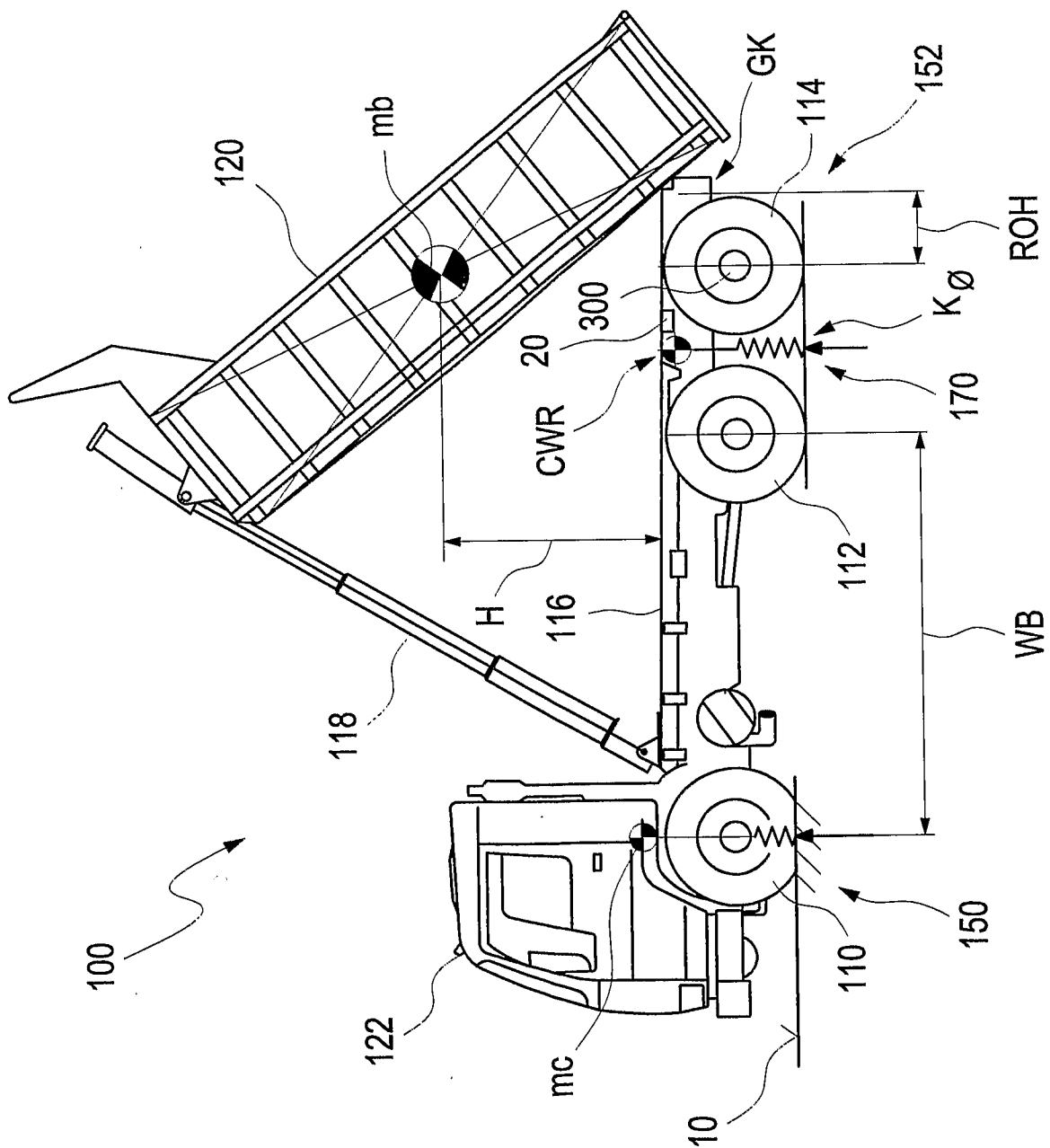
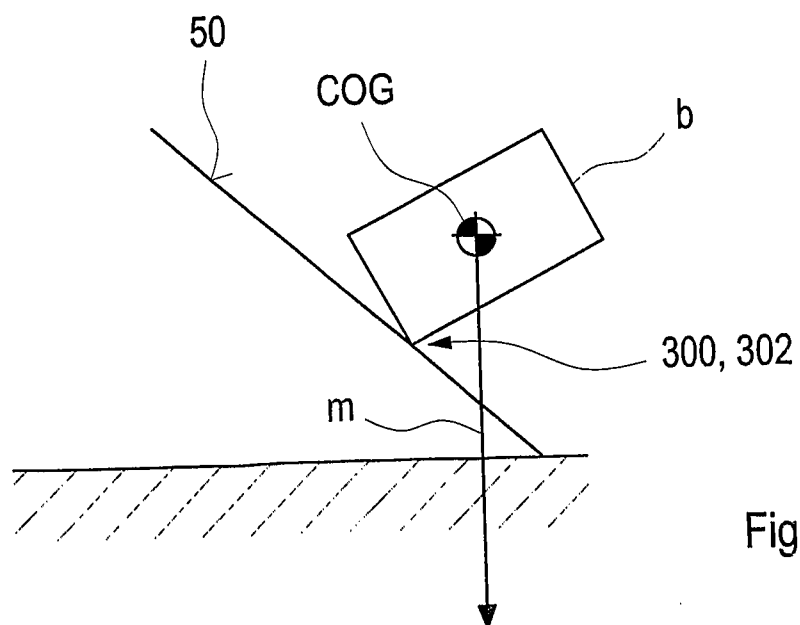
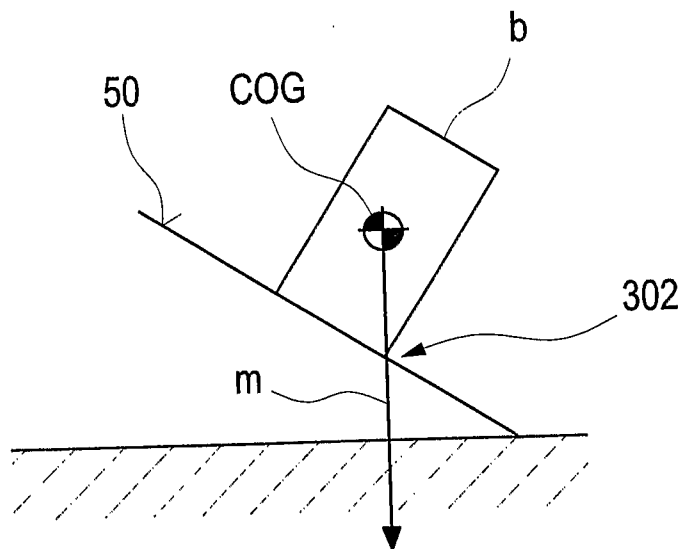
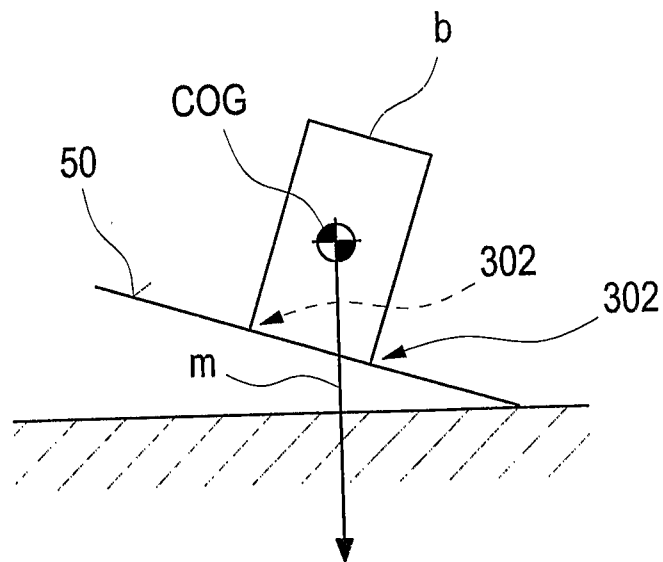


Fig. 1

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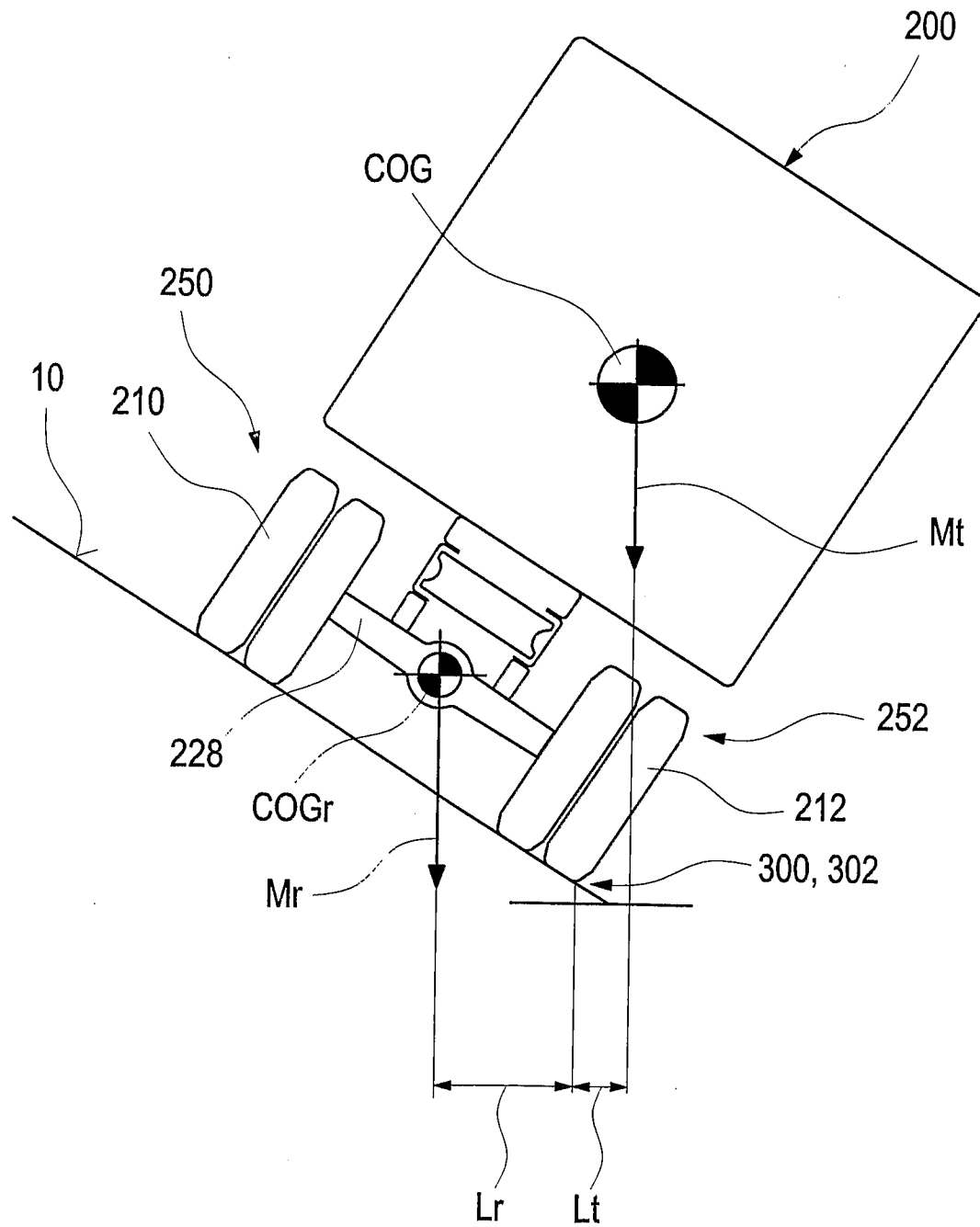


Fig. 3a

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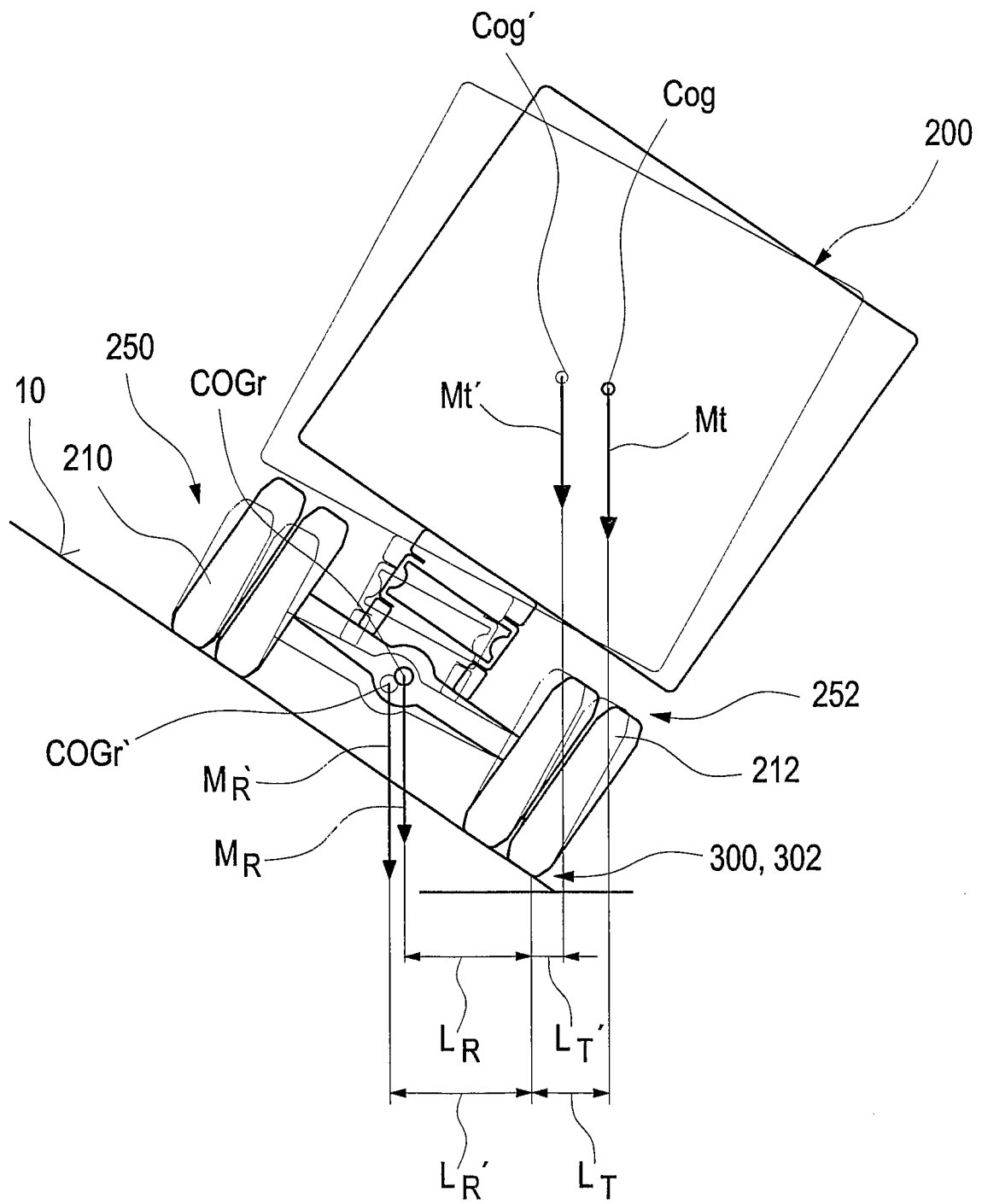


Fig. 3b

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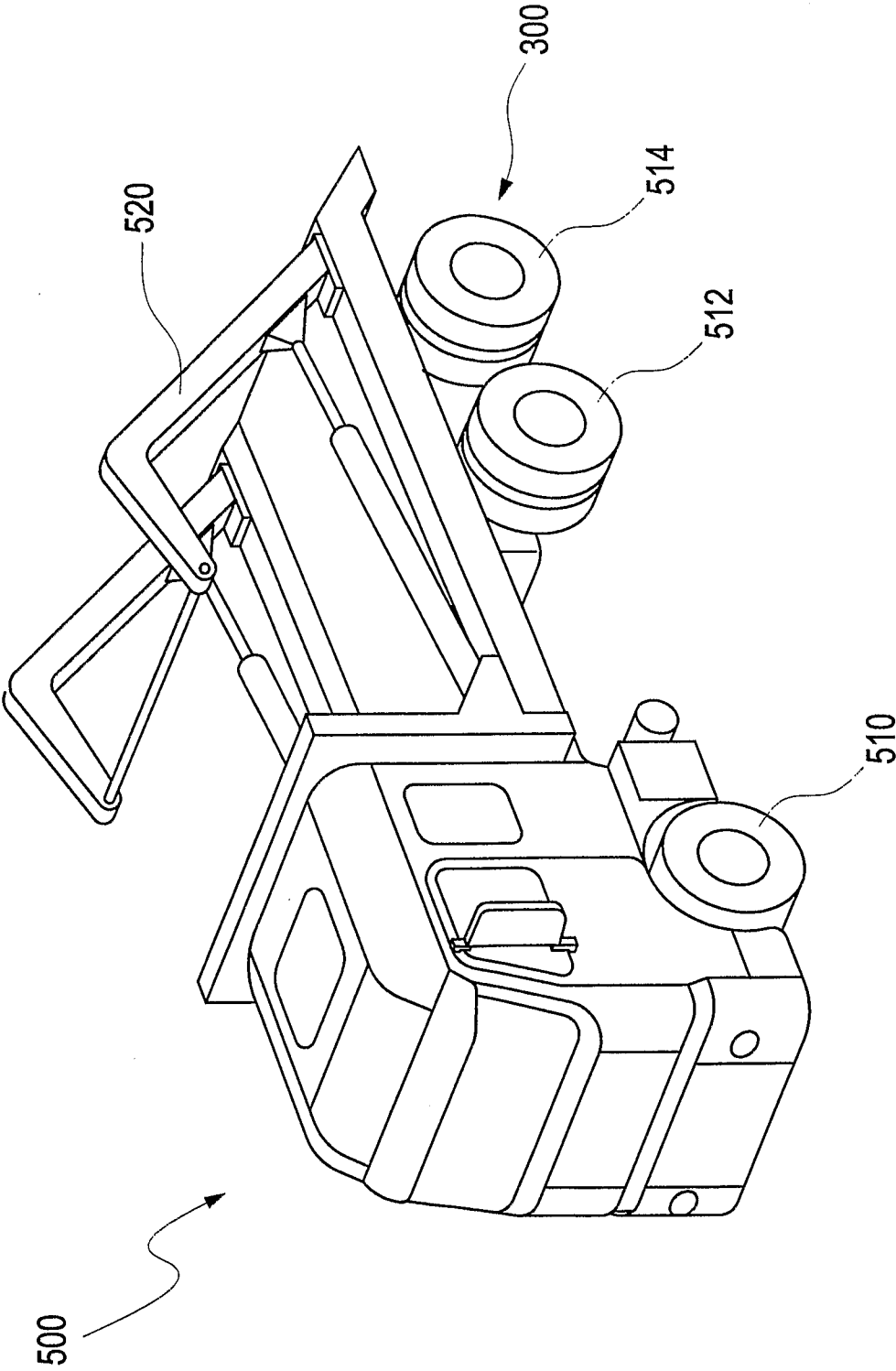


Fig. 4a

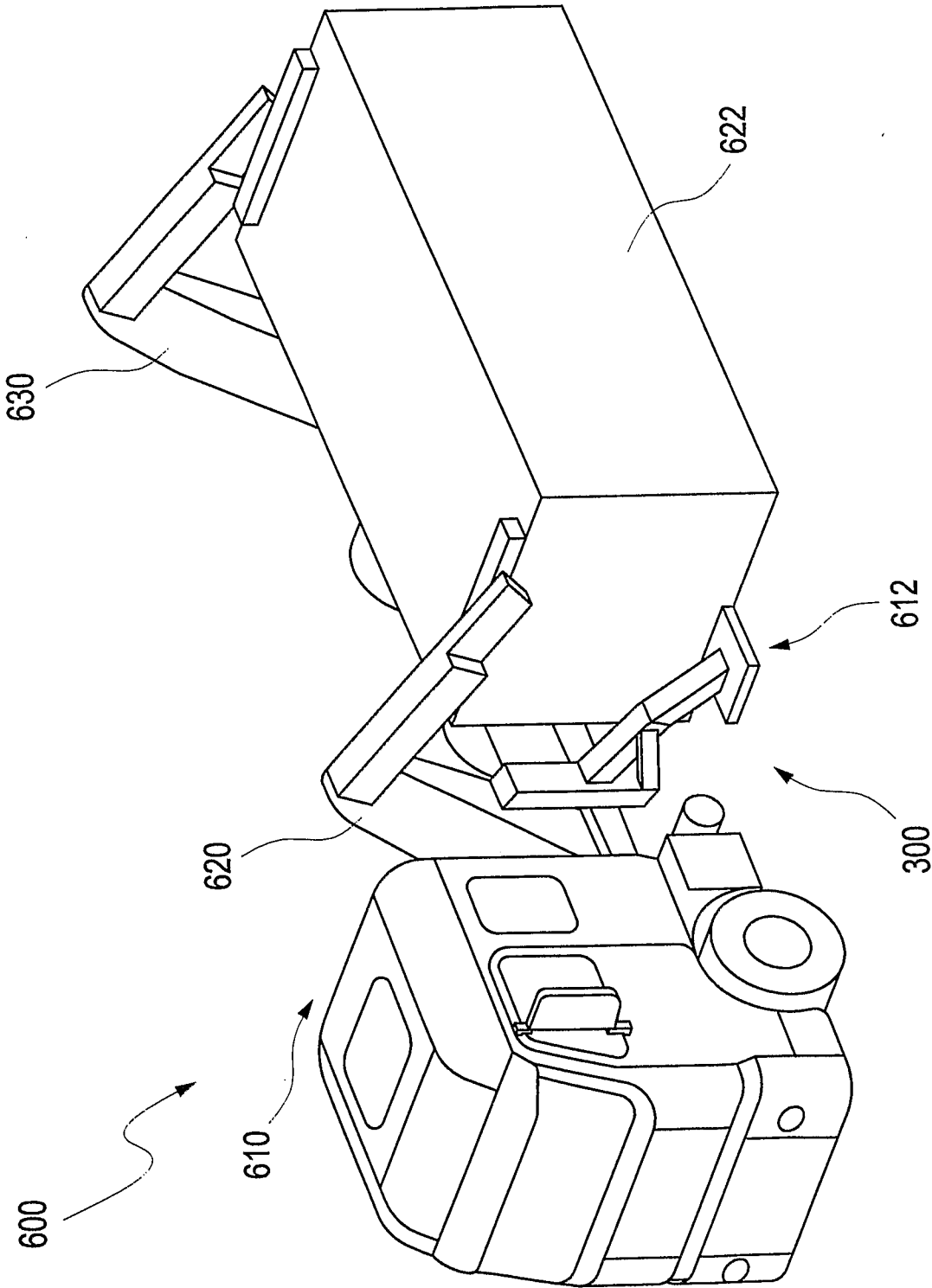


Fig. 4b

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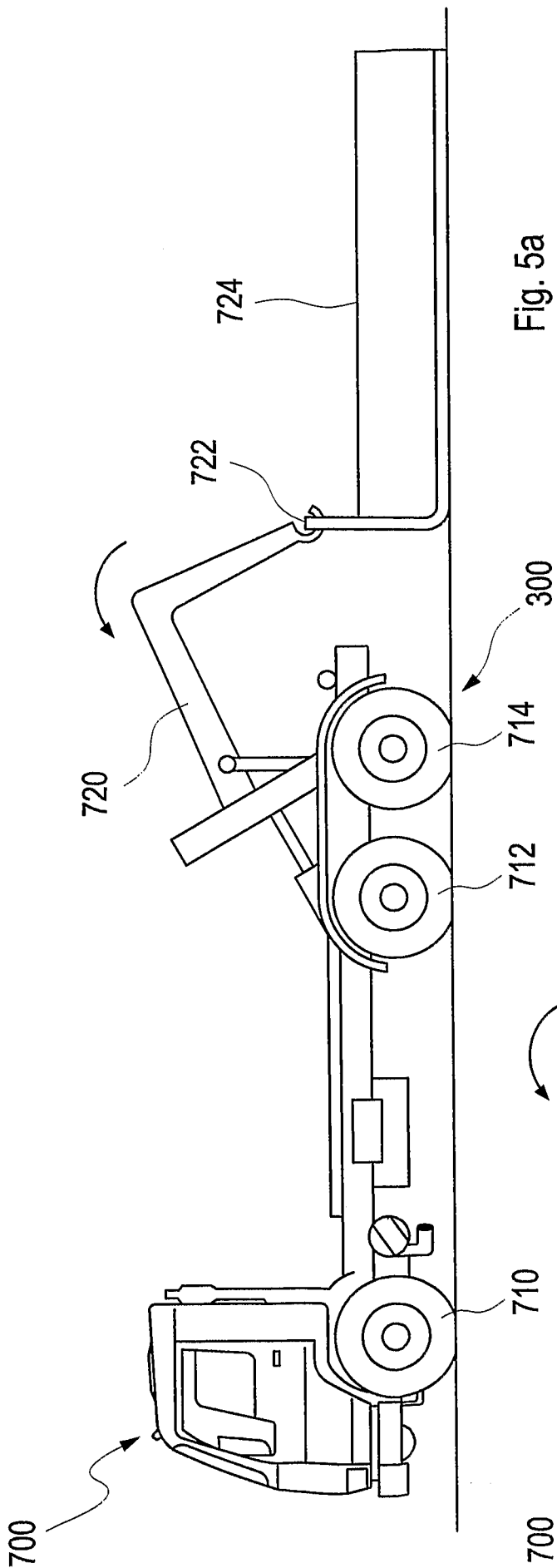


Fig. 5a

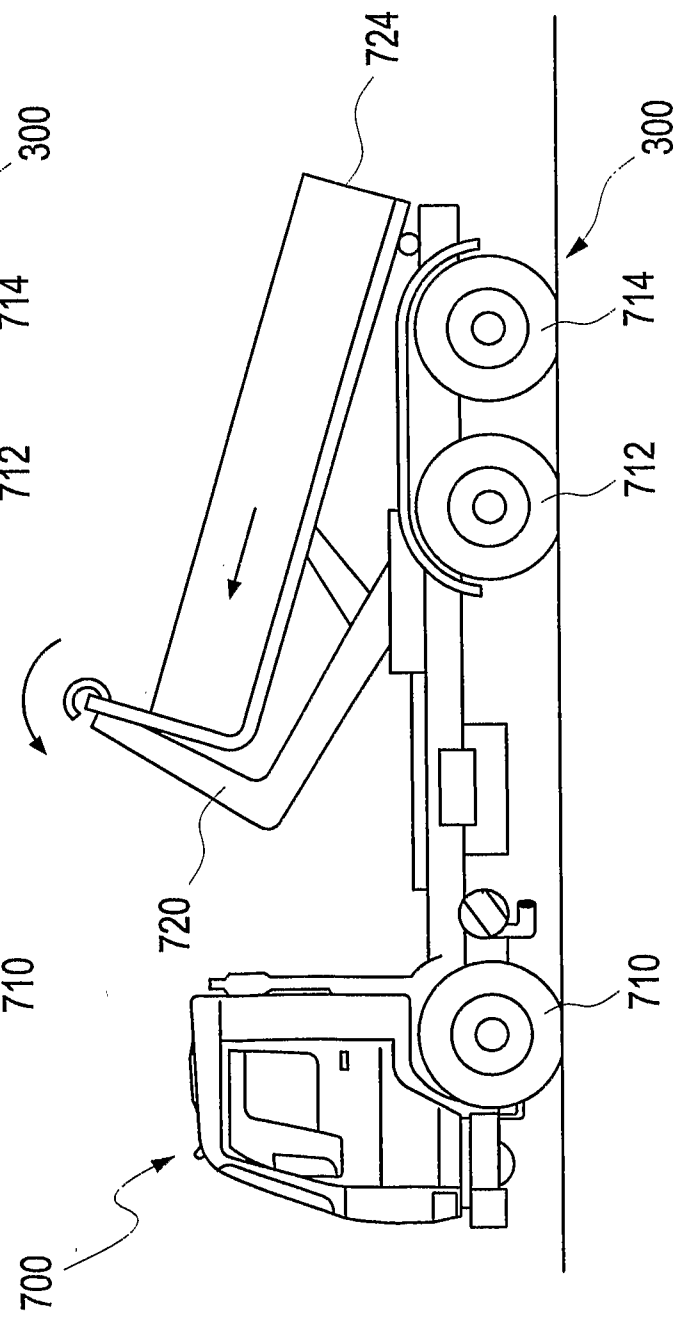


Fig. 5b

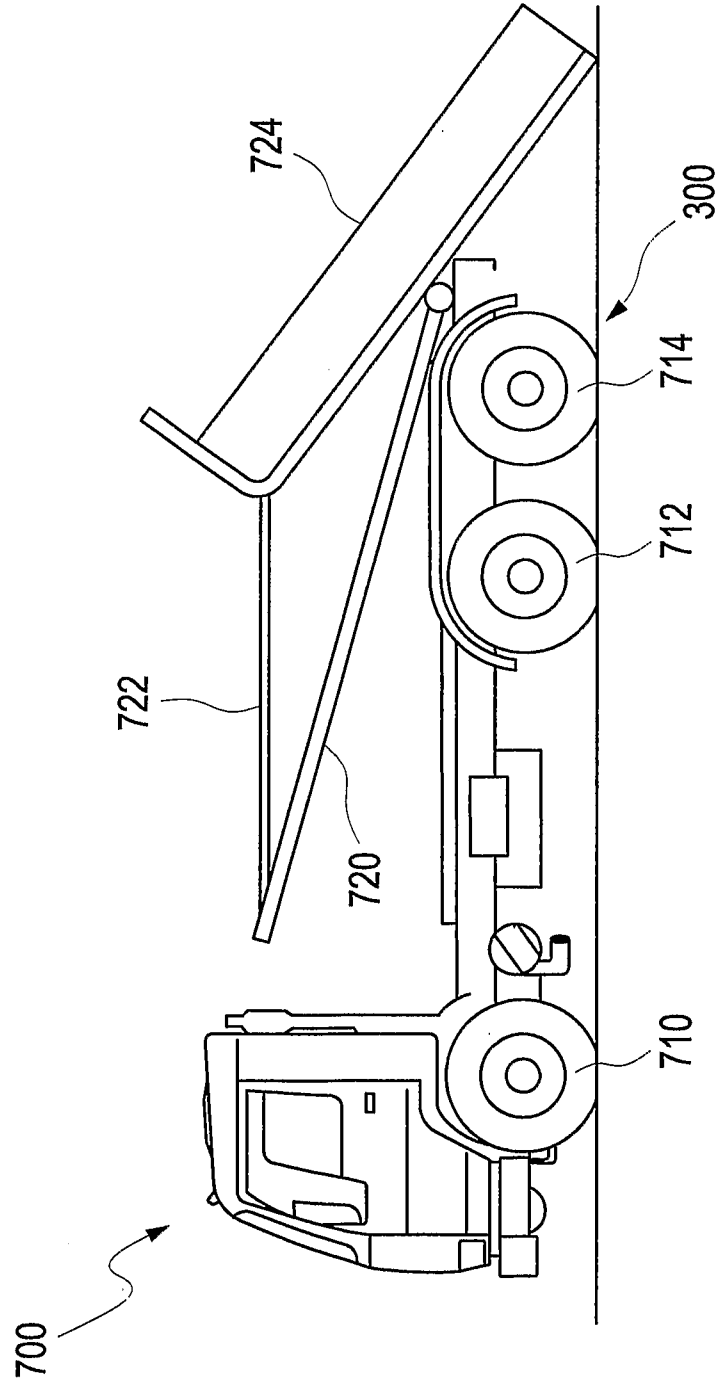


Fig. 5c

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2008/000723

A. CLASSIFICATION OF SUBJECT MATTER

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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)

IPC: B52D, B60C, B60P, B60G, B66C

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 0034060 A1 (CASE CORPORATION), 15 June 2000 (15.06.2000), page 2, line 2 - page 3, line 3; page 6, line 30 - page 9, line 7, figure 2, abstract --	1-13
A	US 20070068238 A1 (WENDTE), 29 March 2007 (29.03.2007), figure 1, abstract, paragraph (0040) --	1-13
A	EP 0440083 A1 (COMPAGNIE GENERALE DES ETABLISSEMENTS MICHELIN - MICHELIN & CIE), 7 August 1991 (07.08.1991), figures 1,4, claim 8, abstract --	1-13

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

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Date of the actual completion of the international search

18 August 2009

Date of mailing of the international search report

19-08-2009

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5495879 A (CABESTRERO), 5 March 1996 (05.03.1996), whole document --	1-13
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INTERNATIONAL SEARCH REPORT

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B62D 37/00 (2006.01)

B60C 23/00 (2006.01)

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Information on patent family members

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