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(54) **A MINE DETONATING APPARATUS AND A METHOD OF STEERING THE SAME**

MINENDETONATIONSVORRICHTUNG UND VERFAHREN ZU IHRER LENKUNG

APPAREIL DE DÉTONATION DE MINE ET PROCÉDÉ DE PILOTAGE ASSOCIÉ

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Description

FIELD OF INVENTION

[0001] The present invention relates to a mine detonating apparatus and in particular to a mine detonating apparatus mountable to a vehicle and adapted to automatically steer along a path that is subsequently driven over by the vehicle. Furthermore, the present invention relates to a method of operating a mine detonating apparatus, and in particular to a method of operating a mine detonating apparatus to automatically steer along a path subsequently driven over by the vehicle.

INTRODUCTION

[0002] In many situations, such as conflicts and peacekeeping operations, there is a requirement for military or peace-keeping personnel to be able to travel over ground which may have been mined or laid with Improvised Explosive Devices (IEDs). Many of these mines and IEDs are fitted with load sensitive devices which trigger an explosion when a wheel passes over them.

[0003] It is known to push one or more rollers in front of a wheeled or tracked vehicle by means of a suitable frame pivotably mounted to the vehicle body. The intention is that the rollers of the mine detonating apparatus trigger the explosion ahead of the vehicle, thereby minimising damage to the vehicle and potential injuries to the passengers.

[0004] To ensure that the mine detonating apparatus provides maximum protection to the vehicle, it is important that it can be steered such that when the vehicle is traversing a corner or around a bend, the rollers of the mine detonating apparatus roll over the ground surface that is subsequently driven over by the vehicle, therefore minimising the risk of the vehicle setting off an explosion and potentially causing significant damage to the vehicle and/or injury to an occupant.

[0005] A known mine detonating apparatus for an armoured personnel carrier is described in WO02/03007A1. As shown in Figure 1, the mine detonating apparatus includes, *inter alia*, a front roller assembly **1** pivotably mounted to the front of the vehicle body **2** and a rear roller assembly **3** pivotably mounted to the rear of the vehicle body **2**. The rotation of the front roller assembly **1** about its pivotable mount **4** is controlled by a pair of hydraulic cylinders **5** connected to the front roller assembly **1** and the vehicle body **2**. The rotation of the rear roller assembly **3** about its pivotable mount **6** drives a pair of hydraulic cylinders **7** connected to the rear roller **3** assembly and the vehicle body **2**. For example, when the vehicle turns, the trailing rear roller assembly **3** swings to the inside of the turn, thereby compressing and extending respective rear hydraulic cylinders **7**. These hydraulic cylinders **7** are connected via hydraulic hoses (not shown) to the front cylinders **5**. Thus, the hydraulic forces generated in the front cylinders **5** steer the front roller assembly **1** to the inside of the turn.

[0006] However, this arrangement has the disadvantage of requiring the presence of a rear roller assembly, which is unpractical for some vehicle types. In addition, the arrangement has a fixed relationship between the angle of the front roller assembly to that of the rear roller assembly. Therefore, depending on the geometry of the vehicle and the mine detonating apparatus, the relationship between the front steer angle and the rear castor angle may vary in a linear or non-linear manner.

[0007] Instead of a rear roller assembly which is hydraulically coupled to the front roller assembly, as shown in Figure 1, a further known apparatus comprises a control system which uses the castor angle of a rear roller system as an input signal to a control system which independently steers the front roller assembly accordingly utilising front cylinders.

[0008] However, this arrangement also has the disadvantage of requiring the presence of a rear roller assembly, which is unpractical for some vehicle types. In particular, steering the front roller assembly using the front cylinders requires a substantial amount of hydraulic energy. Hydraulic energy is typically generated by an electrically driven pump or motor unit, which in turn is driven by power supplied from the host vehicle. Most vehicles, however, have a very limited power supply either from batteries or on-board generators and the constant use of the front cylinders would undesirably consume most of the available power.

[0009] A further known mine detonating apparatus according to the preamble of claim 1 is described in GB2461155B.

[0010] As shown in Figure 2, the disclosed mine detonating apparatus **8** includes two roller assemblies **9a, 9b** that are pushed in front of a vehicle **10** by means of a frame **11** which is pivotably mounted to the vehicle **10**. The frame **11** includes various linkages **12** and a hydraulic actuator **13** which allow the roller assemblies **9a, 9b** to be steered relative to the frame **11**. The various linkages **12** provide a mechanical feedback mechanism that allows the roller assemblies **9a, 9b** to steer such that the frame **11** is moved to or maintained at a specified angle relative to the vehicle **10**. The length of the hydraulic actuator specifies the angle of the frame relative to the vehicle. Additionally, the mine detonating apparatus **8** described in GB2461155B comprises an electronic control system (not shown) which receives a signal from a transducer (not shown) coupled to the steering mechanism of the vehicle **10** and which determines an angle of the frame **11** relative to the vehicle **10** required to move the roller assemblies **9a, 9b** along a path that is assumed to be subsequently driven over by the vehicle **10**. The control system then sets the length of the hydraulic actuator **13** to the

length required to provide the determined angle between the frame **11** and the vehicle **10**.

[0011] However, this arrangement has the disadvantage that the degree of steer applied to the mine detonating apparatus is determined by the angle of the steering mechanism of the vehicle. However, in general, the relationship between the angle of the steering mechanism of the vehicle and the actual radius of the turn being traversed is inconsistent, especially on low friction surfaces such as soft sand.

[0012] In addition, the geometry of the frame and the various linkages disclosed in GB2461155B must be individually designed for each specific vehicle geometry, making it impossible to swap the same mine detonating apparatus between different vehicle types. Also, the pivotably mounted frame is inherently unstable and the mine detonating apparatus includes various linkages that provide mechanical feedback steering the roller assemblies in order to keep the frame at a specified angle and therefore overcome its instability. Consequently, depending on the degree of friction between the roller assemblies and the ground, the steered roller assemblies may not be able to apply sufficient force to keep the frame at the specified angle. Additionally, the roller assemblies may need to operate at a continuous slip angle in order to maintain the required position of the pivotably mounted frame, except in special cases. However, this will subsequently lead to accelerated wear of the roller tyres.

[0013] Accordingly, it would be desirable to eliminate one or more of the above problems by providing an improved mine detonating apparatus.

SUMMARY OF THE INVENTION

[0014] According to a first aspect of the present invention there is provided a mine detonating apparatus for a vehicle, comprising:

- a frame structure pivotably mountable to the vehicle;
- ground engaging means pivotably mounted to the frame structure for applying a load to the ground;
- first actuator means adapted to move the frame structure relative to the vehicle about a first axis substantially vertical relative to the ground;
- transducer means adapted to provide a first feedback signal related to the position of the frame structure relative to the vehicle; and
- controller means configured to receive an input signal relating to an actual path of the vehicle and to determine a desired position of the apparatus relative to the vehicle, wherein the controller means is further configured to receive the first feedback signal to determine an actual position of the apparatus relative to the vehicle, and operate the first actuator means in accordance with a difference between the actual position and the desired position of the apparatus to move the apparatus such that the ground engaging means cover a path subsequently driven over by the vehicle.

[0015] The mine detonating apparatus may further comprise a second actuator means adapted to move the ground engaging means relative to the frame structure about a second axis substantially vertical relative to the ground, wherein the controller means may further be configured to selectively operate the first actuator means and/or the second actuator means in accordance with a difference between the actual position and the desired position of the apparatus to move the apparatus such that the ground engaging means cover a path subsequently driven over by the vehicle.

[0016] Advantageously, the mine detonating apparatus in accordance with the present invention automatically ensures that the ground engaging means always cover the ground the vehicle subsequently drives over at minimal energy expenditure, irrespective of the vehicles intended steered direction, which may be different to the actual direction taken by the vehicle due to the profile and/or composition of the ground surface. In particular, the controller continuously determines the actual path of the vehicle and determines a desired position of the mine detonating apparatus relative to the vehicle. The desired position is the position of the mine detonating apparatus relative to the vehicle that ensures that the mine detonating apparatus follows the path subsequently driven over by the vehicle. The desired position of the mine detonating apparatus is then compared to its actual position, which is determined from a first feedback signal, for example, the angle of the frame structure with respect to the vehicle. In the event the actual position differs from the desired position, first and/or second actuator means are used to move the mine detonating apparatus into the desired position. Thus, the risk of the vehicle undesirably and potentially fatally driving over a mine that has not been detected/disarmed by the mine detonating apparatus is minimised, improving the safety of the vehicle's occupants and minimising unnecessary damage to the vehicle.

[0017] Suitably the first actuator means and/or second actuator means may be operated to automatically steer and re-align the apparatus with the vehicle.

[0018] Suitably the transducer means may be further adapted to provide a second feedback signal related to the position of the ground engaging means relative to the frame structure.

[0019] Suitably the input signal may comprise the first and second feedback signals.

[0020] Suitably the mine detonating apparatus may further comprise any one or more of a Global Positioning System

(GPS) sensor operatively coupled to the mine detonating apparatus and/or the vehicle, an accelerometer operatively coupled to the mine detonating apparatus and/or the vehicle, and an inertial navigation system operatively coupled to the mine detonating apparatus and/or vehicle.

[0021] Alternatively or in addition to the first and second feedback signals, the input signal may comprise a third feedback signal received from any one or more of the GPS sensor, the accelerometer and/or the inertial navigation system.

[0022] This provides the advantage that various different measurement systems can be used to determine the actual path of the vehicle. In particular, a GPS sensor may provide a more accurate measure of the curvature of the vehicle path than determining the actual path from the first and second feedback signals alone. This would be desirable, for example, where the surface being driven over was uneven and undesirable 'noise' was being created in the system which could lead to inaccuracies.

[0023] Suitably the ground engaging means may comprise one or more ground engaging members. The ground engaging members may comprise, for example, wheels, tracks or rollers. Preferably, the ground engaging means comprises two spaced apart ground engaging roller assemblies. This provides the advantage that the mine detonating apparatus can cover sufficient width over the ground. Preferably the width of ground covered by the spaced apart ground engaging means is the same or more than the width covered by the vehicle wheels or tracks. Suitably each roller assembly is pivotably mounted to the frame structure to rotate about the second axis.

[0024] Suitably the first and/or second actuator means may comprise one or more hydraulically and/or electrically driven actuators. Preferably the second actuator means comprises two second actuators each of which are operatively coupled to a ground engaging roller assembly. Preferably the second actuator means are smaller in size relative to the first actuator means. A plurality of ground engaging members allows for each ground engaging member to be relatively small. In addition, allowing the apparatus to be automatically steered by one or both of the second actuators provides an energy efficient apparatus as lower loads are required to operate the ground engaging members compared to operating the first actuator means to move the frame structure.

[0025] Advantageously, for the alignment of the apparatus relative to the vehicle, the controller may selectively utilise only one of the second actuators of either one of the ground engaging members, whilst the remaining actuators (the other of the second actuator means and the first actuator means) are disengaged or allowed to 'float', therefore minimising the energy required to initially align the mine detonating apparatus.

[0026] Also, the controller, first and second actuator means and transducer means form a control loop that allows for constant automatic alignment of the mine detonating apparatus relative to the vehicle to ensure the ground engaging means cover a path subsequently followed by the vehicle.

[0027] Therefore, by operating one or both of the ground engaging means and/or frame structure in accordance with feedback from the frame structure, the actual position of the mine detonating apparatus relative to the vehicle is optimised and aligned towards the desired position determined from the actual path of the vehicle.

[0028] Suitably the controller means may be adapted to selectively lock at least one of the first and second actuator means to lock the frame structure and/or ground engaging means in a predetermined position.

[0029] This provides the advantage that energy is only used for individual actuators necessary to provide an optimal alignment whilst any one of the other actuators is locked in the optimally aligned position.

[0030] Suitably the controller means may be adapted to selectively disengage at least one of the first actuator means and second actuator means to allow the frame structure and/or ground engaging means to move freely about its respective first and/or second axis.

[0031] This provides the advantage that energy expenditure is minimised. Also, by selectively disengaging the second actuator means, for example, the ground engaging means will follow a natural path determined by the alignment of the frame structure relative to the vehicle, and also by the ground surface condition and the speed of the vehicle. Hence, excessive wear on the ground engaging means is avoided and the feedback from the disengaged ground engaging means may be used to determine any slippage in order to optimise the steering of the mine detonating apparatus.

[0032] Suitably the controller means may be adapted to receive, store and process computer readable instructions for operating the first and/or second actuator means.

[0033] This provides the advantage that, apart from the input and feedback signals provided by the vehicle and the transducer means, a typical sequence of operating the first and/or second actuator means may be programmed and executed by the controller. For example, when reversing the vehicle, the controller may execute a standard sequence of which the first and/or second actuator means are disengaged or locked in a predetermined position to facilitate the steering of the vehicle when reversing.

[0034] Preferably the transducer means comprises at least one first sensor operatively coupled to the frame structure. Preferably the transducer means further comprises at least one second sensor operatively coupled to the ground engaging means. Suitably the transducer means may comprise at least one goniometric sensor or at least one displacement sensor.

[0035] This provides the advantage that movement of the ground engaging means relative to the frame structure and movement of the frame structure relative to the vehicle can be directly measured and provided to the controller improving the response time of the controller and consequently the automatic steering.

[0036] The frame structure may be adapted to be mountable to the front of the vehicle with respect to the moving direction of the vehicle.

[0037] According to a second aspect of the present invention, a method for operating a mine detonating apparatus as herein described above mounted to a host vehicle, comprises the steps of:

- (i) providing an input signal relating to an actual path of the host vehicle to a controller means of the apparatus;
- (ii) determining an actual path of the vehicle from the input signal;
- (iii) determining a desired position of the apparatus relative to the vehicle from the actual path;
- (iv) determining an actual position of the apparatus relative to the vehicle from the first feedback signal; and
- (v) operating a first actuator means in accordance with the difference between the actual position and the desired position of the apparatus relative to the vehicle to move the apparatus such that the ground engaging means cover a path subsequently driven over by the vehicle.

[0038] In step (v), the first and/or a second actuator means may be selectively operated in accordance with the difference between the actual position and the desired position of the apparatus relative to the vehicle to move the apparatus such that the ground engaging means cover a path subsequently driven over by the vehicle.

[0039] The method may further comprise the step of selectively disengaging and/or locking any one of the first and/or second actuator means.

[0040] This provides not only the advantage of minimising energy expenditure, but also that the radius of the actual path of the vehicle can be determined through, for example, a disengaged roller assembly of the mine detonating apparatus. In particular, a disengaged second actuator not only allows the roller assembly to run freely to follow a natural path that depends on the alignment of the frame structure, but also a path that depends on the ground surface condition as well as the speed of the host vehicle. Thus, slippage of the rollers may be reduced which in turn desirably minimises wear of the rollers.

[0041] Suitably the step of determining the actual path of the vehicle and apparatus may be based on the first and second feedback signal and a dimension of the frame structure and/or the host vehicle.

[0042] Alternatively or additionally, the path of the host vehicle may be determined based on a third feedback signal received from any one of at least one GPS sensor operatively coupled to the host vehicle, one or more accelerometers operatively coupled to either the frame structure and/or the host vehicle, and at least one inertial navigation system operatively coupled to the host vehicle.

[0043] The method may further comprise the steps of processing a pre-programmed computer readable instruction and selectively operating the first and/or second actuator means in accordance to a predetermined operating sequence.

DESCRIPTION OF THE DRAWINGS

[0044] A preferred embodiment of the present invention will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:

Figure 1 shows a plan view of a first known mine detonating apparatus which is also representative for a second known mine detonating apparatus;

Figure 2 shows a plan view of a third known mine detonating apparatus;

Figure 3 shows a schematic plan view of a mine detonating apparatus in accordance with the present invention coupled to a vehicle;

Figure 4 shows a side elevation of a mine detonating apparatus of the present invention coupled to a vehicle; and

Figure 5 shows a simplified schematic diagram of the control loop formed by the controller, transducer and actuators.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE PRESENT INVENTION

[0045] Referring to Figures 3 and 4, a mine detonating apparatus **100** comprises a frame **120** adapted to be pivotably mounted to a vehicle **150** about an axis **160** and two spaced apart roller assemblies **130**, **140**, pivotably mounted to the frame **120** about their respective axes **170**, **180**.

[0046] The frame **120** can pivot about the axis **160** in order to vary an angle α between the longitudinal axis of the frame **120** and the vehicle **150**. The roller assemblies **130**, **140** can pivot about their respective axes **170**, **180** in order to vary an angle β_L or β_R between a longitudinal axis of each roller assembly **130**, **140** and the frame **120**. Each roller

assembly **130, 140** is able to rotate through a full 360°. The roller assemblies **130, 140** are arranged to apply pressure to the ground in front of the vehicle **150**.

[0047] The mine detonating apparatus **100** also includes actuators in the form of, for example, two frame cylinders **190a, 190b** between the frame **120** and the vehicle **150**, which can be configured to be disengaged or "float", such that the frame **120** is free to rotate about its pivot axis **160**, lock, such that the angle α remains fixed once the frame has been moved into position, or engage, i.e. one frame cylinder **190a** extends/retracts while the other frame cylinder **190b** retracts/extends, such that the angle α increases or decreases, respectively.

[0048] The mine detonating apparatus **100** also includes two castor cylinders **200a, 200b** disposed between each roller assembly **130, 140**, and the frame structure **120**, wherein each of the castor cylinders **200a, 200b** can be independently configured to either "float", such that their respective roller assemblies **130, 140** are free to rotate about their respective axes **170, 180**, lock, such that angles β_L and/or β_R are fixed, or engage, i.e. extend or retract such that respective angles β_L and/or β_R increase or decrease with respect to the frame structure **120**.

[0049] The distance between a centre of rotation **210** of the vehicle **150** and the pivot axis **160** of the frame **120** is defined as length L_V . The length of the frame **120** is defined as length L_R .

[0050] When the frame cylinders **190a, 190b** are in a locked configuration and the castor cylinders **200a, 200b** are in a "float" configuration, a relationship between the actual turning radius R of the vehicle **150** and the respective geometric parameters $L_V, L_R, \alpha, \beta_L, \beta_R$ exists. For example, the actual or true turning radius R of the vehicle in a steady state can be determined approximately by the following equation:

$$R \approx \frac{L_V + L_R \cos \alpha}{\sin(\beta + \alpha)} \quad (1)$$

[0051] It should be noted that when the frame **120** is being steered (i.e. α is varying) β_L and β_R are affected. This needs to be taken into account when calculating R . For example, if α is increasing, β_L and β_R will be larger than would be the case in the steady state.

[0052] It is not necessarily imperative to know both β_L and β_R in order to calculate the actual or true turning radius of the vehicle **150**.

[0053] Referring now to Figure 5, the mine detonating apparatus **100** further comprises a control system **220** that receives an input signal relating to an actual path of the vehicle **150**. During operation, the control system **220** continuously receives the input signal relating to the actual path of the vehicle and continuously determines the current desired position of the mine detonating apparatus **100**. The control system **220** compares the desired with the actual position of the mine detonating apparatus **100** relative to the vehicle **150** and operates any one of the frame cylinders **190a, 190b** or castor cylinder **200a, 200b** to move the frame **120** into the desired position. The actual position of the mine detonating apparatus **100** relative to the vehicle **150** is determined, for example, from the actual rotation angle α determined by respective transducer **229**, which may be a goniometer or displacement sensor mounted on the axis **160**. The input signal used to determine the actual path of the vehicle **150** may comprise the first and second feedback signals **330, 310, 320** relating to the actual rotation angles α, β_L and β_R from respective transducers **229, 230a, 230b**.

[0054] Alternatively, the inputs other than α, β_L and β_R may be used to determine the actual path of the vehicle **150** may comprise a third feedback signal (not shown) received from, for example, a Global Positioning System (GPS) sensor (not shown), one or more accelerometers (not shown) and/or an inertial navigation system (not shown). The GPS may be mounted to the vehicle **150** or frame structure **120**. The accelerometers and inertial navigation system may be mounted to the vehicle **150** and/or frame **120**.

[0055] When not steering, the frame cylinders **190a, 190b** may be locked and the castor cylinders **200a, 200b** may be free to 'float' such that the roller assemblies **130, 140** are free to follow a natural path determined by the angle of the frame structure **120** relative to the vehicle.

[0056] Under normal ground surface condition, i.e. when the roller assemblies have sufficient grip on the ground surface, the actual steer angle α of the frame **120** may be adjusted by disengaging the frame cylinders **190a, 190b** and one of the castor cylinders **200a** or **200b**, such that the frame **120** and one of the roller assemblies **130** or **140** are free to "float" about their respective axes **160, 170, 180**, wherein the other castor cylinder **200a** or **200b** is engaged by the controller **220**. In this particular example, the angle β_R or β_L is varied such that the frame **120** tracks to the specified angle α_s as the vehicle **150** advances, the frame cylinders **190a** and **190b** are then locked to fix the angle α , and the engaged castor cylinder **200a** or **200b** is disengaged to its "float" configuration. Which castor cylinder **200a** or **200b** is chosen to carry out the steer operation depends on the actual angle α , the desired angle α_s and the actual turning radius R of the vehicle. Suitably the roller assembly which is able to generate the greatest torque for moving the apparatus is chosen to perform the steer operation. For example, when α is positive and it is desired to decrease α , the left hand roller assembly **130** should be engaged and if it is desired to increase α , the right hand roller assembly **140** should be used to perform the steering operation. The opposite is the case when α is negative.

[0057] Under extreme ground surface conditions, where, for example, the roller assemblies have insufficient grip on the ground surface, the actual steer angle α of the frame 120 may be adjusted by disengaging the castor cylinders 200a and 200b, such that the roller assemblies 130 and 140 are free to "float" about their respective axes 170 and 180, and the frame cylinders 190a, 190b are engaged by the controller 220 to steer the frame structure 120 until the desired angle α_s is achieved.

[0058] Preferably, the mine detonating apparatus is steered using one of the castor cylinders 200a, 200b rather than the frame cylinders 190a, 190b, to desirably utilise the tractive effort of the vehicle instead of solely using electrical power as would be the case when steering using the frame cylinder 190a, 190b.

[0059] When reversing the vehicle 150, the castor cylinders 200a, 200b may be disengaged such that the roller assemblies 130, 140 are free to "float" about their respective axes 170, 180. The frame cylinders 190a, 190b may either be disengaged to freely rotate about its axis 160, or locked in a specified position. Alternatively, the frame 120 may be steered into a centre position such that $\alpha = 0^\circ$. Configuring the mine detonating device 100 for reversing can either be carried out manually or automatically by providing a pre-programmed operation sequence to the control system 220, such that the control system 220 executes a specific reversing procedure when $90^\circ < \beta_L < 270^\circ$ and/or $90^\circ < \beta_R < 270^\circ$.

[0060] It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departing from the scope of the invention as defined by the appended claims.

Claims

1. A mine detonating apparatus (100) for a vehicle (150), comprising:

- a frame structure (120) pivotably mountable to the vehicle (150);
- ground engaging means (130, 140) pivotably mounted to the frame structure (120) for applying a load to the ground;
- first actuator means (190a, 190b);
- transducer means (229) adapted to provide a first feedback signal (330) related to the position (α) of the frame structure (120) relative to the vehicle (150); and
- controller means (220) configured to receive an input signal relating to an actual path of the vehicle (150) and to determine a desired position of the apparatus (100) relative to the vehicle (150); wherein the (220) means is further configured to receive the first feedback signal (330) to determine an actual position of the apparatus (100) relative to the vehicle (150); and operate the first actuator means (190a, 190b) in accordance with a difference between the actual position and the desired position of the apparatus (100) to move the apparatus (100) such that the ground engaging means (130, 140) cover a path subsequently driven over by the vehicle (150); the apparatus (100) being **characterized by** the first actuator means (190a, 190b) being adapted to move the frame structure (120) relative to the vehicle (150) about a first axis (160) substantially vertical relative to the ground.

2. A mine detonating apparatus (100) according to claim 1, further comprising a second actuator means (200a, 200b) adapted to move the ground engaging means (130, 140) relative to the frame structure (120) about a second axis (170, 180) substantially vertical relative to the ground, wherein the controller means (220) is further configured to selectively operate the first actuator means (190a, 190b) and/or the second actuator means (200a, 200b).

3. A mine detonating apparatus (100) according to any preceding claim, wherein the transducer means (229) is further adapted to provide a second feedback signal (310, 320) related to the position (β_L , β_R) of the ground engaging means (130, 140) relative to the frame structure (120).

4. A mine detonating apparatus (100) according to claim 3, wherein the input signal comprises the first feedback signal (330) and the second feedback signal (310, 320).

5. A mine detonating apparatus (100) according to any preceding claim, further comprising any one or more of a GPS sensor operatively coupled to the mine detonating apparatus (100) and/or configured to be coupled to the vehicle (150); one or more of an accelerometer operatively coupled to the mine detonating apparatus (100) and/or configured to be coupled to the vehicle (150), and an inertial navigation system operatively coupled to the mine detonating apparatus (100) and/or configured to be coupled to vehicle (150).

6. A mine detonating apparatus (100) according to claims 4 and 5, wherein the input signal comprises the first and

second feedback signals (330, 310, 320) and/or a third feedback signal received from any one or more of the GPS sensor and/or one or more of the accelerometer and/or the inertial navigation system.

7. A mine detonating apparatus (100) according to any preceding claim, wherein the ground engaging means (130, 140) comprises one or more ground engaging members.
8. A mine detonating apparatus (100) according to claim 7, wherein the ground engaging means (130, 140) comprises two spaced apart ground engaging roller assemblies.
9. A mine detonating apparatus (100) according to any preceding claim, wherein the first and/or second actuator means (190a, 190b, 200a, 200b) comprise one or more hydraulically and/or electrically driven actuators.
10. A mine detonating apparatus (100) according to claim 8 and 9, wherein the second actuator means (200a, 200b) comprises two second actuators each of which are operatively coupled to a ground engaging roller assembly.
11. A mine detonating apparatus (100) according to any preceding claim, wherein the controller means (220) is adapted to selectively lock at least one of the first and second actuator means (190a, 190b, 200a, 200b) to lock the frame structure (120) and/or ground engaging means (130, 140) in a predetermined position.
12. A mine detonating apparatus (100) according to any preceding claim, wherein the controller means (220) is adapted to selectively disengage at least one of the first actuator means (190a, 190b) and second actuator means (200a, 200b) to allow the frame structure (120) and/or ground engaging means (130, 140) to move freely about its respective first (160) and/or second (170, 180) axis.
13. A mine detonating apparatus (100) according to any preceding claim, wherein the controller means (220) is adapted to receive, store and process computer readable instructions for operating the first (190a, 190b) and/or second (200a, 200b) actuator means.
14. A mine detonating apparatus (100) according to any preceding claim, wherein the transducer means (229) comprises at least one goniometric sensor or at least one displacement sensor.
15. A mine detonating apparatus (100) according to any preceding claim, wherein the frame structure (120) is adapted to be mounted to the front of the vehicle (150) with respect to the moving direction of the vehicle (150).

Patentansprüche

1. Eine Minendetonationsvorrichtung (100) für ein Fahrzeug (150), beinhaltend:

- eine Rahmenstruktur (120), die schwenkbar an dem Fahrzeug (150) montierbar ist;
- ein Bodeneingriffsmittel (130, 140), das schwenkbar an der Rahmenstruktur (120) montiert ist, um eine Last auf den Boden aufzubringen;
- ein erstes Stellgliedmittel (190a, 190b);
- ein Wandlermittel (229), das angepasst ist, um ein erstes Rückmeldesignal (330), das sich auf die Position (α) der Rahmenstruktur (120) relativ zu dem Fahrzeug (150) bezieht, bereitzustellen;
- und
- ein Regelungsmittel (220), das konfiguriert ist, um ein Eingangssignal zu empfangen, welches sich auf eine tatsächliche Bahn des Fahrzeugs (150) bezieht, und um eine gewünschte Position der Vorrichtung (100) relativ zu dem Fahrzeug (150) zu bestimmen;

wobei das Mittel (220) ferner konfiguriert ist, um das erste Rückmeldesignal (330) zu empfangen, um eine tatsächliche Position der Vorrichtung (100) relativ zu dem Fahrzeug (150) zu bestimmen; und um das erste Stellgliedmittel (190a, 190b) gemäß einem Unterschied zwischen der tatsächlichen Position und der gewünschten Position der Vorrichtung (100) zu betätigen, um die Vorrichtung (100) so zu bewegen, dass das Bodeneingriffsmittel (130, 140) eine Bahn abdeckt, die im Folgenden von dem Fahrzeug (150) befahren wird;

wobei die Vorrichtung (100) **dadurch gekennzeichnet** ist, dass das erste Stellgliedmittel (190a, 190b) angepasst ist, um die Rahmenstruktur (120) relativ zu dem Fahrzeug (150) um eine erste Achse (160) zu bewegen, die relativ zu dem Boden im Wesentlichen senkrecht ist.

2. Minendetonationsvorrichtung (100) gemäß Anspruch 1, ferner beinhaltend ein zweites Stellgliedmittel (200a, 200b), das angepasst ist, um das Bodeneingriffsmittel (130, 140) relativ zu der Rahmenstruktur (120) um eine zweite Achse (170, 180), die relativ zu dem Boden im Wesentlichen senkrecht ist, zu bewegen, wobei das Regelungsmittel (220) ferner konfiguriert ist, um das erste Stellgliedmittel (190a, 190b) und/oder das zweite Stellgliedmittel (200a, 200b) selektiv zu betätigen.
3. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das Wandlermittel (229) ferner angepasst ist, um ein zweites Rückmeldesignal (310, 320) relativ zu der Position (β_L , β_R) des Bodeneingriffsmittels (130, 140) relativ zu der Rahmenstruktur (120) bereitzustellen.
4. Minendetonationsvorrichtung (100) gemäß Anspruch 3, wobei das Eingangssignal das erste Rückmeldesignal (330) und das zweite Rückmeldesignal (310, 320) beinhaltet.
5. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, ferner beinhaltend eines oder mehrere beliebige von einem GPS-Sensor, der betriebsfähig an die Minendetonationsvorrichtung (100) gekoppelt ist und/oder konfiguriert ist, um an das Fahrzeug (150) gekoppelt zu werden; einem oder mehreren Beschleunigungsmessern, der/die betriebsfähig an die Minendetonationsvorrichtung (100) gekoppelt und/oder konfiguriert ist/sind, um an das Fahrzeug (150) gekoppelt zu werden, und einem Trägheitsnavigationssystem, das betriebsfähig an die Minendetonationsvorrichtung (100) gekoppelt ist und/oder konfiguriert ist, um an das Fahrzeug (150) gekoppelt zu werden.
6. Minendetonationsvorrichtung (100) gemäß den Ansprüchen 4 und 5, wobei das Eingangssignal das erste und zweite Rückmeldesignal (330, 310, 320) und/oder ein drittes Rückmeldesignal, das von einem oder mehreren beliebigen von dem GPS-Sensor und/oder einem oder mehreren Beschleunigungsmessern und/oder dem Trägheitsnavigationssystem empfangen wird.
7. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das Bodeneingriffsmittel (130, 140) ein oder mehrere Bodeneingriffselemente beinhaltet.
8. Minendetonationsvorrichtung (100) gemäß Anspruch 7, wobei das Bodeneingriffsmittel (130, 140) zwei mit Abstand angeordnete Bodeneingriffsrollenanordnungen beinhaltet.
9. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das erste und/oder zweite Stellgliedmittel (190a, 190b, 200a, 200b) ein oder mehrere hydraulisch und/oder elektrisch angetriebene Stellglieder beinhalten.
10. Minendetonationsvorrichtung (100) gemäß Anspruch 8 und 9, wobei das zweite Stellgliedmittel (200a, 200b) zwei zweite Stellglieder beinhaltet, die jeweils betriebsfähig an eine Bodeneingriffsrollenanordnung gekoppelt sind.
11. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das Regelungsmittel (220) angepasst ist, um selektiv mindestens eines von dem ersten und zweiten Stellgliedmittel (190a, 190b, 200a, 200b) zu sperren, um die Rahmenstruktur (120) und/oder das Bodeneingriffsmittel (130, 140) in einer vorgegebenen Position zu sperren.
12. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das Regelungsmittel (220) angepasst ist, um selektiv mindestens eines von dem ersten Stellgliedmittel (190a, 190b) und zweiten Stellgliedmittel (200a, 200b) zu lösen, um zu ermöglichen, dass sich die Rahmenstruktur (120) und/oder das Bodeneingriffsmittel (130, 140) frei um ihre/seine erste (160) bzw. zweite (170, 180) Achse bewegen.
13. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das Regelungsmittel (220) angepasst ist, um computerlesbare Befehle zum Betätigen des ersten (190a, 190b) und/oder zweiten (200a, 200b) Stellgliedmittels zu empfangen, zu speichern und zu verarbeiten.
14. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei das Wandlermittel (229) mindestens einen goniometrischen Sensor oder mindestens einen Wegsensor beinhaltet.
15. Minendetonationsvorrichtung (100) gemäß einem der vorhergehenden Ansprüche, wobei die Rahmenstruktur (120) angepasst ist, um in Bezug auf die Bewegungsrichtung des Fahrzeugs (150) an der Vorderseite des Fahrzeugs

(150) montiert zu werden.

Revendications

1. Un appareil de détonation de mines (100) destiné à un véhicule (150), comprenant :

- une structure formant cadre (120) montable de manière à pouvoir pivoter sur le véhicule (150) ;
- des moyens se mettant en prise avec le sol (130, 140) montés de manière à pouvoir pivoter sur la structure formant cadre (120) destinés à appliquer une charge sur le sol ;
- un premier moyen formant vérins (190a, 190b) ;
- un moyen formant transducteur (229) conçu pour fournir un premier signal de retour (330) relatif à la position (α) de la structure formant cadre (120) par rapport au véhicule (150) ;
- et
- un moyen formant contrôleur (220) configuré pour recevoir un signal d'entrée ayant trait à une trajectoire effective du véhicule (150) et pour déterminer une position souhaitée de l'appareil (100) par rapport au véhicule (150) ;

dans lequel le moyen (220) est en sus configuré pour recevoir le premier signal de retour (330) afin de déterminer une position effective de l'appareil (100) par rapport au véhicule (150) ; et actionner le premier moyen formant vérins (190a, 190b) conformément à une différence entre la position effective et la position souhaitée de l'appareil (100) afin de mouvoir l'appareil (100) de telle manière que les moyens se mettant en prise avec le sol (130, 140) couvrent une trajectoire qui sera par la suite parcourue par le véhicule (150) ;

l'appareil (100) étant **caractérisé par le fait que** le premier moyen formant vérins (190a, 190b) est conçu pour mouvoir la structure formant cadre (120) par rapport au véhicule (150) autour d'un premier axe (160) substantiellement vertical par rapport au sol.

2. Un appareil de détonation de mines (100) selon la revendication 1, comprenant en sus un deuxième moyen formant vérins (200a, 200b) conçu pour mouvoir les moyens se mettant en prise avec le sol (130, 140) par rapport à la structure formant cadre (120) autour d'un deuxième axe (170, 180) substantiellement vertical par rapport au sol, dans lequel le moyen formant contrôleur (220) est en sus configuré pour actionner de manière sélective le premier moyen formant vérins (190a, 190b) et/ou le deuxième moyen formant vérins (200a, 200b).

3. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel le moyen formant transducteur (229) est conçu en sus pour fournir un deuxième signal de retour (310, 320) relatif à la position (β_L , β_R) des moyens se mettant en prise avec le sol (130, 140) par rapport à la structure formant cadre (120).

4. Un appareil de détonation de mines (100) selon la revendication 3, dans lequel le signal d'entrée comprend le premier signal de retour (330) et le deuxième signal de retour (310, 320).

5. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, comprenant en sus un élément quelconque ou plus d'entre un capteur GPS couplé de manière opérationnelle à l'appareil de détonation de mines (100) et/ou configuré pour être couplé au véhicule (150) ; un accéléromètre ou plus couplé de manière opérationnelle à l'appareil de détonation de mines (100) et/ou configuré pour être couplé au véhicule (150), et un système de navigation inertielle couplé de manière opérationnelle à l'appareil de détonation de mines (100) et/ou configuré pour être couplé au véhicule (150).

6. Un appareil de détonation de mines (100) selon les revendications 4 et 5, dans lequel le signal d'entrée comprend les premier et deuxième signaux de retour (330, 310, 320) et/ou un troisième signal de retour reçu en provenance d'un élément quelconque ou plus d'entre ce capteur GPS et/ou cet un accéléromètre ou plus et/ou ce système de navigation inertielle.

7. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel le moyen se mettant en prise avec le sol (130, 140) comprend un ou plusieurs éléments se mettant en prise avec le sol.

8. Un appareil de détonation de mines (100) selon la revendication 7, dans lequel le moyen se mettant en prise avec le sol (130, 140) comprend deux ensembles formant rouleaux se mettant en prise avec le sol espacés l'un de l'autre.

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9. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel les premier et/ou deuxième moyens formant vérins (190a, 190b, 200a, 200b) comprennent un ou plusieurs vérins à commande hydraulique et/ou électrique.

5 10. Un appareil de détonation de mines (100) selon la revendication 8 et la revendication 9, dans lequel le deuxième moyen formant vérins (200a, 200b) comprend deux deuxièmes vérins qui sont chacun couplés de manière opérationnelle à un ensemble formant rouleau se mettant en prise avec le sol.

10 11. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel le moyen formant contrôleur (220) est conçu pour verrouiller de manière sélective au moins l'un des premier et deuxième moyens formant vérins (190a, 190b, 200a, 200b) afin de verrouiller la structure formant cadre (120) et/ou les moyens se mettant en prise avec le sol (130, 140) dans une position prédéterminée.

15 12. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel le moyen formant contrôleur (220) est conçu pour dégager de manière sélective au moins l'un du premier moyen formant vérins (190a, 190b) et du deuxième moyen formant vérins (200a, 200b) afin de permettre à la structure formant cadre (120) et/ou aux moyens se mettant en prise avec le sol (130, 140) de se mouvoir librement autour de leurs premier (160) et/ou deuxième (170, 180) axes respectifs.

20 13. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel le moyen formant contrôleur (220) est conçu pour recevoir, stocker et traiter des instructions lisibles par un ordinateur pour actionner les premier (190a, 190b) et/ou deuxième (200a, 200b) moyens formant vérins.

25 14. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel le moyen formant transducteur (229) comprend au moins un capteur goniométrique ou au moins un capteur de déplacement.

30 15. Un appareil de détonation de mines (100) selon n'importe quelle revendication précédente, dans lequel la structure formant cadre (120) est conçue pour être montée sur le devant du véhicule (150) par rapport à la direction dans laquelle se meut le véhicule (150).

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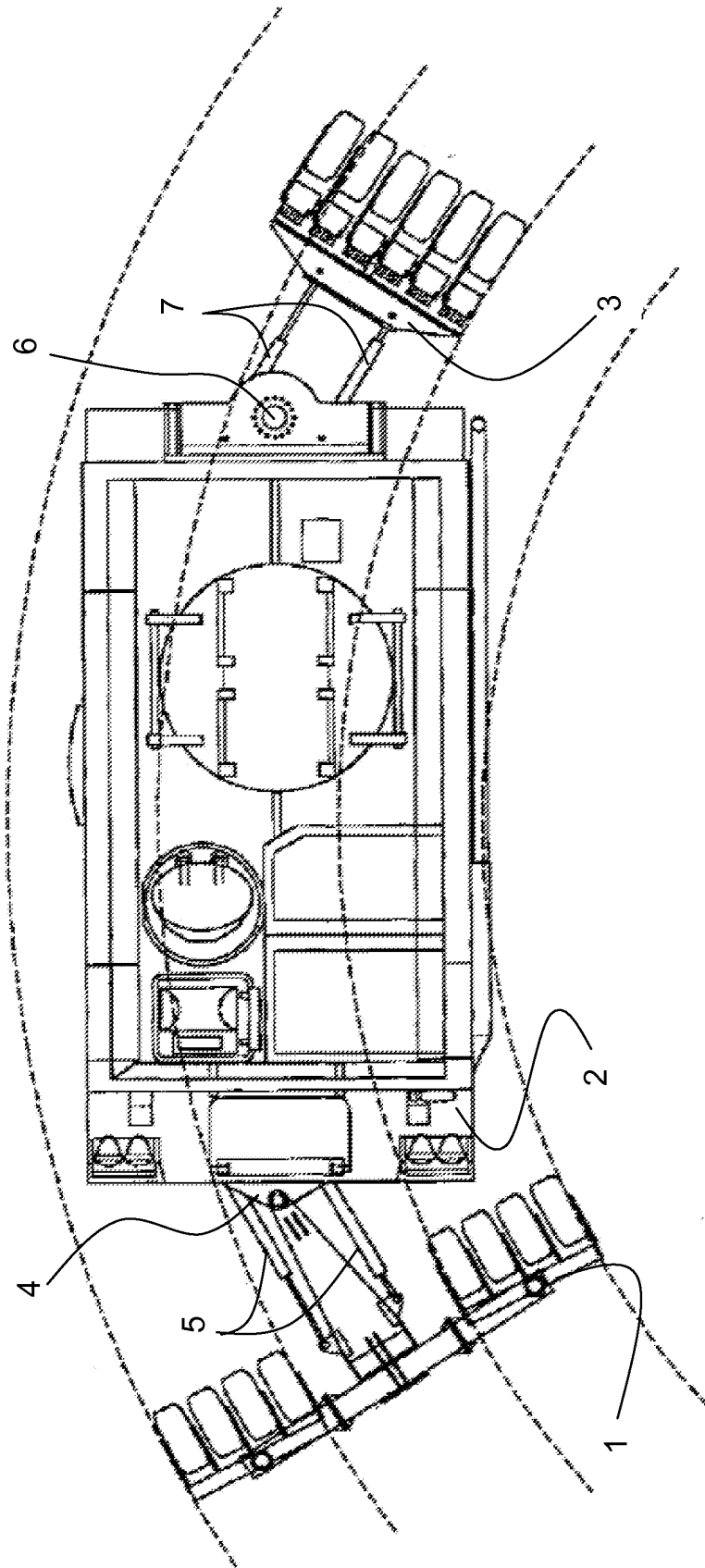


Figure 1 (prior art)

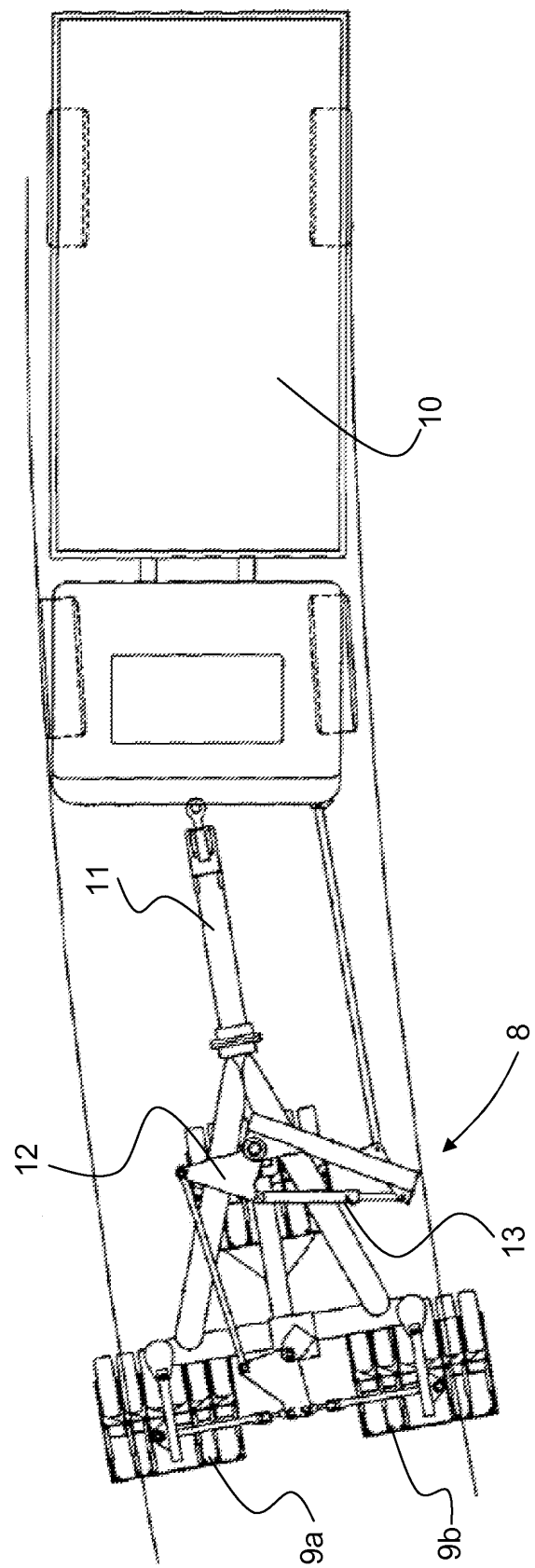


Figure 2 (prior art)

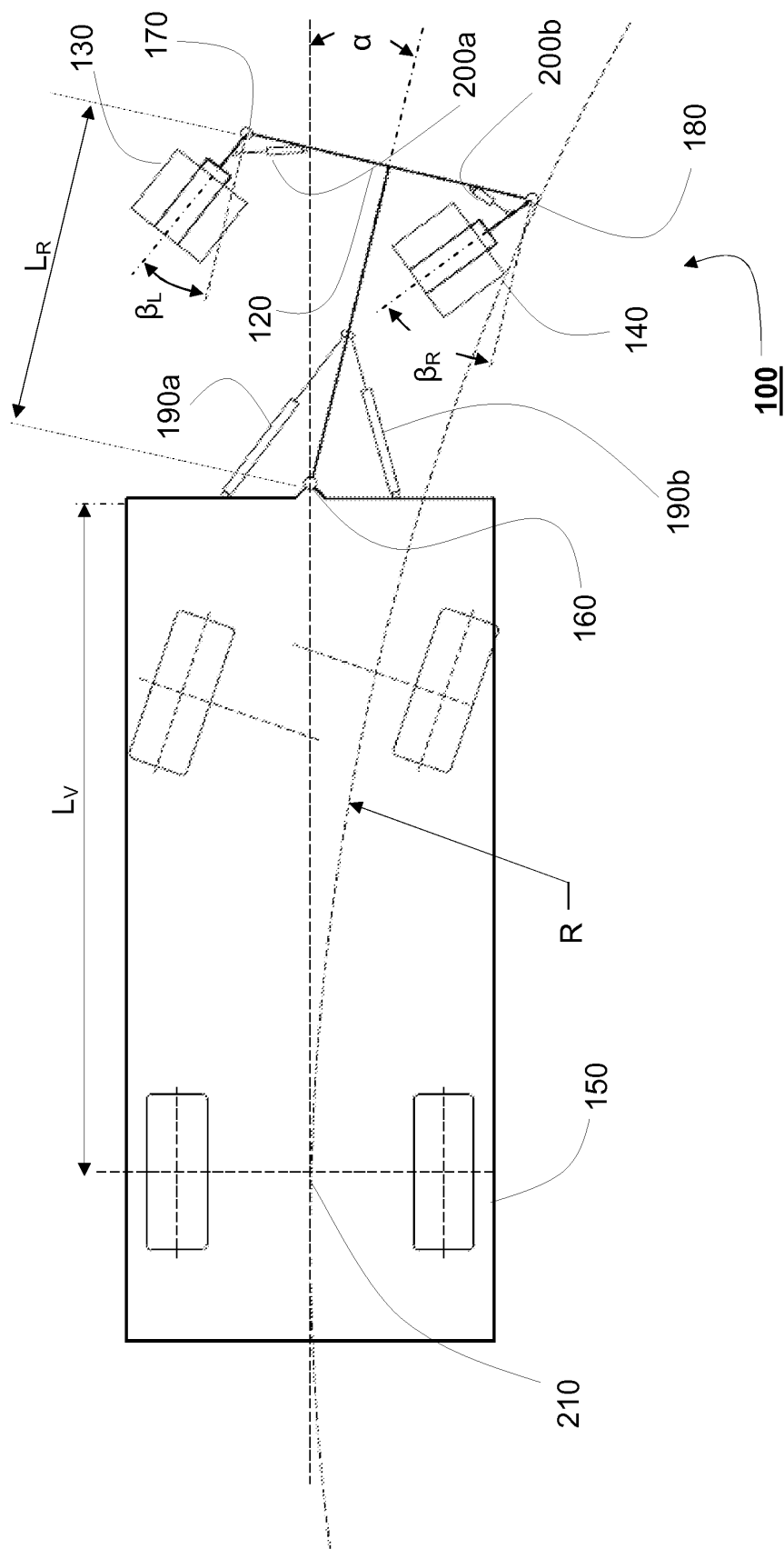


Figure 3

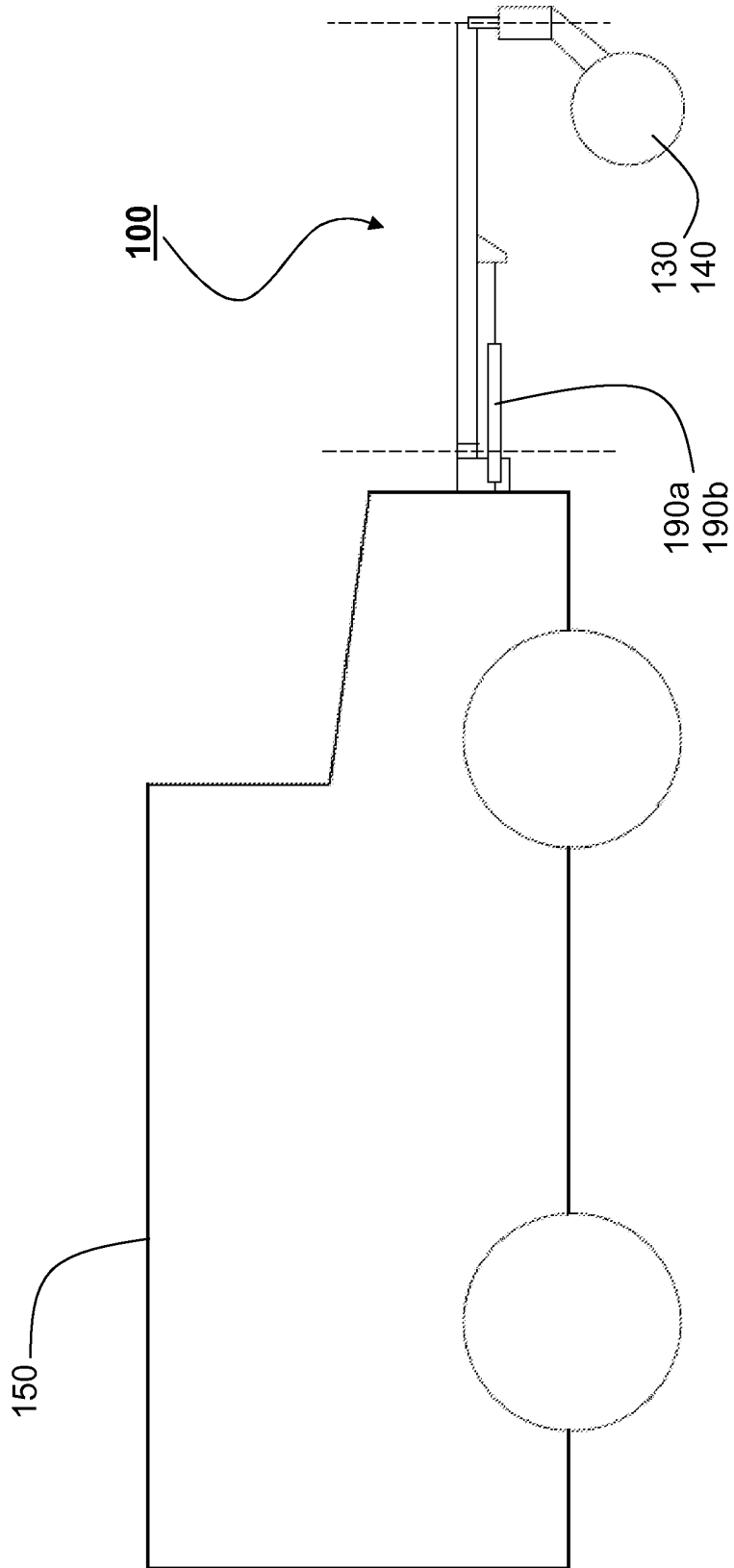


Figure 4

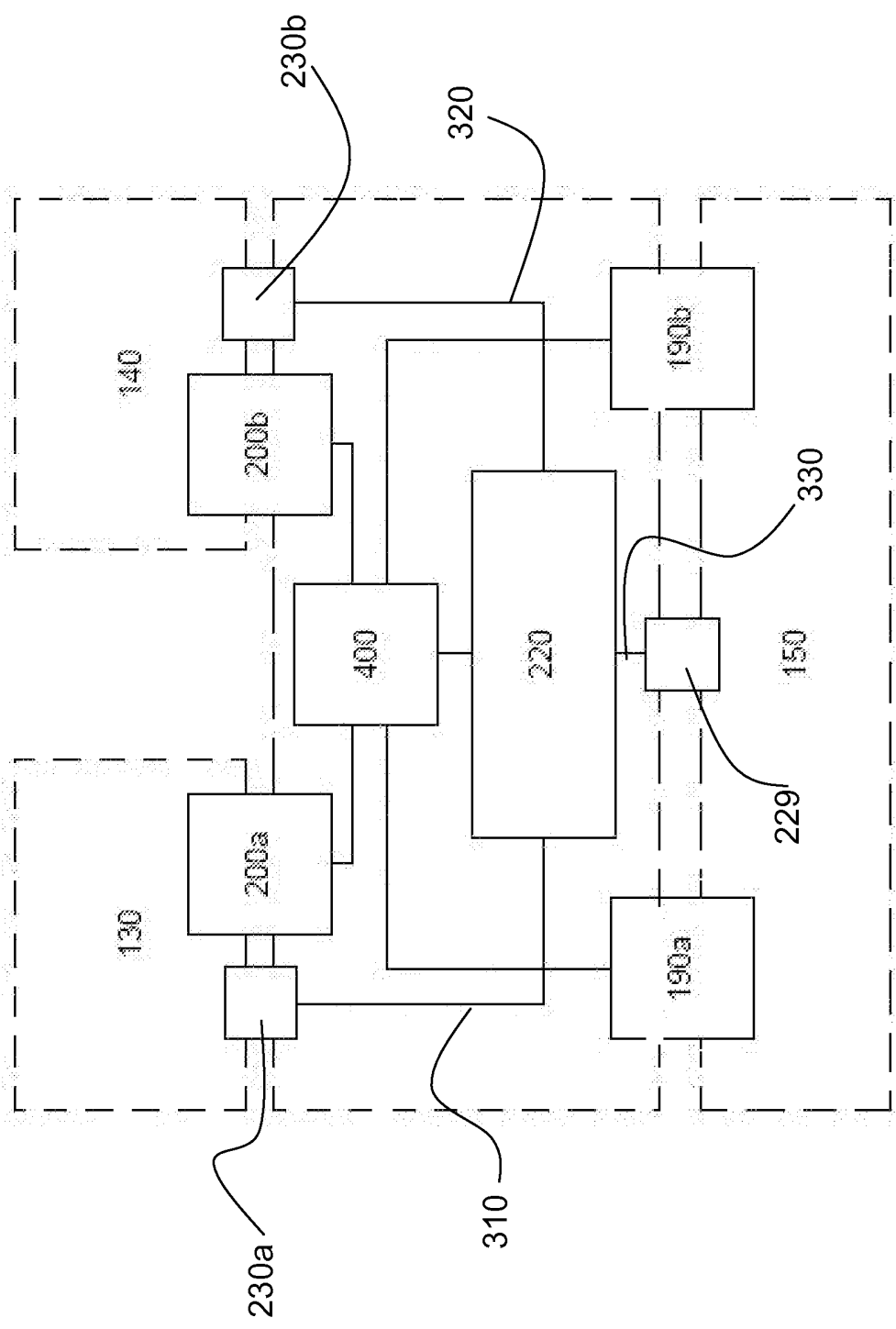


Figure 5

REFERENCES CITED IN THE DESCRIPTION

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