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(54) WORK VEHICLE COMPRISING AN ARM SUPPORTING FORKS

(57) Work vehicle (VEH) comprising an arm (A) comprising a first segment (A_1) connected to a chassis (F) of the vehicle and a forks (FK) hinged to the first segment, a propulsion system such as to allow movement of the vehicle with respect to a support surface, a processing unit (VCU) configured to receive as input an electrical signal generated by an inclinometer (IN) and to compensate for a position of the forks so as to keep it horizontal regardless of an inclination of the support surface on which the vehicle is placed.

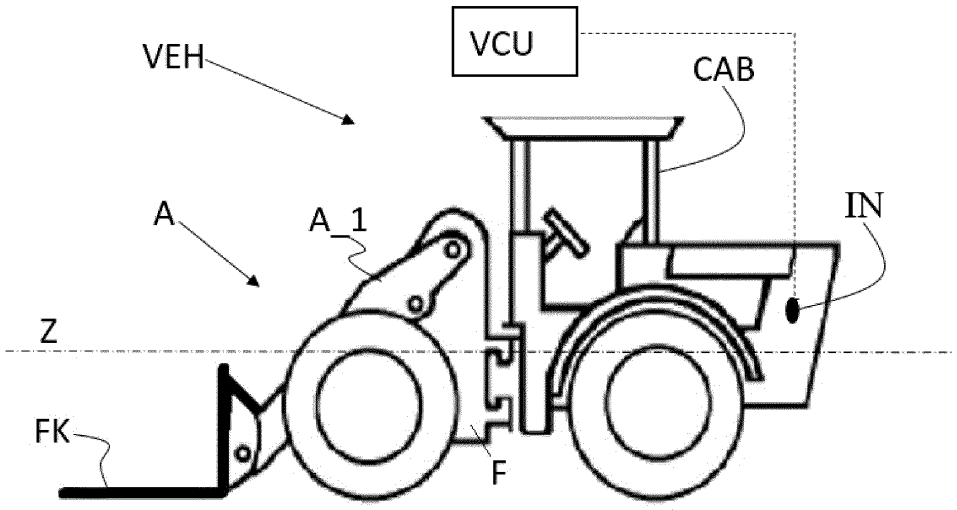

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to the field of work vehicles comprising an arm supporting forks connected to the arm for handling pallets.

State of the art

[0002] Work vehicles are essentially divided into construction vehicles and agricultural vehicles.

[0003] Those work vehicles equipped with a boom are generally capable of supporting forks for moving loads and pallets. Often, especially in the agricultural field, it may be necessary to move a pile of stacked pallets and transport the pile along a route.

[0004] When there are significant bumps and roughness along the path, there is the risk that the stack of pallets could tip over. In particular, when the vehicle proceeds uphill there is a real risk that the pile could tip over onto the operator's cab, while when the vehicle proceeds downhill there is a real risk that the pile could fall in front of the moving vehicle.

[0005] In both cases there is a risk for the operator himself or other vehicles or people who may be around the vehicle. Therefore, operators are often called upon to make use of their experience to manually compensate for the inclination of the ground, often having to stop the vehicle to find the optimal inclination of the forks before resuming the travelling.

[0006] Unless specifically excluded in the detailed description that follows, what is described in this chapter is to be considered as an integral part of the detailed description.

Summary of the invention

[0007] The aim of the present invention is to indicate a work vehicle comprising an articulated arm supporting forks, which makes easier the handling of stacks of pallets.

[0008] The basic idea of the present invention is to implement an automatic correction of the forks in order to keep it horizontal regardless of an inclination of the support surface on which the vehicle is placed.

[0009] The dependent claims describe preferred variants of the invention, forming an integral part of the present description.

Brief description of the figures

[0010] Further objects and advantages of the present invention will be clear from the following detailed description of an example of its implementation (and its variants) and from the attached drawings given purely for explanatory and non-limiting purposes, in which:

- Fig. 1 shows a work vehicle modified according to the present invention;
- Fig. 2 shows an electro-hydraulic circuit implemented in the vehicle of Figure 1.

[0011] The same reference numbers and letters in the figures identify the same elements or components or functions.

[0012] It should also be noted that the terms "first", "second", "third", "higher", "lower" and the like may be used here to distinguish various elements. These terms do not imply a spatial, sequential, or hierarchical order for the modified elements unless specifically indicated or inferred from the text.

[0013] The elements and characteristics illustrated in the different preferred embodiments, including the drawings, can be combined with each other without departing from the scope of protection of the present application as described below.

Detailed description

[0014] Fig. 1 illustrates a work vehicle VEH equipped with an arm A including a first element A_1, substantially elongated, hinged to the chassis F of the vehicle and a second element FK, consisting of forks, hinged to the first element. More specifically, a first end of the first element is connected to the chassis F of the vehicle, while a second end, opposite to the first one, supports the second element in a rotatable manner.

[0015] Fig. 2 shows an electro-hydraulic circuit HC comprising

- a hydraulic pump P arranged to supply the circuit;
- a pair of open center directional valves V1, V2 to control the same number of actuators A1 and A2.

[0016] The processing unit VCU is configured to receive as input an electrical signal generated by the joystick (JK), located in the vehicle's CAB cabin and consequently control the condition of the valves V1 and V2.

[0017] The first hydraulic actuator A1 is associated with the first element A_1 of the arm A and the second hydraulic actuator A2 is associated with the second element FK of the arm A to control the configurations that each element can assume with respect to the relative constraint, i.e. respectively the frame F of the vehicle and the first element A_1.

[0018] The processing unit VCU is furthermore configured to receive as input a signal representative of the speed of the vehicle VS from a sensor named in the same way, which can be, for example, a sensor associated with a vehicle wheel, or a satellite receiver, etc..

[0019] The actuators A1 and A2 are double acting. Each of them has a stem to which a position sensor S1 and S2 is associated.

[0020] The processing unit, based on the signals generated by the position sensors, is able to calculate the

current kinematic configuration of arm A.

[0021] Calculation algorithms are known, which allow the actuator A2 of the second element FK to be controlled so that the latter is parallel with the development axis Z of the vehicle during the movement of the first element A_1. These are useful functions for lifting a pallet while keeping it approximately vertical.

[0022] The "approximately vertical" depends on the fact that the processing unit has pre-stored control maps that allow to control the angle formed by the forks FK with respect to the arm A_1 in the hypothesis that the vehicle rests on a perfectly horizontal surface.

[0023] These algorithms are implemented in the processing unit described above. However, when the vehicle is carrying a load and moving uphill or downhill, such maps are completely ineffective.

[0024] According to the present invention, in an operating mode named as "Horizontal Zero", the processing unit, when the joystick is not operated, is configured to receive as input an inclinometer signal IN so as to determine a deviation of the axis of development Z with a horizontal plane and automatically correct the inclination of the forks FK with respect to the arm A_1 in order to compensate for this deviation.

[0025] When the vehicle moves down along a slope, the processing unit is configured to rotate the forks backwards. This rotation is generally named as "rollback".

[0026] When the vehicle travels up a hill, the processing unit is configured to rotate the forks forward. This rotation is generally called "unload".

[0027] The extent of the inclination, in both cases, is proportional to a deviation detected by the inclinometer of the vehicle Z axis with respect to a horizontal orientation. Furthermore, to eliminate sudden variations in the deviation due to the roughness of the terrain, the processing unit is configured to apply a first order filter to the input signal IN of the inclinometer, whose time constant value is a function of the vehicle speed, in particular:

- the greater the speed and the greater the value of the time constant of the filter,
- the lower the speed and the lower the value of the time constant of the filter.

[0028] Advantageously, the first order filtering allows eliminating the effect of the roughness of the support surface of the vehicle on the signal generated by the inclinometer. Optionally, the processing unit is configured to perform said compensation only when a current vehicle speed exceeds a predetermined threshold.

[0029] The activation of the "Horizontal Zero" operating mode is achieved by means of a further human/machine interface device other than said joystick. It can be, for example, a button located on the dashboard or a virtual menu of the touchscreen instrument panel.

[0030] The processing unit is also configured to calculate a risk of contact between the forks tips and the ground when the forks are tilted forward. If there is a risk of contact between the forks and the ground, then the processing unit proceeds to lift the arm A_1 in order to move the tips of the forks away from the ground.

[0031] Once the distance of the free end of the first segment A_1 from the ground is known, the length of the forks and the angle formed by the forks with respect to the arm are known, it is possible to calculate or map an interference condition between the tips of the forks and the ground. Preferably, the processing unit is configured to predict interference with the ground before operating the unload procedure and raise the arm so as to prevent the subsequent unload procedure from causing the aforementioned interference of the forks with the ground.

[0032] The present invention can advantageously be carried out by means of a computer program, which includes coding means for carrying out one or more steps of the method, when this program is executed on a computer. Therefore, it is understood that the scope of protection extends to said computer program and further to computer readable means comprising a recorded message, said computer readable means comprising program coding means for carrying out one or more steps of the method, when said program is executed on a computer.

[0033] Constructive variations to the non-limiting example described are possible, without departing from the scope of protection of the present invention, including all the equivalent embodiments for a person skilled in the art, to the content of the claims.

[0034] From the above description, the person skilled in the art is able to realize the object of the invention without introducing further construction details.

Claims

1. Work vehicle (VEH) including

- an arm (A) comprising a first segment (A_1) connected to a chassis (F) of the vehicle and forks (FK) hinged to the first segment,
- an electro-hydraulic circuit (HC) to move the arm,
- a joystick (JK) to control the arm (A),
- a propulsion system that allows the vehicle to move with respect to a support surface,
- a processing unit (VCU) configured to receive as input a first electrical signal generated by said joystick and to control said electro-hydraulic circuit in response to said first electrical signal received and configured to keep the arm stationary when the joystick is released,
- an inclinometer (IN),

in an operating mode, named as "Horizontal Zero", the processing unit, when the joystick is released, is configured to receive as input a second electrical signal generated by said inclinometer and to com-

pensate a position of said forks so as to keep the forks horizontal independently by an inclination of said support surface on the basis of said second electrical signal.

2. The vehicle according to claim 1, wherein said processing unit is configured to perform said compensation only when a current speed of the vehicle exceeds a predetermined threshold.

3. Vehicle according to claim 1 or 2, wherein the processing unit is configured to apply a first order filtration to said second electrical signal generated by said inclinometer.

4. The vehicle according to claim 3, wherein said first order filtration has a time constant value that is a function of a value of a current speed of the vehicle.

5. Vehicle according to claim 4, wherein the value of the time constant is directly proportional to the value of the current speed of the vehicle.

6. Vehicle according to any one of the preceding claims 1 - 5, wherein the processing unit is configured to calculate a risk of interference between the forks and the vehicle support surface and to raise the arm so as to avoid said interference before or during a procedure of forward inclination of said forks.

7. Vehicle according to any of the previous claims 1 - 6, wherein an activation of said "Horizontal Zero" operating mode is achieved by means of a further human/machine interface device other than said joystick.

8. Method of controlling forks of a work vehicle (VEH) comprising

- an arm (A) comprising a first segment (A_1) connected to a chassis (F) of the vehicle and said forks (FK) hinged to the first segment,
- an electro-hydraulic circuit (HC) to move the arm,
- a joystick (JK) to control the arm (A),
- a propulsion system that allows the vehicle to be moved with respect to a support surface,
- a processing unit (VCU) configured to receive a first electrical signal generated by said joystick and to control said electro-hydraulic circuit in response to said first electrical signal received and configured to keep the arm stationary when the joystick is released,
- an inclinometer (IN),

the method comprising a step, when the joystick is released, of compensating a position of said forks so as to keep the forks horizontal regardless of an inclination of said supporting surface on the basis of a signal generated by said inclinometer.

9. The method of claim 8, further comprising a preliminary step of acquiring a current vehicle speed and performing said compensation step when the current speed exceeds a predetermined threshold.

10. A method according to claim 8 or 9, further comprising applying a first order filtration to the second electrical signal generated by said inclinometer.

11. A computer program comprising instructions for causing the processing unit (VCU) of claim 1 to implement the control method of claim 8.

12. A computer readable medium having stored the program of claim 11.

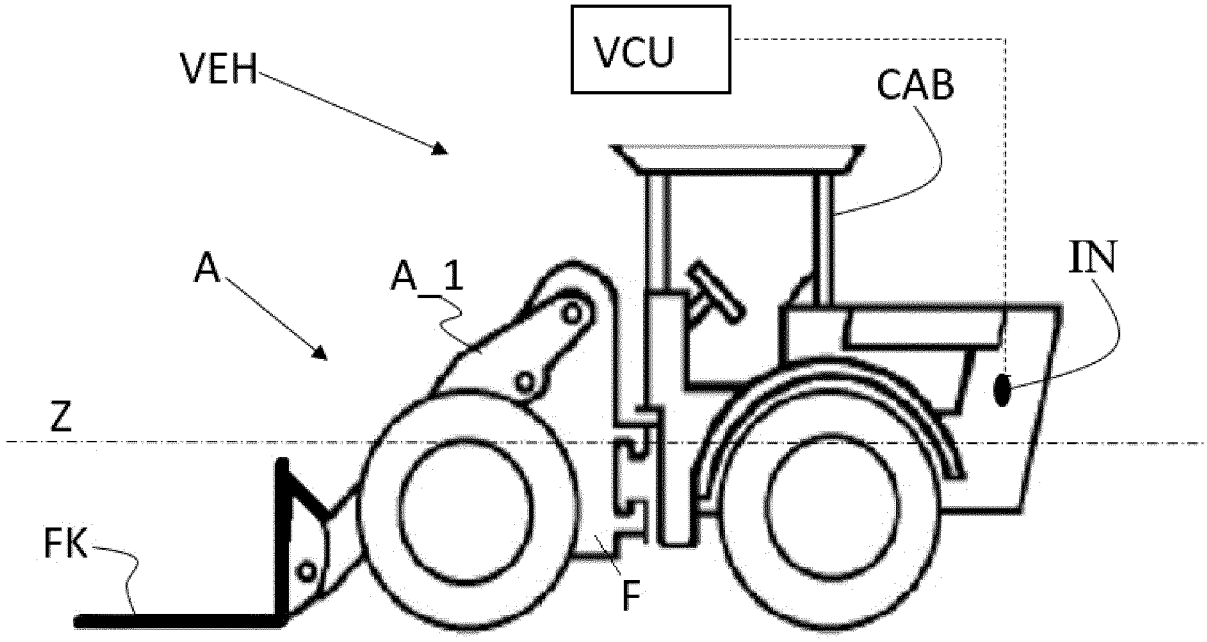

Fig. 1

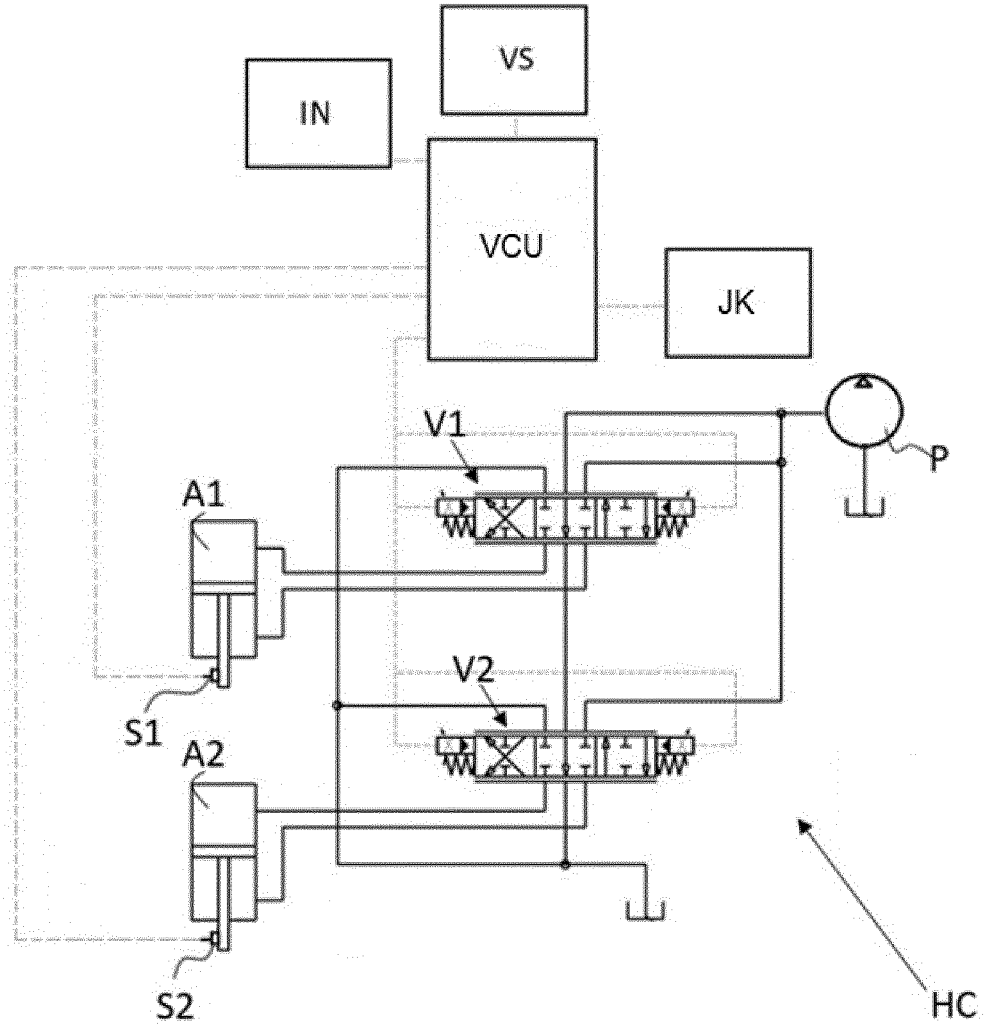

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 24 22 1159

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 May 2025	Popescu, Alexandru

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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