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(54) Title of the Invention: VEHICLE HEIGHT CONTROLLER OF CRAWLER VEHICLE BODY

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1. Title of the Invention

VEHICLE HEIGHT CONTROLLER OF CRAWLER VEHICLE BODY

2. Claim

A vehicle height controller of a crawler vehicle body, comprising:

left and right rolling cylinders 3 that control a vehicle body 1 to be in a transversely horizontal state while independently moving a pair of left and right crawlers 2 up and down relative to the vehicle body 1, and

a pitching cylinder 5 that controls a pitch attitude of a chassis 4 while tilting and pivoting the chassis 4 where a workplace is mounted longitudinally relative to the vehicle body 1, wherein

the vehicle body 1 is controlled to be at a lowest vehicle position, and, at a parallel position, which is substantially parallel transversely relative to the crawlers [2], by the rolling cylinders 3 and the pitching cylinder 5 due to the predetermined tilt of the vehicle body 1.

3. Detailed Description of the Invention

(Industrial Field of Application)

The present invention relates to a vehicle height controller of a crawler vehicle body, and can be utilized in mobile farming machines having a traveling device with a crawler configuration, such as combines.

(Prior Art, and Problem to be Solved by the Invention)

In mobile farming machines, such as combines, work performance of reaping, thrashing or the like is excellently maintained by controlling a thrashing device, a reaper or the like on a vehicle body to be in transversely horizontal state, but if control of a height of a vehicle body, i.e., a vehicle height, is further combined with such horizontal control, the control becomes complicated. In particular, if the vehicle height becomes higher, the vehicle body greatly tilts during the horizontal control, and this may easily cause overturn.

The present invention is to lower a height of a vehicle body when such vehicle body greatly tilts and to stabilize the vehicle body due to lowering a position of the center of gravity, and to bring the vehicle body back to a predetermined basic attitude, which is easily controllable

The present invention has a configuration of a vehicle height controller of a crawler vehicle body having

left and right rolling cylinders 3 that control a vehicle body 1 to be in a transversely horizontal state while independently moving a pair of left and right crawlers 2 up and down relative to the vehicle body 1, and

a pitching cylinder 5 that controls a pitch attitude of a chassis 4 while tilting and pivoting the chassis 4 where a workplace is mounted longitudinally relative to the vehicle body 1, wherein

the vehicle body 1 is controlled to be at a lowest vehicle position, and, at a parallel position, which is substantially parallel transversely relative to the crawlers [2], by the rolling cylinders 3 and the pitching cylinder 5 due to the predetermined tilt of the vehicle body 1.

(Operation)

For example, if a reaping soil surface is soft ground during combine operation, the vehicle 1 is controlled to be horizontal. When the vehicle body 1 greatly tilts transversely, because of this tilt, the left and right rolling cylinders 3 are extended or retracted and it causes a change in vertical gaps between the vehicle body 1 and the left and right crawlers 2, and transversely horizontal control is performed so as to maintain the vehicle body 1 to be transversely horizontal based upon the already-set vehicle height. Further, when the pitch of the vehicle body 1 is great, the pitch of the chassis 4 relative to the vehicle body 1 is changed due to extension or retraction of the pitch cylinder 5, and longitudinally horizontal control is performed to adjust the chassis 4 to be in a longitudinally horizontal attitude.

During such horizontal controls of the vehicle body 1 and the chassis 4, if the vehicle body 1 greatly tilts toward any direction to the extent more than the predetermined [limit] and reaches a limitation where there is risk of overturn, then the vehicle body 1 and the chassis 4 are descended to a reference height, which is a lowest vehicle height chassis 4 is performed by extending or retracting the left and right rolling cylinders 3 and the pitching cylinder 5. Further, at the lowest vehicle height position, each of the left and right rolling cylinders 3, the pitching cylinder 5 and the like are at a certain extended/retracted position, and the vehicle 1 becomes transversely in parallel with the left and right crawlers 2, and the chassis 4 becomes longitudinally in parallel with the vehicle body 1.

(Effect of the Invention)

As mentioned above, when the vehicle body 1 is controlled to be in a transversely horizontal state relative to a pair of the left and right crawlers 2, if the vehicle body 1 tilts to a dangerous angle for some reason, its vehicle height automatically is descended to the lowest vehicle height position because of this risky situation, and if the chassis 4 tilts relative to the vehicle body 1, a pitch of this chassis 4 is also recovered, and these vehicle body 1 and chassis 4 are longitudinally in parallel [with each other], and in addition, become transversely in parallel with the left and right crawlers 2; thus, the vehicle body 1 and the position of the center of gravity of entire weight of the operating machine are descended to become stabilized. Further, in addition, following horizontal control and vehicle height control, because the vehicle body 1, the chassis 4 and the like are in parallel with the left and right crawlers 2 and the controls will start from the lowest vehicle height position, thus no confusion of operation occurs and the machine can travel with safe control.

(Embodiment)

In illustration examples, a traveling device of a combine is constructed such that a pair of the left and right crawlers 2 are placed below the vehicle body 1 to be independently movable up and down, and an engine, a reaper, a thrashing device, a maneuvering gear and the like are mounted above the vehicle body 1, and the chassis 4 is placed. It is constructed such that a crawler frame 7 where track rollers 6 of each crawler 2 are arranged is supported to enable vertical movement relative to the vehicle body 1 in a parallel manner via a pair of the front

rear side support arm 8 and a bracket 10 on the vehicle body 1 are coupled with the rolling cylinder 3 that is telescopically activated by a rolling control valve 12 of a hydraulic circuit 11; and the front and rear support arms 8 and 9 are coupled with a rod 14 and the support arms 8 and 9 are pivoted around pivot parts 15 and 16 relative to the vehicle body 1 and the crawler frame 7 can move up and down.

The symbol 17 represents a sprocket at the front end of the crawler 2, and it is secured to a drive shaft 18 that protrudes toward both left and right sides from a traveling transmission case integrally with a front end of the vehicle body 1, and the crawler 2 can be driven by rotating this sprocket 17.

In the chassis 4, the front end side is supported to be pivotable around an axis of the pivot part 16 relative to the vehicle body 1, and the rear end is supported to the vehicle bode 1 via the link arm 19; the upper end of this link arm 19 and the chassis 4 are coupled with a pitching cylinder 5 that is controlled to be extended or retracted by a pitching control valve 20 of the hydraulic circuit 11; and the link arm 19 is pivoted due to the extension and retraction of this pitching cylinder 5 by hydraulic pressure and the chassis 4 can be pitched with the pivot part 16.

A rolling control valve 12, a pitching control valve 20 and an unload valve 22 of the left and right crawlers 2 arranged in the hydraulic circuit 11 of a hydraulic pump P are in an electromagnetic solenoid configuration, and have a lower left solenoid 23, a lower right solenoid 24, an upper right solenoid 25, a lower right solenoid 26, a forward tilt solenoid 27, a backward tilt solenoid 28, an unload solenoid 29 and the like, and are placed at an output side of the controller 30 constituting a vehicle body horizontal controller. The symbol 31 represents an automatic lamp, and will be illuminated when predetermined automatic control is performed to the controller 30.

Further, this controller 30 has a microcomputer, and also constitutes a vehicle height controller that controls a height of the vehicle body 1, a pitching controller and the like. An overall vertical switch right solenoids 23 and 25 and the lower left & right solenoids 24 and 26 to move the vehicle body 1 up and down in the transversely horizontal state, and that determines a vehicle height is placed at the input side of this controller 30. With the operation of a tilting lever in a maneuvering device forward or backward or left or right, a tilting lever switch 33 that simultaneously activates the lower left solenoid 24 and the upper right solenoid 25 with the operation to tilt toward the left side to roll the vehicle body 1 toward the left side; that simultaneously activates the lower right solenoid 26 and the upper left solenoid 23 with the operation to tilt toward the right side to roll the vehicle body 1 toward the right side; and, that activates the forward tilt solenoid 27 and the backward tilt solenoid 28 by tilting forward or backward to pitch the vehicle body 1 to the tilted side is placed.

Further, a thrashing clutch ~~switch 34~~ is ~~a switch for~~ engaging or disengaging a thrashing clutch that transmits momentum to a thrashing device.~~, and~~ ~~engaging~~ this thrashing clutch ~~switch 34~~ engages the thrashing clutch, and,

the thrashing clutch switch 34 is engaged and a vehicle body horizontal switch 35 is also activated and transversely horizontal controls by the vehicle body and longitudinally horizontal controller 3 are maintained.

The vehicle body horizontal switch 35 is for controlling and maintaining the vehicle body 1 to be transversely horizontal and longitudinally horizontal. Using a roll sensor 36 that is placed in the vehicle body 1 and detects a roll angle, and, a pitch sensor 37 that is placed in the chassis 4 and detects a pitch angle, whether or not the vehicle body 1 or the chassis 4 is tilted beyond a predetermined range is detected. If it is detected, the vehicle body horizontal switch 35 performs transversely rolling control and longitudinally pitching control so as allow these roll

state by controlling the solenoids 23 to 26 or the solenoids 27 and 28.

A left stroke sensor 38 is to detect an extended or retracted length of the left rolling cylinder 3; a right stroke sensor 39 is to detect an extended or retracted length of the right rolling cylinder 3; and a longitudinal stroke sensor 40 is to detect an extended or retracted length of the pitching cylinder 5. In controls that require detection of these stroke sensors 38 to 40 and the like, feedback control is performed.

The vehicle height control is automatically performed when the vehicle height exceeds a limit for some reason by using the height of the vehicle body 1 as reference upon completion of the vehicle height control by the overall vertical switch 32, and this control is performed so as to maintain the reference vehicle height. These reference vehicle height, transition height before control and the like are according to mean values of the vehicle height in each of left and right crawlers 2.

As shown in Fig. 4, the vehicle height at the left crawler 2 side is detected as L by the left stroke sensor 38, and the vehicle height at the right crawler 2 side is detected as R by the right stroke sensor 39, and the mean height is expressed as follows:

$$H = (L + R)/ 2$$

The left and right stroke sensors 38 and 39 are established to detect that the left and right rolling cylinders 3 have been retracted and reached a position to be no longer retracted as an abnormal stop, and, the longitudinal stroke sensor 40 is established to detect that the pitching cylinder 5 has been extended and reached a position to be no longer extended as an abnormal stop. Because these left and right rolling cylinders 3 have retracted, the vehicle body 1 is lowered, and because the pitching cylinder 5 has been extended, the chassis 4 becomes in a longitudinally parallel state relative to the vehicle body 1, and becomes in a front-downward tilted state due to the retraction. Therefore, the left and right crawlers 2 and the vehicle body 1 are in the transversely parallel state at the lowest vehicle height position where the to the left and right crawlers 2, and in addition, the chassis 4 becomes in transversely and longitudinally parallel states relative to this vehicle body 1 at the position where the chassis 4 is rotated backward-tilting at maximum relative to the vehicle body 1, and this becomes the lowest vehicle height reference.

As shown in Fig. 4, the left and right crawlers 2 are controlled to vary from the lowest height *h* to the highest height *H* relative to the vehicle body 1. With the transversely horizontal control, as shown in Fig. 5, when a traveling ground is sloped toward the left side, because the vehicle body 1 also tilts toward the same direction due to this situation, this tilt is detected by the roll sensor 36, and if this detected tilt angle becomes a certain level or greater, the left and right rolling control valves 3 are activated and the rolling cylinders 3 are controlled to be extended or retracted, and the vehicle body 1 becomes in a transversely horizontal attitude. At this time, if detected values by the left and right stroke sensors 38 and 39 at the initially set reference height are deemed as L and R, respectively, detected values after the traveling ground has tilted become L+α by the left and right stroke sensors 38 and R-β by the right stroke sensor 39 in Fig. 5. Now, the values are output as α=β, but in actuality, the left rolling cylinder 3 is extended so as to push the vehicle body 1 upward against a load, and the right rolling cylinder 3 is retracted in a direction to receive a load oppositely; thus, there are a difference in speed between extension and retraction, and these values are detected as α is nearly equal to β. Further, the vehicle height at this time is adjusted so as to satisfy the following condition:

$$\{(L+\alpha) + (R-\beta)\}/ 2 = (L+R)/ 2.$$

However, when the vehicle body 1 becomes in a transversely horizontal state, if the vehicle height become as mentioned below for some reason,

$$\{(L+\alpha) + (R-\beta)\}/ 2 \neq (L+R)/ 2,$$

the vehicle height control is corrected and this is

controlled to correct the vehicle height to become a condition for (L+R)/ 2.

As shown in Fig. 6, because the traveling ground has reached a predetermined dangerous tilt angle A, which is a limitation at greater risk that would cause a combine machine body to be overturned, and because this is detected by the roll sensor 36, the left and right rolling cylinders 3 are retracted and the vehicle body 1 is descended to be at the lowest vehicle height position. At this time, both the left and right stroke sensors 38 and 39 both detect *h*, and it causes an emergency stop. At the same time as this, the output for extension or retraction of the rolling cylinder 3 will be stopped (see Fig. 7).

Further, when the chassis 4 pitches relative to 1 at this time, this is controlled to extend the pitching cylinder 5 and to bring it to be in parallel with the vehicle body 1, and the longitudinal stroke sensor 40 detects an emergency stop (see Fig. 8). This causes stoppage of the output for extension or retraction of the pitching cylinder 5.

Such vehicle height control to the lowest vehicle height position may be performed not only by detection of a dangerous tilt angle by the roll sensor 36, but also by detection of a dangerous tilt angle by the pitch sensor 37, and in addition, by switching the vehicle speed from a range of low speed, such as operating speed, to a range of high speed, such as traveling speed on roads, as well.

As mentioned above, even if the left and right cylinders 3 are retracted and detected values by the stroke sensors 38 and 39 no longer change, outputs thereafter will be stopped due to the detection of an emergency stop, but when such detected values are output by manual operation with the overall vertical switch 32 or a tilting lever switch 33, if it is configured such that the output by manual operation can be continued regardless of the stroke sensors 38 and 39 (see Fig. 9), even though the stroke sensors 38 and 39 fail, the output operation can be performed and the manual operation can be controlled.

4. Detailed Description of Drawings

Drawings show one embodiment of the present invention, and Fig 1 is a side view, Fig. 2 is a control block diagram, Fig. 3 is a hydraulic circuit diagram, Figs. 4 to 6 are partial front view showing operation, and Figs. 7 to 9 are flowcharts showing partial control.

(Description of Symbols)

1 vehicle body
2 crawler
3 rolling cylinder
4 chassis
5 pitching cylinder

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