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(56) Documents Cited:
GB 2276596 A
EP 0926042 A1
JP 2001260917 A
US 20020192081 A1
EP 1431162 A2
JP 010223074 A
JP 2000219142 A

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(54) Abstract Title: **Variable speed hydraulic steering device**

(57) The invention relates to a hydraulic steering device 1 for a work machine, in particular an industrial truck. A steering input device such as a steering wheel 2 is actively connected to a steering valve 4, which as a function of an angle of the steering wheel 2, controls the connection of a steering drive 13 to a pressure medium source 6 and a container 11. The pressure medium source 6 typically comprises a pump. In order to improve safety, especially at high vehicle speeds, means 20 are provided for influencing the steering speed. The means 20 may comprise an electronically controlled flow regulating device.

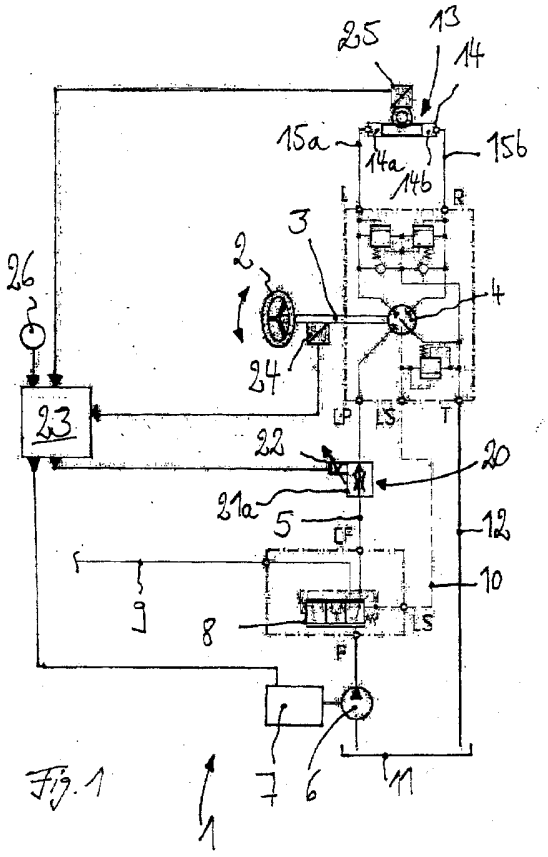


Fig. 1

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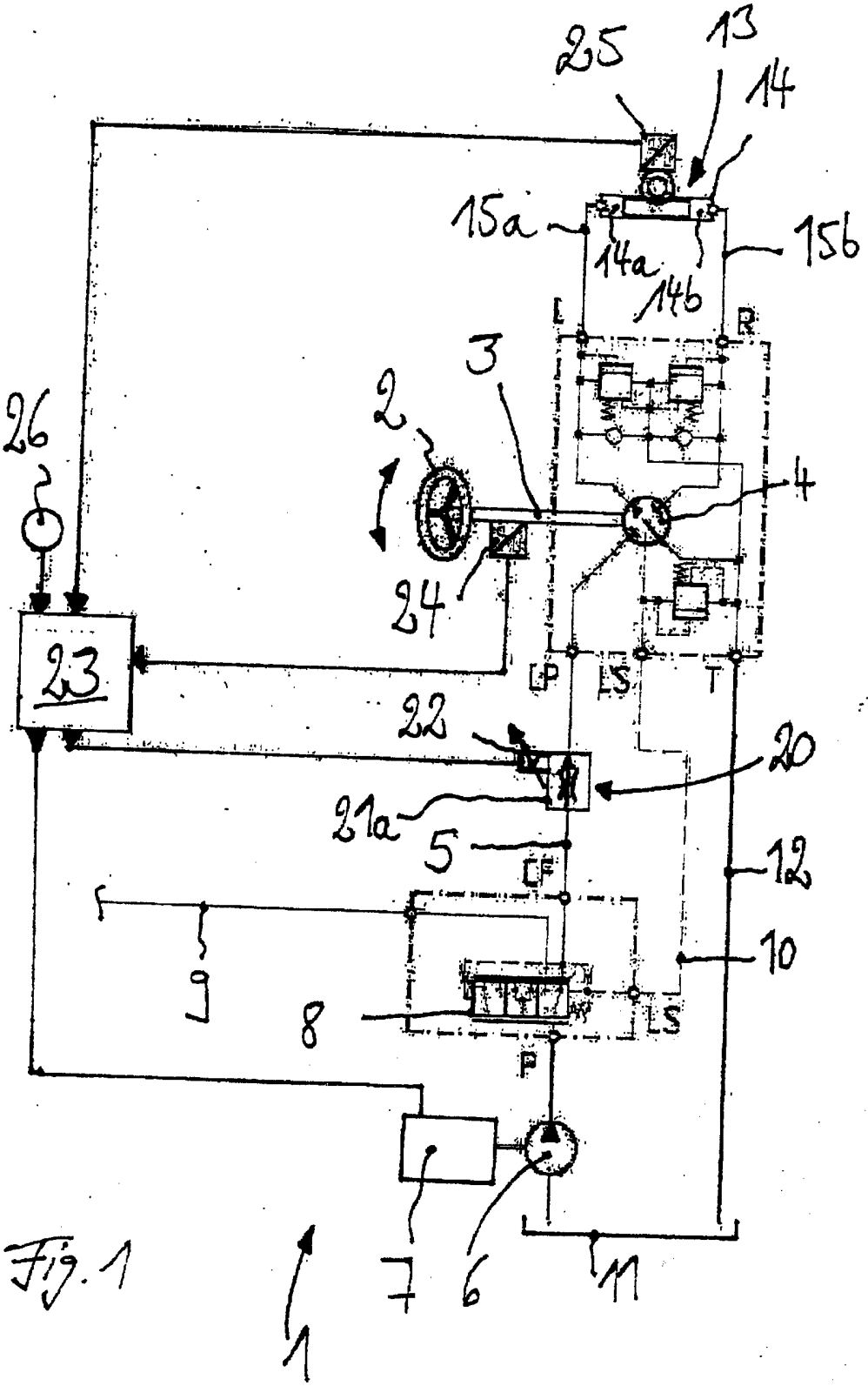

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Fig. 1

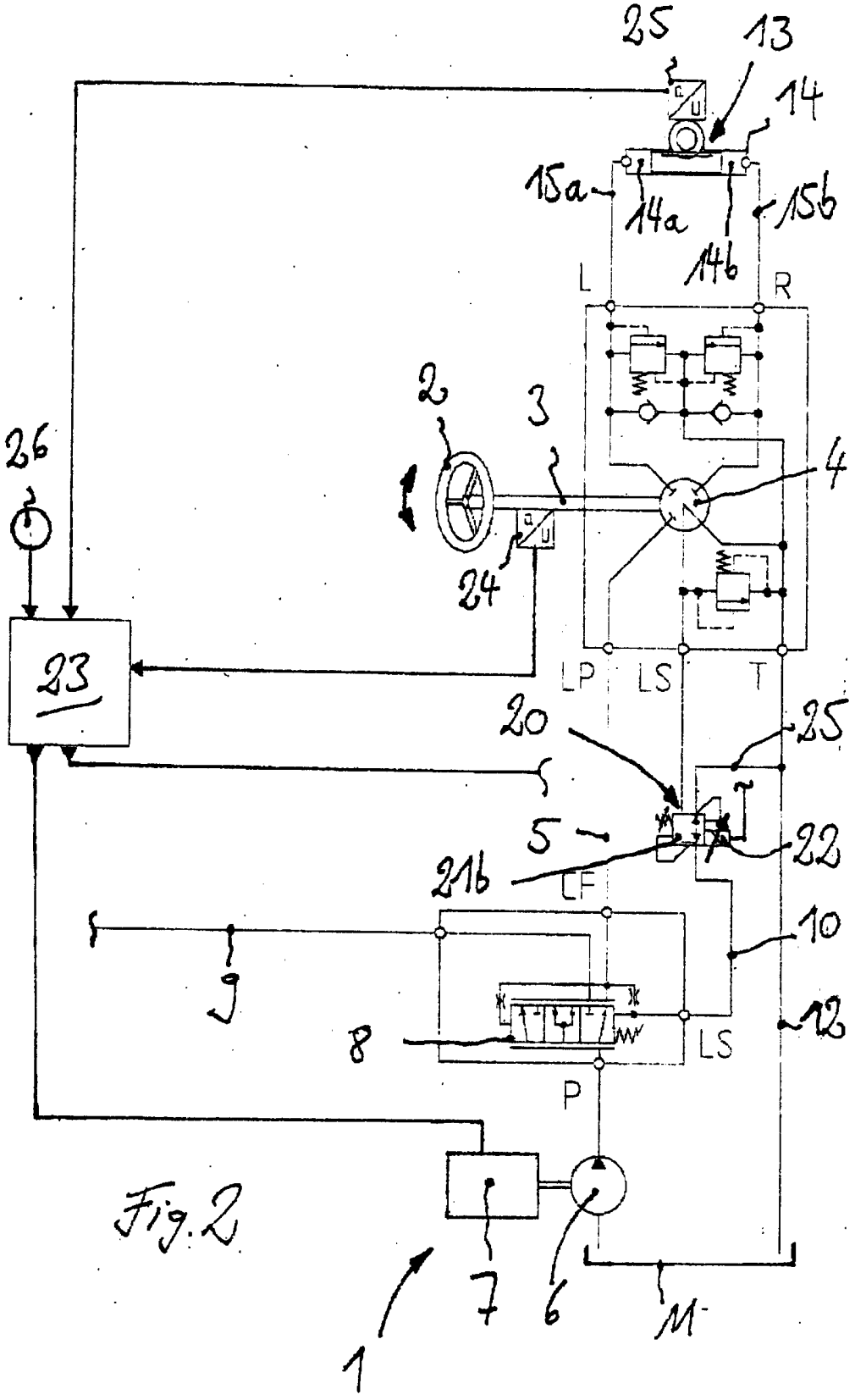

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Fig. 2

Hydraulic steering device

The invention relates to a hydraulic steering device for a work machine, in particular an industrial truck, comprising a steering angle transmitter actively connected to a steering valve, which, as a function of the actuation of the steering angle transmitter, controls the connection of a steering drive to a pressure medium source and a container.

Hydraulic steering devices, in which a steering valve actuated by a steering angle transmitter, for example a steering wheel, controls the loading of a steering drive, for example a steering cylinder, which is actively connected at a steering axle to the steered wheels, are used in work machine is configured as industrial trucks, for example forklift trucks. In generic steering devices, the steering angle transmitter is drive-connected to the steering valve via a steering shaft, so the steering speed of the steering drive is proportional to the actuating speed of the steering angle transmitter.

In generic hydraulic steering devices used in work machines, in particular industrial trucks, it can occur that a high actuating speed, and therefore a high steering speed of the steering drive, is set by the operator on the steering angle transmitter at a high driving speed, as a result of which there may be a risk of lateral tilting of the work machine. Reliable operation of the work machine, with a high degree of vehicle stability against lateral tilting, is therefore not ensured.

The object of the present invention is to provide a hydrostatic steering means of the type mentioned at the outset allowing reliable operation of the work machine with a high degree of vehicle stability.

According to the invention, this object is achieved in that a means is provided for influencing the steering speed of the steering drive. The means according to the invention for influencing the steering speed of the steering drive allows the steering speed of the steering drive of the hydrostatic steering device, which is set b' 'he operator by means of the actuating

speed of the steering angle transmitter, easily to be influenced and therefore varied. The steering speed of the steering drive of the hydrostatic steering device may thus be influenced in a simple manner in such a way that, irrespective of the actuating speed set on the steering angle transmitter, reliable operation of the work machine, in particular the industrial truck, is ensured with a high degree of vehicle stability against lateral tilting.

Reliable operation of the work machine, with a high degree of vehicle stability and a reduced risk of lateral tilting, may be achieved if, according to a preferred embodiment of the invention, the steering speed of the steering drive may be influenced, using the means, as a function of the vehicle state of the work machine, in particular of the driving speed of the work machine and/or the curved path of the work machine and/or the actuating speed of the steering angle transmitter, and the steering speed of the steering drive may, in particular, be reduced. On actuation of the steering device at a high actuating speed and/or a high driving speed and/or a curved path having a small curve radius, the steering speed of the steering drive may be reduced, by appropriate activation of the means, and reliable operation of the work machine, with increased vehicle stability against lateral tilting, thus ensured.

According to a preferred embodiment of the invention, the means is configured as a current regulating device. In a hydrostatic steering device, a current regulating device allows the steering speed to be influenced in a simple manner by influencing the amount of pressure medium flowing to the steering drive or the amount of pressure medium flowing from the steering drive.

In addition, according to a further embodiment of the invention, the means may be configured as a pressure regulating device. A pressure regulating device also allows the amount of pressure medium flowing to or from the steering drive, and hence the steering speed, to be influenced in a simple manner.

The means may be arranged in a container line guided from the steering valve to a container.

Particular advantages are obtained if the means is arranged in a conveyor line guided from the pump to the steering valve. This allows the amount of pressure medium flowing to the steering valve, and hence the steering speed of the steering drive, and the pressure at the steering drive, and hence the steering force of the steering drive, to be influenced in a simple manner.

In addition, the means may be arranged in a load indicating line of the steering device. The steering device load in the load indicating line determines the amount of pressure medium flowing to the steering drive and therefore the steering speed. The steering speed may thus be influenced in a simple manner by influencing the load in the load indicating line, wherein, owing to the small amount of pressure medium flowing in the load indicating line, a cost-effective current regulating device or pressure regulating device requiring little overall space may be used.

According to a preferred embodiment of the invention, the current regulating device is configured as an adjustable current regulating device, in particular as an adjustable current regulating valve, influencing of the amount of pressure medium flowing to the steering drive or the amount of pressure medium flowing from the steering drive or the pressure medium flowing in the load indicating line being achieved in a simple manner by appropriate adjustment of the current regulating device.

Particular advantages are obtained if the adjustable current regulating device comprises an adjustable measurement restrictor. An adjustable measurement restrictor allows the amount of pressure medium flowing through the current regulating valve to be controlled in a simple manner and influencing of the steering speed of the steering drive thus to be achieved.

According to a preferred embodiment of the invention, the measurement restrictor may be loaded on activation in the direction for

reducing the restrictor cross section. On activation of the measurement restrictor, the current regulating device is therefore loaded in the direction for reducing the flow rate. In the non-activated state, the measurement restrictor therefore has a maximum restrictor cross section, as a result of which the current regulating device is in a maximum flow rate position and the steering speed set on the steering valve by means of the actuating speed of the steering angle transmitter is therefore not influenced. On activation, the measurement restrictor is loaded in the direction for a minimum restrictor cross section, as a result of which the current regulating device is loaded in the direction for a minimum flow cross section, reduction of the steering speed of the steering drive thus being achieved by means of reduction of the amount of pressure medium flowing to the steering valve. A high degree of operational safety for the steering device and therefore for the work machine may therefore be achieved, as in the non-activated state the emergency steering characteristics of the hydrostatic steering device are available to the measurement restrictor and therefore to the current regulating device.

According to an advantageous further embodiment of the invention, the pressure regulating device is configured as an adjustable pressure reducing valve, in particular an adjustable three-way pressure reducing valve. A pressure reducing valve of this type allows the pressure of the pressure medium flowing to the steering drive or the pressure of the pressure medium flowing from the steering drive or the steering device load in the load indicating line, and hence the steering speed, to be influenced in a simple manner by appropriate adjustment of the pressure regulating device.

Expediently, the means is electrically activatable.

Simple activation may be achieved if, according to a preferred embodiment of the invention, the current regulating device comprises a measurement restrictor which may be activated by means of an electromagnet, in particular a proportional magnet.

Simple activation of the means configured as the pressure regulating device may be achieved if the pressure regulating device may be loaded by means of an electromagnet, in particular a proportional magnet, in the direction for reducing the steering device load in the load indicating line. On activation, the pressure regulating device is loaded in the direction for reducing the load of the steering device, as result of which reduction of the amount of pressure medium flowing to the steering drive, and therefore reduction of the steering speed of the steering drive, is achieved. A high degree of operational safety for the steering device and therefore for the work machine may thus be achieved.

Expediently, the means may be activated using an electronic control device, the electronic control device being actively connected on the input side to at least one sensor device detecting the vehicle state of the work machine, in particular a sensor device detecting the driving speed of the work machine and/or a sensor device, in particular a steering angle sensor associated with the steering drive, detecting the curved path of the work machine, and/or a sensor device detecting the actuating speed of the steering angle transmitter. A current regulating device which may be activated using an electronic control device allows the steering speed of the steering drive to be reduced in a simple manner as a function of the vehicle state, in particular of the driving speed and/or of the steering angle occurring during a curved path and therefore of the curve radius and/or the actuating speed of the steering angle transmitter, for increasing operational safety and the degree of vehicle stability against lateral tilting of the work machine.

Further advantages and details of the invention will be described in greater depth with reference to the embodiment illustrated in the schematic drawings, in which:

Figure 1 shows a first embodiment of a steering device according to the invention; and

Figure 2 shows a second embodiment of a steering device according to the invention.

Figure 1 illustrates a hydraulic steering device 1 according to the invention for a work machine, for example an industrial truck configured as a forklift truck. The steering device 1 comprises a steering angle transmitter 2, for example a steering wheel, which is actively drive-connected to a steering valve 4 by means of a steering shaft 3. The steering valve 4 is shown surrounded by dot-dash lines and is configured as a conventional steering orbitrol. The steering valve 4 is connected to a conveyor line 5 of a pressure medium source 6, which is configured as a pump and drive-connected to a drive motor 7, for example an electric motor. A priority valve 8, to the output side of which is connected a conveyor branch line 9 guided to a working hydraulic means, for example a lift drive, an inclining drive and an accessory drive of the industrial truck, is arranged in the conveyor line 5, a preferred supply of the steering device 1 being ensured by loading of the priority valve 8 with the load of the steering device 1 guided in a load indicating line 10. The steering valve 4 is also connected to a container line 12 guided to a container 11. The steering device 1 further comprises a steering drive 13 configured, for example, as a double-acting steering cylinder 14 arranged on a steering axle of the industrial truck and actively connected (in a manner not shown) to the steered wheels. The steering cylinder 14 comprises a first control pressure chamber 14a and a second control pressure chamber 14b, which are connected to the steering valve 4 by means of control lines 15a and 15b respectively.

According to the invention, a means 20 for influencing the steering speed of the steering drive 13, which means is configured as an electrically activatable current control device 21a, for example as an electrically adjustable two-way current control valve, is arranged in the conveyor line 5 between the priority valve 8 and the steering valve 4. The current control device 21a comprises a measuring orifice which may be adjusted by means

of an electromagnet 22, in particular a proportional magnet, wherein the measuring orifice, in the non-activated state, is in a maximum restrictor cross section position and, on activation, may be loaded by the electromagnet 22 in the direction for reducing the restrictor cross section, as a result of which the amount of pressure medium flowing to the steering drive 13 is reduced.

The electromagnet 22 is connected on the output side to an electronic control device 23, which on the input side is actively connected to a sensor device 24, which is arranged on the steering shaft 3 and by means of which the actuating speed of the steering angle transmitter 2 may be detected. The electronic control device 23 is also actively connected on the input side to a sensor device 25, which detects the curved path of the work machine and is configured as a steering angle sensor arranged on the steering drive 13. The electronic control device 23 is also actively connected on the input side to a sensor device 26 detecting the driving speed of the work machine. On the output side, the electronic control device 23 is also connected to the drive motor 7.

As shown in Figure 2, the means 20 for influencing the steering speed of the steering drive 13, which means is configured as an electrically activatable pressure control device 21b, for example as an electrically activatable three-way pressure reducing valve, is arranged, according to the invention, in the load indicating line 10 guided to the priority valve 8. The pressure control device 21b may be loaded by means of the electromagnet 22, in particular a proportional magnet, which is actively connected on the output side to the control device 23, in the direction for reducing the load present in the load indicating line and acting on the priority valve 8. In the non-activated state of the pressure control device 21b, the load indicating line is open. As the activation of the electromagnet 22 increases, the portion of the load indicating line 10 that is guided to the priority valve 8 is connected to a container branch line 25 attached to the container line 12, so the load acting on the priority valve 8 is reduced. As a result, the priority valve 8 is acted on

by the pressure in the conveyor line 5 toward the right, as shown in Figure 2, and therefore in the direction of the position blocking the connection of the conveyor line 5 to the pressure medium source, as a result of which the amount of pressure medium flowing to the steering drive 13 via the conveyor line 5 is reduced.

On actuation, detected by the sensor device 24, of the steering angle transmitter 2, the drive motor 7 is activated by the control device 23, as a result of which pressure medium is conveyed from the pressure medium source 6 into the conveyor line 5.

The amount of pressure medium flowing to the steering drive 13 via the actuated steering valve 4 may be reduced by appropriate activation of the electromagnet 22 of the current control device 21a in the direction for reducing the restrictor cross section of the measuring orifice of the current regulating device 21a or by appropriate activation of the electromagnet 22 of the pressure control device 21b in the direction for reducing the load present in the load indicating line 10 and acting on the priority valve 8, as a result of which the amount of pressure medium flowing to the steering drive 13 is reduced and the steering speed of the steering drive 13 may therefore be influenced in the direction for reducing the steering speed.

The current control device 21a or the pressure regulating device 21b is controllable, by means of the electronic control device 23, as a function of the driving speed, detected by means of the sensor device 26, of the industrial truck and/or as a function of the steering angle occurring during a curved path and detected by means of the sensor device 25, and therefore as a function of the curve radius, as a result of which the steering speed of the steering drive 13 may be influenced, for increasing the vehicle stability against lateral tilting, as a function of the vehicle state of the industrial truck, in particular as a function of the driving speed, the steering angle and therefore the curve radius and the actuating speed of the steering angle transmitter 2.

Claims

1. A hydraulic steering device for a work machine, in particular an industrial truck, comprising a steering angle transmitter actively connected to a steering valve, which, as a function of the actuation of the steering angle transmitter, controls the connection of a steering drive to a pressure medium source and a container, characterised in that a means is provided for influencing the steering speed of the steering drive.

2. A hydraulic steering device according to claim 1, characterised in that the steering speed of the steering drive may be influenced, using the means, as a function of the vehicle state of the work machine, in particular of the driving speed of the work machine and/or the curved path of the work machine and/or the actuating speed of the steering angle transmitter, wherein the steering speed of the steering drive may, in particular, be reduced.

3. A hydraulic steering device according to either claim 1 or claim 2, characterised in that the means is configured as a current regulating device.

4. A hydraulic steering device according to either claim 1 or claim 2, characterised in that the means is configured as a pressure regulating device.

5. A hydraulic steering device according to any one of claims 1 to 4, characterised in that the means is arranged in a container line guided from the steering valve) to a container.

6. A hydraulic steering device according to any one of claims 1 to 4, characterised in that the means is arranged in a conveyor line guided from the pump to the steering valve.

7. A hydraulic steering device according to any one of claims 1 to 4, characterised in that the means is arranged in a load indicating line of the steering device.

8. A hydraulic steering device according to claim 3, characterised in that the current regulating device is configured as an adjustable current regulating device, in particular as an adjustable current regulating valve.

9. A hydraulic steering device according to claim 8, characterised in that the current regulating device comprises an adjustable measurement restrictor.

10. A hydraulic steering device according to claim 9, characterised in that the measurement restrictor may be loaded on activation in the direction for reducing the restrictor cross section.

11. A hydraulic steering device according to claim 4, characterised in that the pressure regulating device is configured as an adjustable pressure reducing valve, in particular a three-way pressure reducing valve.

12. A hydraulic steering device according to any one of claims 1 to 11, characterised in that the means is electrically activatable.

13. A hydraulic steering device according to claim 12, characterised in that the current regulating device comprises a measurement restrictor which

may be activated by means of an electromagnet, in particular a proportional magnet.

14. A hydraulic steering device according to claim 12, characterised in that the pressure regulating device may be loaded by means of an electromagnet, in particular a proportional magnet, in the direction for reducing the steering device load in the load indicating line.

15. A hydraulic steering device according to any one of claims 1 to 14, characterised in that the means is actively connected to an electronic control device.

16. A hydraulic steering device according to claim 15, characterised in that the electronic control device is actively connected on the input side to at least one sensor device detecting the vehicle state of the work machine, in particular a sensor device detecting the driving speed of the work machine and/or a sensor device, in particular a steering angle sensor associated with the steering drive, detecting the curved path of the work machine, and/or a sensor device detecting the actuating speed of the steering angle transmitter.

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Application No:	GB0609396.7	**Examiner:**	Mark Thwaites
Claims searched:	1-16	**Date of search:**	29 August 2006

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-4, 6, 8, 12, 15, 16	JP2001260917 A (KAYABA) esp abstract, fig 1 & paras 8-11 & 28-31
X	1-4, 6, 8, 12, 15, 16	JP01223074 A (MITSUBISHI) esp abstract & fig 1
X	1-4, 12, 15, 16	US2002/0192081 A1 (OKADA) esp abstract & figs 1-3
A	-	EP1431162 A2 (TOYOTA) esp abstract & figs 1 & 6
A	-	EP0926042 A1 (TOYODA) esp abstract & figs 1 & 3
A	-	GB2276596 A (CROWN) abstract & fig 1
A	-	JP2000219142 A (HINO) abstract & figs 1 & 2

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