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(54) **Method and device for limiting lifting moment of a loading crane**

Verfahren und Vorrichtung zur Lastmomentbegrenzung eines Ladekrans

Procédé et dispositif de limitation de couple d'une grue de chargement

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(73) Proprietor: **Cargotec Patenter AB**
341-81 Ljungby (SE)

(72) Inventor: **Rydahl, Lars**
SE-824 40, HUDIKSVALL (SE)

(74) Representative: **Löfgren, Jonas et al**
Bjerkéns Patentbyrå KB
Box 1274
801 37 Gävle (SE)

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Description

FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention relates to a lorry according to the preamble of claim 1 as known from JP 2007 314257 A and a method for regulating the maximum allowed lifting moment of a hydraulic lorry crane.

[0002] In order to avoid overloading of a hydraulic crane, it is known to establish a, with respect to the strength of the crane, maximum allowed value for the lifting moment of the crane. The expression "base value" is in the following used as a denomination for this maximum allowed value for the lifting moment of the crane established based on the strength properties of the crane. This base value may be a fixed value which takes into account the position of the crane boom system which, with respect to strength, is the most critical one among the allowed positions for the crane boom system of the crane, or a variable value established instantaneously in dependence on the swing-out angle of the inner boom of the crane and possibly further variables defining the prevailing position of the crane boom system of the crane. The value for the maximum allowed lifting moment is normally converted into a corresponding value for the maximum allowed working pressure for the lifting cylinder of the crane, and by limiting this working pressure it is secured that the lifting moment of the crane will not exceed the maximum allowed lifting moment.

[0003] For a lorry crane, i.e. a crane mounted on a lorry, the value of the maximum allowed lifting moment also has to be adapted in dependence on the stability of the lorry, to thereby avoid a tipping of the lorry due to inappropriate manoeuvring of the crane.

[0004] To prevent the lorry from tipping, the tipping moment presently exerted on the lorry by the crane and by the load carried by the crane has to be lower than the stabilizing moment given by the weight of the lorry without cargo in combination with the weight of the possible load located on the lorry. The magnitude of the tipping moment and the stabilizing moment depends i.a. on the position of the tipping line over which the crane boom system of the crane presently extends. In dependence on the position of the support legs of the lorry and the horizontal slewing position of the crane, this tipping line may extend between two vehicle wheels, between two support legs or between one vehicle wheel and one support leg. The position of the tipping line can be established based on information about the slewing angle of the column of the crane and information about the horizontal extension length of the support legs of the lorry. When the position of the tipping line of the lorry is known, the perpendicular distance between the tipping line and the centre of gravity of the lorry without cargo can be calculated, which in its turn makes it possible to calculate the stabilizing moment given by the weight of the lorry without cargo. When the position of the tipping line, the slewing angle of the column of the crane and the lifting radius of the crane are known, the perpendicular distance between the tipping line and the load suspension point of the crane can be calculated, which in its turn makes it possible to estimate the tipping moment exerted by the crane when the lifting moment of the crane corresponds to the above-mentioned base value for the maximum allowed lifting moment.

[0005] A lorry normally lacks a sensor for establishing the prevailing wheel force of the load-bearing vehicle wheels of the lorry, which implies that there is no possibility to calculate the stabilizing moment given by the load presently located on the lorry. In the automatic stability monitoring of a conventional lorry crane, only the stabilizing moment given by the weight of the lorry without cargo is therefore taken into account, and it will thereby not be possible to adapt the lifting capacity of the crane in dependence on the stabilizing moment given by the weight of the possible load presently located on the lorry. When the crane of the lorry is manoeuvred with a load located on the lorry, the value for the maximum allowed lifting moment of the crane will therefore often be lower than what would have been possible if also the stabilizing moment from the load had been taken into account, which consequently implies that the lifting capacity of the crane is limited to a greater extent than actually required with respect to the stability.

[0006] According to a known principle for stability monitoring of a lorry crane, the tipping moment M_O exerted by the crane when the lifting moment of the crane corresponds to the above-mentioned base value $M_{C,bas}$ for the maximum allowed lifting moment and the stabilizing moment M_S given by the weight of the lorry without cargo are calculated in the manner described above. Thereafter, it is checked whether a predetermined stability condition is fulfilled with these tipping and stabilizing moments, namely whether the ratio between the stabilizing moment M_S and the tipping moment M_O is equal to or larger than the value of a given stability constant k ($M_S/M_O \geq k$). If the stability condition is fulfilled, i.e. if $M_S/M_O \geq k$, said base value $M_{C,bas}$ is used as an upper limit for the allowed lifting moment of the crane. If the stability condition is not fulfilled, i.e. $M_S/M_O < k$, a reduction factor κ is established, and a reduced value $M_{C,red}$ for the maximum allowed lifting moment of the crane is established as the product of the base value $M_{C,bas}$ and the reduction factor κ, i.e. $M_{C,red}=M_{C,bAs}\cdot\kappa$. The reduction factor κ is calculated as the quotient between the stabilizing moment M_S and the product of the stability constant k and the tipping moment M_O, i.e. $\kappa=M_S/(k\cdot M_O)$. The reduced value $M_{C,red}$ is then used as an upper limit for the maximum allowed lifting moment of the crane.

[0007] JP 2008 074561 A discloses a lorry provided with a hydraulic crane and support legs. The ground contact reaction force of each support leg is detected and a warning signal is emitted when the ground contact reaction force of a support leg is below a predetermined threshold value. The threshold value is reduced when the horizontal extension length of the support leg is increased.

OBJECT OF THE INVENTION

[0008] The object of the present invention is to provide a new and favourable manner for regulating the maximum allowed lifting moment of a hydraulic lorry crane.

SUMMARY OF THE INVENTION

[0009] According to the present invention, said object is achieved by means of a lorry having the features defined in claim 1 and a method having the features defined in claim 7.

[0010] With the solution according to the invention, it will be possible, when establishing the maximum allowed lifting moment of a hydraulic crane, to take advantage of the stabilizing moment given by the load presently located on the lorry, so that the reduction of the maximum allowed lifting moment of the crane required in certain situations in view of the stability of the crane can be limited while maintaining a proper safety against a tipping of the lorry.

[0011] Preferred embodiments of the invention will appear from the dependent claims and the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention will in the following be more closely described by means of embodiment examples, with reference to the appended drawings. It is shown in:

Fig 1 a schematic rear view of a lorry provided with support legs and a hydraulic crane;

Fig 2 a schematic planar view of the lorry, the support legs and the crane according to Fig 1;

Fig 3 a schematic perspective view of a manoeuvring unit with a number of manoeuvring members for controlling different crane functions; and

Fig 4 a schematic illustration of an embodiment of a crane included in a lorry according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0013] Figs 1 and 2 show a lorry 1 provided with load-bearing vehicle wheels 2_1-2_4 and a chassis 3 supported by the vehicle wheels. In the illustrated example, the lorry is provided with two rear wheels 2_1, 2_2 and two front wheels 2_3, 2_4, but the lorry could also be provided with a larger number of load-bearing vehicle wheels than here illustrated. A hydraulic crane 20 is mounted on and carried by the chassis 3. Two horizontally extendable support legs 4_1, 4_3 are arranged on one side of the longitudinal axis of the vehicle, and two horizontally extendable support legs 4_2, 4_4 are arranged on the opposite side of the longitudinal axis of the vehicle. The lorry could alternatively be provided with a larger or smaller number of support legs than here illustrated. The respective support leg 4_1-4_4 has a first force member 5, suitably in the form of a hydraulic cylinder, by means of which the support leg is horizontally displaceable from a retracted position close to the chassis 3 to an extended position at a distance from the chassis 3. Alternatively, the respective support leg 4_1-4_4 could be manually displaceable horizontally from a retracted position close to the chassis 3 to an extended position at a distance from the chassis 3. The support legs 4_1-4_4 are shown in the extended position in Figs 1 and 2. Furthermore, the respective support leg 4_1-4_4 has a second force member 6, by means of which the support leg is manoeuvrable to an active support position in contact with the ground or other underlayer. The support legs 4_1-4_4 are shown in the active support position in Figs 1 and 2. In its active support position, the respective support leg rests against the underlayer through a support leg foot 7 arranged at the lower end of a telescopically lowerable lower support leg part 8 of the support leg. In the illustrated example, the second force member 6 consists of a hydraulic cylinder, by means of which the lower support leg part 8 of the support leg is displaceable upwards and downwards in relation to an upper support leg part 9.

[0014] The lorry 1 comprises means 10 (schematically indicated in Fig 4) for establishing the horizontal extension length of the respective support leg 4_1-4_4. These means 10 comprise sensors which sense the displacement position of the horizontally displaceable part 12 of the respective support leg or the displacement position of the movable part of said first force member 5 of the respective support leg.

[0015] Furthermore the lorry 1 comprises means 11 (schematically indicated in Fig 4) for establishing the force F exerted by the second force member 6 of the respective support leg 4_1-4_4 when the support leg is in the active support position. This force corresponds to the contact force exerted by the support leg against the underlayer and consequently the normal force acting on the support leg from the underlayer. When the second force member 6 of the respective support leg 4_1-4_4 consists of a hydraulic cylinder, the means 11 comprise pressure sensors for sensing the differential pressure of each one of these hydraulic cylinders.

[0016] The hydraulic lorry crane 20 comprises:

- a column 21, which is rotatable in relation to the chassis 3 about an essentially vertical axis of rotation A1 by means of a not shown rotating device;
- a liftable and lowerable crane boom 22, here denominated inner boom, which is articulately fastened to the column 21 in such a manner that it is turnable in relation to the column about an essentially horizontal axis of rotation A2; and
- a hydraulic cylinder 23, here denominated lifting cylinder, for lifting and lowering the inner boom 22 in relation to the column 21.

[0017] The slewing angle θ of the column 21 in relation to the chassis 3 is established by means of a sensor 14 (schematically indicated in Fig 4), which continuously senses the slewing position of the column.

[0018] In the example illustrated in Fig 1, the crane 20 also comprises a liftable and lowerable crane boom 24, here denominated outer boom, which is articulately fastened to the inner boom 22 in such a manner that it is turnable in relation to the inner boom about an essentially horizontal axis of rotation A3. A hydraulic cylinder 25, here denominated outer boom cylinder, carries out the lifting and lowering of the outer boom 24 in relation to the inner boom 22. In this case, the crane boom system 29 of the crane is formed by the inner boom 22 and the outer boom 24.

[0019] In the illustrated example, the lifting cylinder 23 comprises a cylinder part 23a which is articulately fastened to the column 21, and a piston which is received in this cylinder part and displaceable in relation to it, the piston being provided with a piston rod 23b, which is articulately fastened to the inner boom 22. The outer boom cylinder 25 comprises a cylinder part 25a which is articulately fastened to the inner boom 22, and a piston which is received in this cylinder part and displaceable in relation to it, the piston being provided with a piston rod 25b, which is articulately fastened to the outer boom 24.

[0020] In the illustrated example, the outer boom 24 comprises two crane boom sections 24a, 24b which are mutually displaceable in the longitudinal direction of the outer boom for adjustment of the extension length of the outer boom. The crane boom sections 24a, 24b are displaceable in relation to each other by means of a hydraulic cylinder 26 carried by the outer boom 24.

[0021] In the illustrated example, a rotator 27 is articulately fastened to the outer end of the outer boom, which rotator in its turn carries a lifting hook 28. In order to perform lifting operations requiring a great range, a liftable and lowerable crane boom in the form of a so-called jib may be mounted to the outer end of the outer boom 24.

[0022] The crane 20 further comprises an electronic regulating device 30 (schematically indicated in Fig 4), which is adapted to check whether one or more predetermined stability conditions for the lorry are fulfilled with a lifting moment of the crane corresponding to a, with respect to the strength of the crane, maximum allowed value $M_{C,bas}$, here denominated base value, for the lifting moment of the crane. This base value $M_{C,bas}$ may be a given fixed value which takes into account the position of the crane boom system which, with respect to strength, is the most critical one among the allowed positions for the crane boom system 29 of the crane, or a variable value established by the regulating device 30 in dependence on the swing-out angle of the inner boom 22 of the crane in the vertical plane and possibly further variables defining the prevailing position of the crane boom system of the crane.

[0023] If the regulating device 30 will establish that said stability condition is not fulfilled, the regulating device 30 is adapted to establish a reduced value $M_{C,red}$ for the maximum allowed lifting moment of the crane, the regulating device 30 being adapted, when establishing this reduced value $M_{C,red}$, to take into account the horizontal extension length of the respective support leg 4_1-4_4 that is in the active support position, the slewing angle θ of the column 21 in relation to the chassis 3 in the horizontal plane, and the force F_i exerted by the second force member 6 of the respective support leg that is in the active support position and is not included in the prevailing tipping line of the lorry. A preferred implementation of this will be described in the following.

[0024] As a lorry 1 has a considerable weight, the support legs 4_1-4_4 are not designed to carry the entire weight of the lorry when the crane 20 is used. When the crane 20 is used, the main part of the weight of the lorry is carried by the vehicle wheels 2_1-2_4, whereas the support legs 4_1-4_4 that are in the active support position only carry a minor part of the weight of the lorry. When all the support legs 4_1-4_4 are in the active support position, there are consequently six different possible tipping lines for the lorry 1 illustrated in Fig 2, namely:

- a first possible tipping line between the contact points against the underlayer of the rear support legs 4_1, 4_2;
- a second possible tipping line between the contact points against the underlayer of the right rear support leg 4_1 and the right front support leg 4_3;
- a third possible tipping line between the contact points against the underlayer of the right front support leg 4_3 and the right front wheel 2_3;
- a fourth possible tipping line between the contact points against the underlayer of the right front wheel 2_3 and the

left front wheel 2_4;

- a fifth possible tipping line between the contact points against the underlayer of the left front wheel 2_4 and the left front support leg 4_4; and
- a sixth possible tipping line between the contact points against the underlayer of the left front support leg 4_4 and the left rear support leg 4_2.

[0025] The position of the prevailing tipping line L_O (see Fig 2), i.e. the position of the tipping line over which the lorry 1 presently runs the risk of tipping in case of an overloading of the crane 20, depends on the prevailing slewing position of the crane boom system 29 in the horizontal plane and the horizontal extension length of the support legs 4_1-4_4 that are in the active support position. By establishing the slewing angle θ of the column 21 in relation to the chassis 3 and the horizontal extension length of the respective support leg 4_1-4_4, it will consequently be possible to establish the position of the prevailing tipping line L_O. Based on the thus established position of the prevailing tipping line L_O and the slewing angle θ of the column 21 in relation to the chassis 3, the angle θ' between the crane boom system 29 and the normal to the tipping line can then be established, as well as the perpendicular distance H between the vertical axis of rotation A1 of the crane and the prevailing tipping line L_O.

[0026] The tipping moment M_O of the crane 20 with respect to the prevailing tipping line L_O and with a lifting moment of the crane corresponding to the above-mentioned base value $M_{C,bas}$ is given by the following formula:

$$M_O = M_{C,bas} \cdot \frac{R \cdot \cos(\theta') - H}{R}$$

where R is the lifting radius of the crane, i.e. the horizontal distance from the vertical axis of rotation A1 of the crane to the load suspension point P. The lifting radius R can be calculated based on measured values on the variables defining the prevailing position of the crane booms 22, 24 of the crane. The lifting radius R may alternatively be set to a fixed value representing the largest possible lifting radius of the crane.

[0027] Equilibrium of moments about the tipping line L_O with a lifting moment of the crane corresponding to the above-mentioned base value $M_{C,bas}$ will give the following relationship:

$$m_v \cdot g \cdot h_v + m_e \cdot g \cdot h_e = M_O + \sum_{i=1}^{n}(F_i \cdot D_i) + \sum_{i=1}^{m}(R_i \cdot d_i)$$

where F_i is the support leg force of the active support leg i, which corresponds to the force exerted by the second force member 6 of the support leg, D_i is the perpendicular distance between the contact point of the support leg i against the underlayer and the prevailing tipping line L_O, R_i is the wheel force of the vehicle wheel i, d_i is the perpendicular distance between the contact point of the vehicle wheel i against the underlayer and the prevailing tipping line L_O, m_v is the mass of the lorry without cargo, g is the gravitational constant, h_v is the perpendicular distance between the centre of gravity G_v of the lorry without cargo and the prevailing tipping line L_O, m_e is the mass of the possible load 13 presently located on the lorry, and h_e is the perpendicular distance between the centre of gravity G_e of said load 13 and the prevailing tipping line L_O.

[0028] In the above-mentioned relationship of equilibrium of moments, $\sum_{i=1}^{n}(F_i \cdot D_i)$ consequently represents the moment from the support leg forces, $\sum_{i=1}^{m}(R_i \cdot d_i)$ represents the moment from the unknown wheel forces, $m_v \cdot g \cdot h_v$ represents the moment from the known mass of the unloaded lorry, and $m_e \cdot g \cdot h_e$ represents the moment from the unknown mass of the possible load.

[0029] Considering that the wheel forces R_i are unknown but always positive, the above-mentioned equilibrium relationship is changed into the following inequality:

$$m_v \cdot g \cdot h_v + m_e \cdot g \cdot h_e \geq M_O + \sum_{i=1}^{n}(F_i \cdot D_i) \qquad (1)$$

In any case, a stabilizing moment ($m_V \cdot g \cdot h_V$) is obtained by the mass of the lorry in itself, and when a load is located on the lorry, a supplementary stabilizing moment ($m_e \cdot g \cdot h_e$) is also obtained by the mass of this load. The stabilizing moment M_S is consequently equal to the sum of the moment from the mass of the unloaded lorry and the moment from the mass of the possible load located on the lorry, i.e. $M_S = m_V \cdot g \cdot h_V + m_e \cdot g \cdot h_e$. From this it follows that $M_S \geq m_V \cdot g \cdot h_V$. From the inequality (1) above, it also follows that $M_S \geq M_O + \sum_{i=1}^{n}(F_i \cdot D_i)$.

[0030] The conventional stability condition that the ratio between the stabilizing moment M_S and the tipping moment M_O is to be larger than or equal to the value on a stability constant k with a given value higher than 1, for instance 1.2, may be used as stability condition. This stability condition can consequently be written in the following manner:

$$\frac{M_S}{M_O} \geq k \qquad (2)$$

[0031] When checking whether the stability condition (2) is fulfilled or not, the stabilizing moment M_s may now be made to assume the highest of the values $m_V \cdot g \cdot h_V$ and $M_O + \sum_{i=1}^{n}(F_i \cdot D_i)$.

[0032] If the stability condition (2) is not fulfilled, the regulating device 30 is adapted to establish the above-mentioned reduced value $M_{C,red}$ for the maximum allowed lifting moment of the crane as the product of the base value $M_{C,bas}$ and a reduction factor κ which is established by the regulating device and has a value lower than 1. In this case, the regulating device 30 is adapted to make said reduction factor κ assume a basic value κ_{bas} when $m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n}(F_i \cdot D_i)$, i.e. when the stabilizing moment M_s has had the value $m_V \cdot g \cdot h_V$ in connection with the establishment that the stability condition (2) is not fulfilled. This basic value κ_{bas} for the reduction factor is suitably established according to the following formula:

$$\kappa_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

[0033] When $M_O + \sum_{i=1}^{n}(F_i \cdot D_i) \geq m_v \cdot g \cdot h_v$, i.e. when the stabilizing moment M_S has had the value $M_O + \sum_{i=1}^{n}(F_i \cdot D_i)$ in connection with the establishment that the stability condition (2) is not fulfilled, the regulating device 30 is adapted to make said reduction factor κ assume an increased value κ_{eh}, which is higher than said basic value κ_{bas}. This increased value κ_{eh} for the reduction factor is suitably established according to the following formula:

$$\kappa_{eh} = \frac{\sum_{i=1}^{n}(F_i \cdot D_i)}{(k-1) \cdot M_O}$$

[0034] The last-mentioned formula follows from the fact that the stability condition in the last-mentioned case can be written as: $\frac{M_S}{M_O} = \frac{M_O + \sum_{i=1}^{n}(F_i \cdot D_i)}{M_O} \geq k$, which can be reformulated into the following condition:

$$\frac{\sum_{i=1}^{n}(F_i \cdot D_i)}{M_O} \geq k - 1.$$

[0035] The regulating device 30 is in a conventional manner adapted to convert the prevailing value ($M_{C,bas}$ or $M_{C,red}$) for the maximum allowed lifting moment of the crane 20 into a corresponding value for the maximum allowed working pressure for the lifting cylinder 23.

[0036] The control system for controlling the different crane functions, i.e. lifting/lowering by means of the lifting cylinder 23, tilting by means of the outer boom cylinder 25, extension/retraction by means of the hydraulic cylinder 26 etc, comprises a pump 40 (see Fig 4), which pumps hydraulic fluid from a reservoir 41 to a directional-control-valve block 42. The directional-control-valve block 42 comprises a directional-control-valve section 43 for each of the hydraulic cylinders 23, 25 and 26 of the crane boom system, to which hydraulic cylinders hydraulic fluid is supplied in a conventional manner in dependence on the setting position of the slide member in the respective directional-control-valve section 43. The setting position of the slide members in the directional-control-valve sections 43 is controlled either through a number of manoeuvring members, for instance in the form of manoeuvring levers 44, each of which being connected to its own slide member, or by remote control through a manoeuvring unit 45 (see Fig 3) comprising a manoeuvring member S1-S6 for each slide member. In the case of remote control, the control signals are transmitted through cable or a wireless connection from the manoeuvring unit 45 to an electronic control unit, for instance in the form of a microprocessor, which in its turn controls the setting position of the slide members in the valve sections 43 of the directional-control-valve block 42 in dependence on the magnitude of the respective control signal from the manoeuvring unit 45.

[0037] Each individual directional-control-valve section 43 consequently controls the magnitude and the direction of the flow of hydraulic fluid to a specific hydraulic cylinder and thereby controls a specific crane function. For the sake of clarity, only the directional-control-valve section 43 for the lifting cylinder 23 is illustrated in Fig 4.

[0038] The directional-control-valve block 42 further comprises a shunt valve 46, which pumps excessive hydraulic fluid back to the reservoir 41, and an electrically controlled dump valve 47, which can be made to return the entire hydraulic flow from the pump 40 directly back to the reservoir 41.

[0039] In the shown embodiment example, the directional-control-valve block 42 is of load-sensing and pressure-compensating type, which implies that the magnitude of the hydraulic flow supplied to a hydraulic cylinder is always proportional to the position of the slide member in the corresponding directional-control-valve section 43, i.e. proportional to the setting position of the manoeuvring lever 44. The directional-control-valve section 43 comprises a pressure limiter 48, a pressure compensator 49 and a directional-control-valve 50. Directional-control-valve blocks and directional-control-valve sections of this type are known and available on the market. Also other types of valve devices than the one here described may of course be used in the crane 20 in question.

[0040] A load holding valve 51 is arranged between the respective hydraulic cylinder and the associated directional-control-valve section 43, which load holding valve makes sure that the load will remain hanging when the hydraulic system runs out of pressure when the dump valve 47 is made to return the entire hydraulic flow from the pump 40 directly back to the reservoir 41.

[0041] The crane further comprises a pressure sensor 52 arranged to measure the hydraulic pressure on the piston side of the lifting cylinder 23. The regulating device 30 is connected to the pressure sensor 52 in order to receive measuring signals from this sensor related to said hydraulic pressure.

[0042] The regulating device 30 continuously reads the output signal from the pressure sensor 52 and compares this output signal with the established value for the maximum allowed working pressure for the lifting cylinder 23. If the pressure sensed by the pressure sensor 52 exceeds the established maximum allowed working pressure for the lifting cylinder 23, the regulating device 30 delivers a signal to the dump valve 47 which dumps the hydraulic flow directly to the reservoir 41, which results in that the hydraulic system runs out or pressure and the load is held in its position by means of the load holding valve 51. In this situation, the control system is adapted to allow only moment reducing crane movements.

[0043] In the example described above, the regulating device 30 is adapted to let the maximum allowed working pressure for the lifting cylinder 23 represent the maximum allowed hydraulic pressure on the piston side of the lifting cylinder. However, the regulating device 30 could alternatively be adapted to let the maximum allowed working pressure for the lifting cylinder 23 represent the maximum allowed differential pressure in the hydraulic cylinder. This differential pressure is defined as the hydraulic pressure on the piston side of the lifting cylinder minus the hydraulic pressure on its piston rod side divided by the cylinder ratio. In the last-mentioned case, the regulating device 30 is also arranged to receive measuring signals from a pressure sensor 53 which measures the hydraulic pressure on the piston rod side of the lifting cylinder 23 so as to thereby be able to establish the prevailing differential pressure in the hydraulic cylinder and compare this differential pressure with the established value on the maximum allowed working pressure for the lifting cylinder. The expression "working pressure" as used in this description and the following claims, consequently refers either to the hydraulic pressure on the piston side of the lifting cylinder or the differential pressure in the lifting cylinder.

[0044] The invention is of course not in any way limited to the embodiments described above. On the contrary, several possibilities to modifications thereof should be apparent to a person skilled in the art without thereby deviating from the basic idea of the invention as defined in the appended claims. The control system of the crane may for instance have another design than the control system which is illustrated in Fig 4 and described above.

Claims

1. A lorry provided with load-bearing vehicle wheels (2_1-2_4), a chassis (3) supported by the vehicle wheels, a hydraulic crane (20) carried by the chassis and two or more support legs (4_1-4_4) connected to the chassis, the respective support leg having a force member (6) by means of which the support leg is manoeuvrable to an active support position in contact with the ground or other underlayer, wherein the crane (20) comprises:

   - a column (21), which is rotatable in relation to the chassis (3) about an essentially vertical axis;
   - a liftable and lowerable crane boom (22), here denominated inner boom, which is articulately fastened to the column (21);
   - a hydraulic cylinder (23), here denominated lifting cylinder, for lifting and lowering the inner boom (22) in relation to the column (21); and
   - an electronic regulating device (30), which is adapted to check whether one or more predetermined stability conditions for the lorry are fulfilled with a lifting moment of the crane corresponding to a, with respect to the strength of the crane, maximum allowed value ($M_{C,bas}$), here denominated base value, for the lifting moment of the crane, the regulating device (30) being adapted to establish a reduced value ($M_{C, red}$) for the maximum allowed lifting moment of the crane if said one or more stability conditions are not fulfilled,

   characterized in that the regulating device (30), when establishing said reduced value ($M_{C, red}$), is adapted to take into account the horizontal extension length of the respective support leg (4_1-4_4) that is in the active support position, the slewing angle (θ) of the column (21) in relation to the chassis (3), and the force (F_i) exerted by the force member (6) of the respective support leg that is in the active support position and is not included in the prevailing tipping line of the lorry.

2. A lorry according to claim 1, **characterized in that** the regulating device (30) is adapted to establish said reduced value ($M_{C,red}$) as the product of said base value ($M_{C,bas}$) and a reduction factor (κ), which is established by the regulating device and has a value lower than 1.

3. A lorry according to claim 2, **characterized in:**

   - **that** the regulating device (30) is adapted to make said reduction factor (κ) assume a basic value (κ_{bas}) when the following condition (I) is fulfilled:

$$m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n} (F_i \cdot D_i) \qquad \text{(I)}$$

   where m_v is the mass of the lorry without cargo, g is the gravitational constant, h_v is the perpendicular distance between the centre of gravity of the lorry without cargo and the prevailing tipping line, M_O is the tipping moment of the crane (20) with respect to the prevailing tipping line and with a lifting moment of the crane corresponding to said base value ($M_{C,bas}$), F_i is the force exerted by the force member (6) of the active support leg *i* and D_i is the perpendicular distance between the contact point of the active support leg *i* against the underlayer and the

prevailing tipping line, and
- **that** the regulating device (30) is adapted to make said reduction factor (κ) assume an increased value (κ_{eh}), which is higher than said basic value (κ_{bas}), when said condition (I) is not fulfilled.

4. A lorry according to claim 3, **characterized in that** the regulating device (30) is adapted to establish said basic value (κ_{bas}) for the reduction factor according to the following formula:

$$\kappa_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

where κ_{bas} is said basic value, m_v, g, h_v and M_O are as above and k is a stability constant with a given value higher than 1.

5. A lorry according to claim 4, **characterized in that** the regulating device (30) is adapted to establish said increased value (κ_{eh}) for the reduction factor according to the following formula:

$$\kappa_{eh} = \frac{\sum_{i=1}^{n}(F_i \cdot D_i)}{(k-1) \cdot M_O}$$

where κ_{eh} is said increased value and F_i, D_i, M_O and k are as above.

6. A lorry according to any of claims 1-5, **characterized in that** the regulating device (30) is adapted to convert the prevailing value ($M_{C,bas}$ or $M_{C,,red}$) for the maximum allowed lifting moment of the crane into a corresponding value for the maximum allowed working pressure for the lifting cylinder (23).

7. A method for regulating the maximum allowed lifting moment of a hydraulic crane (20) which is mounted on a chassis (3) of a lorry (1), which chassis is supported by load-bearing vehicle wheels (2_1-2_4), where the lorry comprises two or more support legs (4_1-4_4) connected to the chassis (3), the respective support leg having a force member (6), by means of which the support leg is manoeuvrable to an active support position in contact with the ground or other underlayer, and the lorry (20) comprises:

- a column (21), which is rotatable in relation to the chassis (3) about an essentially vertical axis;
- a liftable and lowerable crane boom (22), here denominated inner boom, which is articulately fastened to the column (21);
- a hydraulic cylinder (23), here denominated lifting cylinder, for lifting and lowering the inner boom (22) in relation to the column (21);

the method comprising the steps:

- to check by means of an electronic regulating device (30) whether one or more predetermined stability conditions for the lorry are fulfilled with a lifting moment of the crane corresponding to a, with respect to the strength of the crane, maximum allowed value ($M_{C,bas}$), here denominated base value, for the lifting moment of the crane; and
- to establish a reduced value ($M_{C,red}$) for the maximum allowed lifting moment of the crane by means of said regulating device (30) if said one or more stability conditions are not fulfilled, the horizontal extension length (L_i) of the respective support leg (4_1-4_4) that is in the active support position, the slewing angle (θ) of the column (21) in relation to the chassis (3) and the force (F_i) exerted by the force member (6) of the respective support leg that is in the active support position and is not included in the prevailing tipping line of the lorry being taken into account when establishing said reduced value ($M_{C,red}$).

8. A method according to claim 7, **characterized in that** said reduced value ($M_{C,red}$) is established as the product of said base value ($M_{C,bas}$) and a reduction factor (κ) with a value lower than 1.

9. A method according to claim 8, **characterized in:**

- **that** said reduction factor (κ) is made to assume a basic value (κ_{bas}) when the following condition (I) is fulfilled:

$$m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n}(F_i \cdot D_i) \qquad \text{(I)}$$

where m_v is the mass of the lorry without cargo, g is the gravitational constant, h_v is the perpendicular distance between the centre of gravity of the lorry without cargo and the prevailing tipping line, M_O is the tipping moment of the crane (20) with respect to the prevailing tipping line and with a lifting moment of the crane corresponding to said base value ($M_{C,bas}$), F_i is the force exerted by the force member (6) of the active support leg *i,* and D_i is the perpendicular distance between the contact point of the active support leg *i* against the underlayer and the prevailing tipping line, and
- **that** said reduction factor (κ) is made to assume an increased value (κ_{eh}), which is higher than said basic value (κ_{bas}), when said condition (I) is not fulfilled.

10. A method according to claim 9, **characterized in that** said basic value (κ_{bas}) for the reduction factor is established according to the following formula:

$$\kappa_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

where κ_{bas} is said basic value, m_v, g, h_v and M_O are as above, and k is a given stability constant with a value higher than 1.

11. A method according to claim 10, **characterized in that** said increased value (κ_{eh}) for the reduction factor is established according to the following formula:

$$\kappa_{eh} = \frac{\sum_{i=1}^{n}(F_i \cdot D_i)}{(k-1) \cdot M_O}$$

where κ_{eh} is said increased value, and F_i, D_i, M_O and k are as above.

12. A method according to any of claims 7-11, **characterized in that** the prevailing value ($M_{C,bas}$ or $M_{C,red}$) for the maximum allowed lifting moment of the crane is converted into a corresponding value for the maximum allowed working pressure for the lifting cylinder (23).

Patentansprüche

1. Lastkraftwagen mit lasttragenden Fahrzeugrädern (2_1 - 2_4), einem Chassis (3), das von den Fahrzeugrädern getragen wird, einem hydraulischen Kran (20), der von dem Chassis getragen wird und zwei oder mehr Stützbeinen (4_1 - 4_4), die mit dem Chassis verbunden sind, wobei das entsprechende Stützbein ein Kraftelement (6) aufweist, mit dessen Hilfe das Stützbein in eine aktive Stützposition manövrierbar ist, in der es mit dem Boden oder einem anderem Untergrund in Berührung steht, wobei der Kran (20) folgendes aufweist:

eine Säule (21), die in Bezug auf das Chassis (3) um eine im wesentlichen vertikale Achse drehbar ist;
einen hebbaren und senkbaren Kranarm (22), hier mit innerer Arm bezeichnet, der an der Säule (21) gelenkig befestigt ist;
einen hydraulischen Zylinder (23), hier Hubzylinder genannt, der zum Heben und Senken des inneren Arms (22) in Bezug auf die Säule (21) dient; und
eine elektronische Regelvorrichtung (30), die in der Lage ist zu überprüfen, ob eine oder mehrere vorbestimmte

Stabilitätsbedingungen für den Lastkraftwagen erfüllt sind, und zwar bei einem Hubmoment des Krans, das in Bezug auf die Festigkeit des Krans einem maximal zulässigen Wert ($M_{C,bas}$), hier als Basiswert bezeichnet, für das Hubmoment des Krans entspricht, wobei die Regelvorrichtung (30) in der Lage ist, für das maximal zulässige Hubmoment des Krans einen reduzierten Wert ($M_{C,red}$) zu erzeugen, wenn die eine oder mehrere Stabilitätsbedingungen nicht erfüllt sind, **dadurch gekennzeichnet, daß** die Regelvorrichtung (30) in der Lage ist, wenn sie den reduzierten Wert ($M_{C,red}$) erzeugt, die waagerechte Erstreckungslänge des entsprechenden Stützbeins (4_1 - 4_4), das sich in der aktiven Stützposition befindet, den Schwenkwinkel (θ) der Säule (21) in Bezug auf das Chassis (3) sowie die Kraft (F_i), die durch das Kraftelement (6) des entsprechenden Stützbeins ausgeübt wird, das sich in der aktiven Tragposition befindet und nicht in der vorherrschenden Kipplinie des Lastkraftwagens eingeschlossen ist, zu berücksichtigen.

2. Lastkraftwagen nach Anspruch 1, **dadurch gekennzeichnet, daß** die Regelvorrichtung (30) in der Lage ist, den reduzierten Wert ($M_{C,red}$) als Produkt des Basiswertes ($M_{C,bas}$) und einem Reduzierungsfaktor (κ) zu erzeugen, wobei letztgenannter durch die Regelvorrichtung gegeben ist und einen Wert geringer als 1 aufweist.

3. Lastkraftwagen nach Anspruch 2, **dadurch gekennzeichnet, daß** die Regelvorrichtung (30) in der Lage ist, den Reduzierungsfaktor (κ) als einen Basiswert (κ_{bas}) anzunehmen, wenn die folgende Bedingung (I) erfüllt ist:

$$m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n}(F_i \cdot D_i) \qquad \text{(I)}$$

wobei m_v die Masse des Lastkraftwagens ohne Ladung ist, g die Schwerkraftkonstante ist, h_v der senkrechte Abstand zwischen dem Schwerkraftzentrum des Lastkraftwagens ohne Ladung und der vorherrschenden Kipplinie ist, M_O das Kippmoment des Krans (20) in Bezug auf die vorherrschende Kipplinie und mit einem Hubmoment des Krans ist, das dem Basiswert ($M_{C,bas}$) entspricht, F_i die Kraft ist, die durch das Kraftelement (6) des aktiven Stützbeins i ausgeübt wird, und D_i der senkrechte Abstand zwischen dem Berührungspunkt des aktiven Stützbeins i auf dem Untergrund und der vorherrschenden Kipplinie ist, und daß die Regelvorrichtung (30) in der Lage ist, den Reduzierungsfaktor (κ) zu veranlassen, einen erhöhten Wert (κ_{eh}) anzunehmen, der höher ist als der Basiswert (κ_{bas}), wenn die Bedingung (I) nicht erfüllt ist.

4. Lastkraftwagen nach Anspruch 3, **dadurch gekennzeichnet, daß** die Regelvorrichtung (30) in der Lage ist, den Basiswert (κ_{bas}) für den Reduzierungsfaktor nach der folgenden Formel zu bilden:

$$\kappa_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

wobei κ_{bas} der Basiswert ist, m_v, g, h_v und M_O die obigen Bedeutungen haben und k eine Stabilitätskonstante mit einem gegebenen Wert größer als 1 ist.

5. Lastkraftwagen nach Anspruch 4, **dadurch gekennzeichnet, daß** die Regelvorrichtung (30) in der Lage ist, den erhöhten Wert (κ_{eh}) für den Reduktionsfaktor gemäß der folgenden Formel zu bilden:

$$\kappa_{eh} = \frac{\sum_{i=1}^{n}(F_i \cdot D_i)}{(k-1) \cdot M_O}$$

wobei κ_{eh} der erhöhte Wert ist und F_i, D_i, M_O und k die obigen Bedeutungen haben.

6. Lastkraftwagen nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß** die Regelvorrichtung (30) in der Lage ist, den vorherrschenden Wert ($M_{C,bas}$ oder $M_{C,red}$) für das maximal zulässige Hubmoment des Krans in einen entsprechenden Wert für den maximal zulässigen Arbeitsdruck des Hubzylinders (23) umzuwandeln.

7. Verfahren zur Regelung des maximal zulässigen Hubmomentes eines hydraulischen Krans (20), der auf einem Chassis (3) eines Lastkraftwagens (1) aufgebaut ist, wobei das Chassis durch lasttragende Fahrzeugräder (2_1 - 2_4) gestützt wird, wobei ferner der Lastkraftwagen zwei oder mehr Stützbeine (4_1 - 4_4) aufweist, die mit dem Chassis (3) verbunden sind, das entsprechende Stützbein ein Kraftelement (6) besitzt, mit dessen Hilfe das Stützbein in eine aktive Stützposition bringbar ist, und zwar in Berührung mit dem Boden oder einem anderen Untergrund, und der Kran (20) folgendes aufweist:

eine Säule (21), die in Bezug auf das Chassis (3) um eine im wesentlichen vertikale Achse drehbar ist;
einen hebbaren und senkbaren Kranarm (22), hier mit innerer Arm bezeichnet, der an der Säule (21) gelenkig befestigt ist;
einen hydraulischen Zylinder (23), hier Hubzylinder genannt, der zum Heben und Senken des inneren Arms (22) in Bezug auf die Säule (21) dient;
wobei das Verfahren die folgenden Schritte aufweist:

mit Hilfe einer elektronischen Regelvorrichtung (30) Überprüfen, ob eine oder mehrere vorbestimmte Stabilitätsbedingungen für den Lastkraftwagen erfüllt sind, und zwar bei einem Hubmoment des Krans, das in Bezug auf die Festigkeit des Krans einem maximal zulässigen Wert ($M_{C,bas}$), hier mit Basiswert bezeichnet, für das Hubmoment des Krans entspricht; und
Erzeugen eines reduzierten Wertes ($M_{C,red}$) für das maximal zulässige Hubmoment des Krans mit Hilfe der Regelvorrichtung (30), wenn die eine oder mehrere Stabilitätsbedingungen nicht erfüllt sind, wobei die waagerechte Erstreckungslänge (L_i) des entsprechenden Stützbeins (4_1 - 4_4), das sich in der aktiven Stützposition befindet, der Schwenkwinkel (θ) der Säule (21) in Bezug auf das Chassis (3) und die Kraft (F_i), die durch das Kraftelement (6) des entsprechenden Stützbeins ausgeübt wird, das sich in der aktiven Stützposition befindet und nicht in der vorherrschenden Kipplinie des Lastkraftwagens eingeschlossen ist, berücksichtigt werden, wenn der genannte reduzierte Wert ($M_{C,red}$) erzeugt wird.

8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet, daß** der reduzierte Wert ($M_{C,red}$) als Produkt des Basiswertes ($M_{C,bas}$) und einem Reduzierungsfaktor (κ) mit einem Wert kleiner als 1 erzeugt wird.

9. Verfahren nach Anspruch 8, **dadurch gekennzeichnet, daß** der Reduzierungsfaktor (κ) veranlasst wird, einen Basiswert (κ_{bas}) anzunehmen, wenn die folgende Bedingung (I) erfüllt ist:

$$m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n} (F_i \cdot D_i) \qquad \text{(I)}$$

wobei m_v die Masse des Lastkraftwagens ohne Ladung ist, g die Schwerkraftkonstante ist, h_v der senkrechte Abstand zwischen dem Schwerkraftzentrum des Lastkraftwagens ohne Ladung und der vorherrschenden Kipplinie ist, M_O das Kippmoment des Krans (20) in Bezug auf die vorherrschende Kipplinie und mit einem Hubmoment des Krans ist, das dem Basiswert ($M_{C,bas}$) entspricht, F_i die Kraft ist, die durch das Kraftelement (6) des aktiven Stützbeins i ausgeübt wird, und D_i der senkrechte Abstand zwischen dem Berührungspunkt des aktiven Stützbeins i auf dem Untergrund und der vorherrschenden Kipplinie ist, und
daß der Reduzierungsfaktor (κ) veranlasst wird, einen erhöhten Wert (κ_{eh}) anzunehmen, der höher ist als der Basiswert (κ_{bas}), wenn die Bedingung (I) nicht erfüllt wird.

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, daß** der Basiswert (κ_{bas}) für den Reduzierungsfaktor gemäß der folgenden Formel aufgestellt wird:

$$\kappa_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

wobei κ_{bas} der Basiswert ist, m_v, g, h_v und M_O die obigen Bedeutungen haben und k eine gegebene Stabilitätskonstante mit einem Wert größer als 1 ist.

11. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, daß** der erhöhte Wert (κ_{eh}) für den Reduzierungsfaktor gemäß der folgenden Formel aufgestellt wird:

$$\kappa_{eh} = \frac{\sum_{i=1}^{n}(F_i \cdot D_i)}{(k-1)\cdot M_O}$$

wobei κ_{eh} der erhöhte Wert ist und F_i, D_i, M_O und k die obigen Bedeutungen haben.

12. Verfahren nach einem der Ansprüche 7 bis 11, **dadurch gekennzeichnet, daß** der vorherrschende Wert ($M_{C,bas}$ oder $M_{C,red}$) für das maximal zulässige Hubmoment des Krans in einen entsprechenden Wert für den maximal zulässigen Arbeitsdruck des Hubzylinders (23) umgewandelt wird.

Revendications

1. Camion pourvu de roues (2_1 à 2_4) de véhicule porteuses, un châssis (3) supporté par les roues de véhicule, une grue (20) hydraulique portée par le châssis et deux ou plusieurs jambes (4_1 à 4_4) de support reliées au châssis, chaque jambe de support ayant un élément (6) de force, au moyen duquel la jambe de support peut être manoeuvrée pour aller dans une position active de support en contact avec le sol ou une autre assise, la grue (20) comprenant :

- une colonne (21), qui peut tourner par rapport au châssis (3) autour d'un axe essentiellement vertical ;
- une flèche (22) de grue, qui peut être élevée et abaissée, dénommée ici flèche intérieure, qui est articulée à la colonne (21) ;
- un vérin (23) hydraulique, dénommé ici vérin de levage, pour lever et abaisser la flèche (22) intérieure par rapport à la colonne (21) et
- un dispositif (30) électronique de régulation, qui est conçu pour vérifier si une ou plusieurs conditions déterminées à l'avance de stabilité du camion sont satisfaites avec un couple de levage de la grue correspondant à, par rapport à la puissance de la grue, une valeur ($M_{C,bas}$) maximum autorisée, dénommée ici valeur de base, du couple de levage de la grue, le dispositif (30) de régulation étant conçu pour établir une valeur ($M_{C,red}$) réduite du couple de levage maximum autorisée de la grue, si la une ou les plusieurs conditions de stabilité ne sont pas satisfaites,

caractérisé en ce que le dispositif (30) de régulation est, lorsqu'il établit la valeur ($M_{C,red}$) réduite, conçu pour prendre en compte la longueur d'étendue horizontale de chaque jambe (4_1 à 4_4) de support qui est dans la position active de support, l'angle (θ) d'orientation de la colonne (21) par rapport au châssis (3) et la force (F_i) appliquée par l'élément (6) de force de chaque jambe de support qui est dans la position active de support et qui n'est pas incluse dans la ligne de basculement régnante du camion.

2. Camion suivant la revendication 1, **caractérisé en ce que** le dispositif (30) de régulation est conçu pour établir la valeur ($M_{C,red}$) réduite sous la forme du produit de la valeur ($M_{C,bas}$) de base et d'un facteur (K) de réduction, qui est établi par le dispositif de régulation et qui a une valeur inférieure à 1.

3. Camion suivant la revendication 2, **caractérisé en :**

- **ce que** le dispositif (30) de régulation est conçu pour faire que le facteur (K) de réduction prenne une valeur (K_{bas}) de base, lorsque la condition (I) suivante est satisfaite :

$$m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n}(F_i \cdot D_i) \qquad \text{(I)}$$

dans laquelle m_v est la masse du camion sans chargement, g est la constante de gravité, h_v est la distance perpendiculaire entre le centre de gravité du camion sans chargement et la ligne de basculement régnante, M_O est le couple de basculement de la grue (20) par rapport à la ligne de basculement régnante et avec un couple de levage de la grue correspondant à la valeur ($M_{C,bas}$) de base, F_i est la force appliquée par l'élément (6) de force de la jambe i active de support et D_i est la distance perpendiculaire entre le point de contact de la jambe i active de support sur l'assise et la ligne de basculement régnante et

- ce que le dispositif (30) de régulation est conçu pour faire que le facteur (K) de réduction prenne une valeur (K_{eh}) accrue qui est plus grande que la valeur (K_{bas}) de base, lorsque la condition (I) n'est pas satisfaite.

4. Camion suivant la revendication 3, **caractérisé en ce que** le dispositif (30) de régulation est conçu pour établir la valeur (K_{bas}) de base du facteur de réduction selon la formule suivante :

$$K_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

dans laquelle K_{bas} est la valeur de base, et m_V, g, h et M_O sont tels que ci-dessus et k est une constante de stabilité ayant une valeur donnée supérieure à 1.

5. Camion suivant la revendication 4, **caractérisé en ce que** le dispositif (30) de régulation est conçu pour établir la valeur (K_{eh}) accrue du facteur de réduction selon la formule suivante :

$$K_{eh} = \frac{\sum_{i=1}^{n} (F_i \cdot D_i)}{(k-1) \cdot M_O}$$

dans laquelle K_{eh} est la valeur accrue et F_i, D_i, M_O et k sont comme ci-dessus.

6. Camion suivant l'une quelconque des revendications 1 à 5, **caractérisé en ce que** le dispositif (30) de régulation est conçu pour transformer la valeur ($M_{C,bas}$ ou $M_{C,red}$) régnante du couple de levage maximum autorisée de la grue en une valeur correspondante de la pression de travail maximum autorisée du vérin (23) de levage.

7. Procédé de régulation du couple de levage maximum autorisé d'une grue (20) hydraulique, qui est montée sur un châssis (3) d'un camion (1), lequel châssis est supporté par des roues (2_1 à 2_4) de véhicule porteuses, le camion comprenant deux ou plusieurs jambes (4_1 à 4_4) de support reliées au châssis (3), chaque jambe de support ayant un élément (6) de force, au moyen duquel la jambe de support peut être manoeuvrée jusqu'à aller à une position active de support en contact avec le sol ou une autre assise, et le camion (20) comprend :

- une colonne (21), qui peut tourner par rapport au châssis (3) autour d'un axe essentiellement vertical ;
- une flèche (22) de grue, qui peut être élevée et abaissée, dénommée ici flèche intérieure, qui est articulée à la colonne (21) ;
- un vérin (23) hydraulique, dénommé ici vérin de levage, pour lever et abaisser la flèche (22) intérieure par rapport à la colonne (21) ;

le procédé comprenant les stades :

- de vérification au moyen d'un dispositif (30) électronique de régulation, si une ou plusieurs conditions déterminées à l'avance de stabilité du camion sont satisfaites avec un couple de levage de la grue correspondant à, par rapport à la puissance de la grue, une valeur ($M_{C,bas}$) maximum autorisée, dénommée ici valeur de base, du couple de levage de la grue et
- d'établissement d'une valeur ($M_{C,red}$) réduite du couple de levage maximum autorisée de la grue au moyen du dispositif (30) de régulation, si la une ou les plusieurs conditions de stabilité ne sont pas satisfaites, la longueur (L_i) d'extension horizontale de chaque jambe (4_1 à 4_4) de support quie est dans la position active de support, l'angle (θ) d'orientation de la colonne (21) par rapport au châssis (3) et la force (F_i) appliquée par l'élément (6) de force de chaque jambe de support qui est dans la position active de support et qui n'est pas incluse dans la ligne de basculement régnante du camion étant pris en compte, lors de l'établissement de la valeur ($M_{C,red}$) réduite.

8. Procédé suivant la revendication 7, **caractérisé en :**

- **ce que** la valeur ($M_{C,red}$) réduite est établie comme le produit de la valeur ($M_{C,bas}$) de base et d'un facteur (K) de réduction ayant une valeur inférieure à 1.

9. Procédé suivant la revendication 8, **caractérisé en :**

- **ce qu'**on fait en sorte que le facteur(K) de réduction prenne une valeur (K_{bas}) de base, lorsque la condition (I) suivante est satisfaite :

$$m_v \cdot g \cdot h_v \geq M_O + \sum_{i=1}^{n} (F_i \cdot D_i) \qquad \text{(I)}$$

dans laquelle m_V est la masse du camion sans chargement, g est la constante de gravité, h_V est la distance perpendiculaire entre le centre de gravité du camion sans chargement et la ligne de basculement régnante, M_O est le couple de basculement de la grue (20) par rapport à la ligne de basculement régnante et avec un couple de levage de la grue correspondant à la valeur ($M_{C,bas}$) de base, F_i est la force appliquée par l'élément (6) de force de la jambe *i* active de support et D_i est la distance perpendiculaire entre le point de contact de la jambe *i* active de support sur l'assise et la ligne de basculement régnante et

- ce qu'on fait en sorte que le facteur (K) de réduction prenne une valeur (K_{eh}) accrue qui est plus grande que la valeur (K_{bas}) de base, lorsque la condition (I) n'est pas satisfaite.

10. Procédé suivant la revendication 9, **caractérisé en ce qu'**on établit la valeur (K_{bas}) de base du facteur de réduction selon la formule suivante :

$$K_{bas} = \frac{m_v \cdot g \cdot h_v}{k \cdot M_O}$$

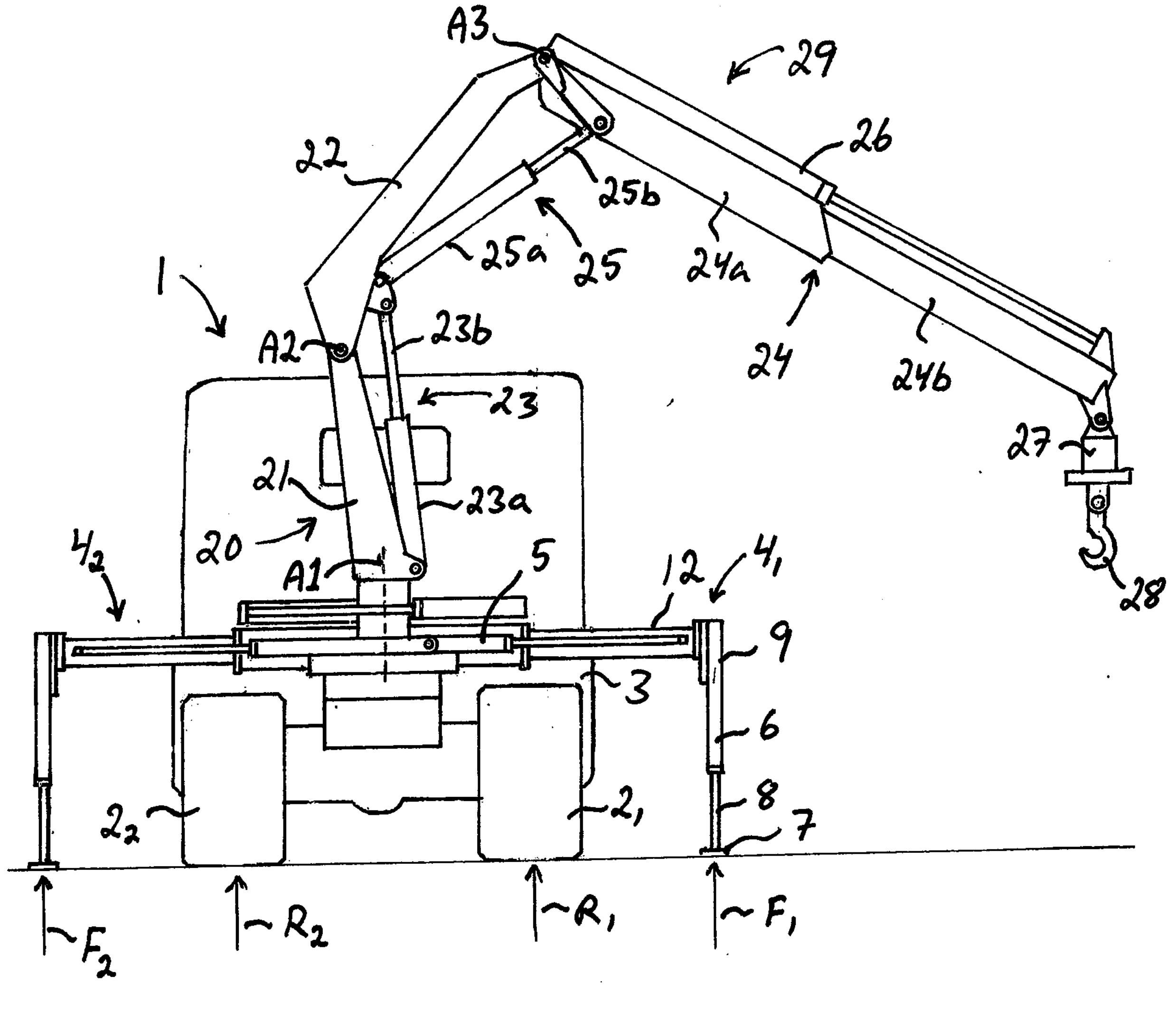
dans laquelle K_{bas} est la valeur de base, et m_V, g, h et M_O sont tels que ci-dessus et k est une constante de stabilité ayant une valeur donnée supérieure à 1.

11. Procédé suivant la revendication 10, **caractérisé en ce qu'**on établit la valeur (K_{eh}) accrue du facteur de réduction selon la formule suivante :

$$K_{eh} = \frac{\sum_{i=1}^{n} (F_i \cdot D_i)}{(k-1) \cdot M_O}$$

dans laquelle K_{eh} est la valeur accrue et F_i, D_i, Mo et K sont comme ci-dessus.

12. Procédé suivant l'une quelconque des revendications 7 à 11, **caractérisé en ce que** l'on transforme la valeur ($M_{C,bas}$ ou $M_{C,red}$) régnante du couple de levage maximum autorisée de la grue en une valeur correspondante de la pression de travail maximum autorisée du vérin (23) de levage.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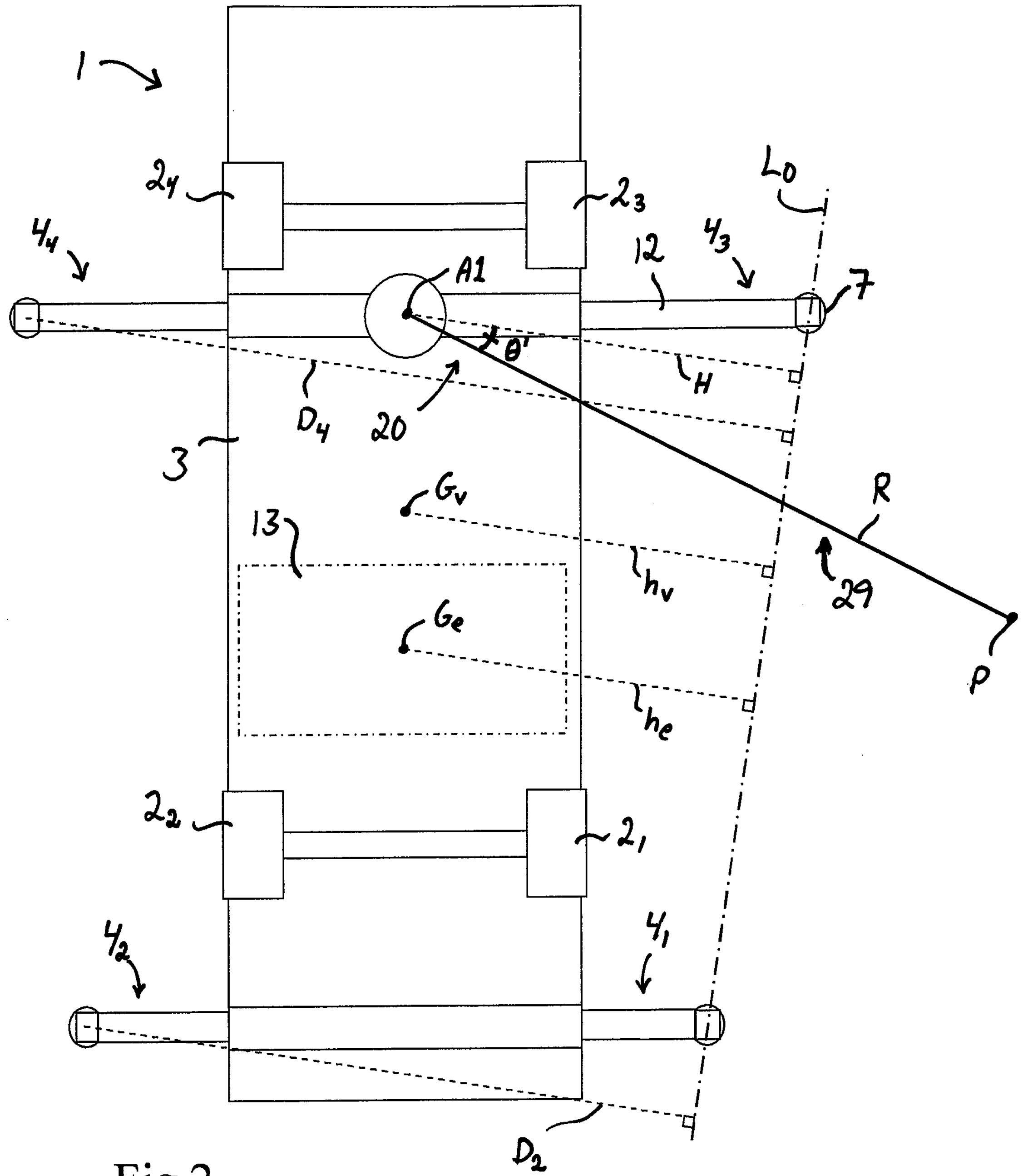
27
21
23a
20
4₂
A1
5
12
4₁
28
9
3
6
8
2₂
2₁
7
F₂
R₂
R₁
F₁

Fig 1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2_4
2_3
L_0
4_4
4_3
12
A1
7
θ'
H
D_4
20
3
G_v
R
13
h_v
29
G_e
P
h_e
2_2
2_1
4_2
4_1
D_2

Fig 2

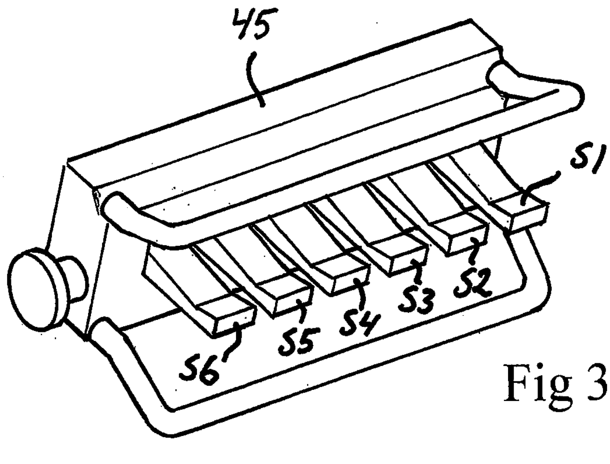
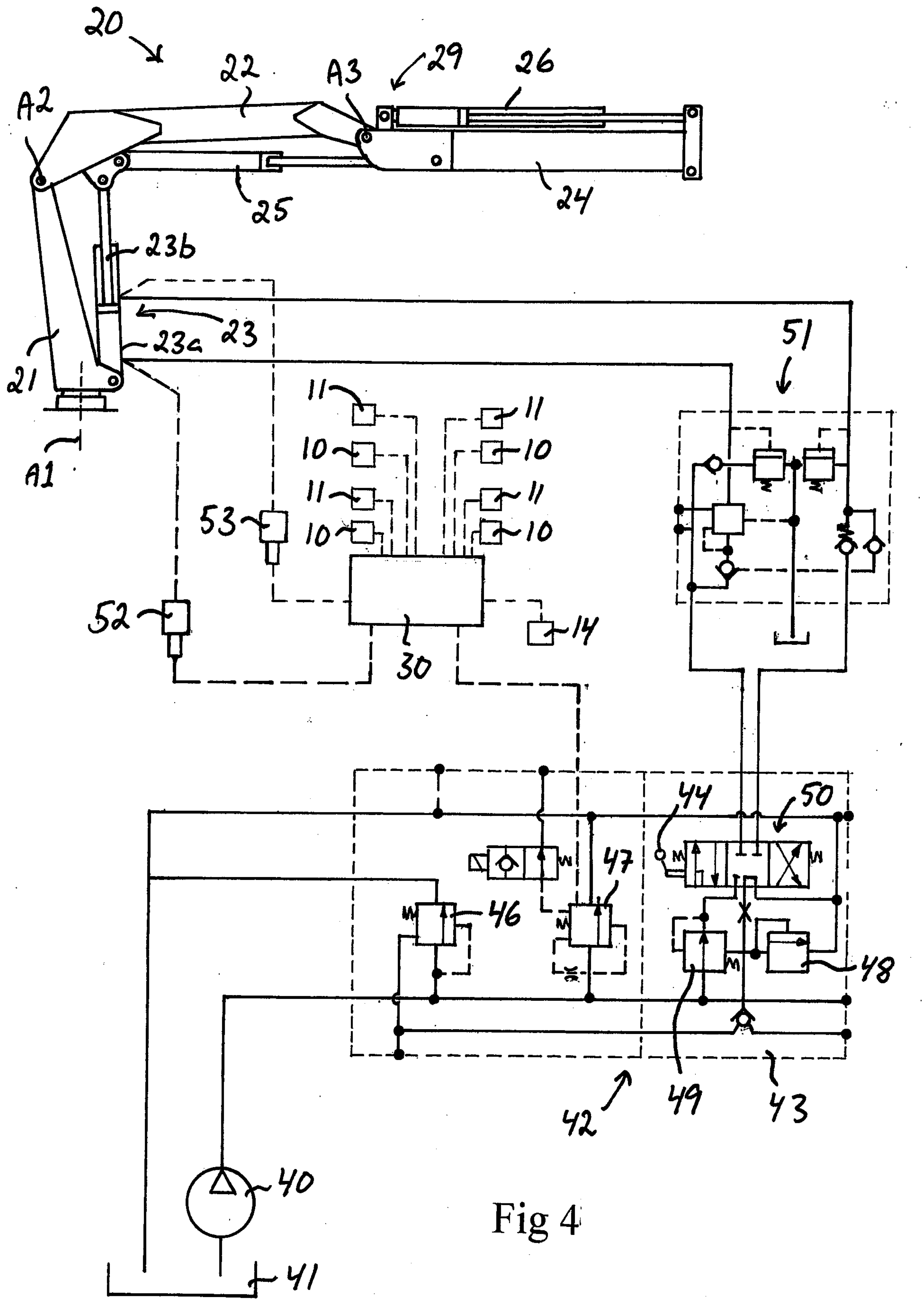

45
S1
S6
S5
S4
S3
S2

Fig 3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A3
29
26
A2
25
24
23b
23
23a
21
A1
51
11
10
11
10
11
10
11
10
53
52
30
14
44
50
47
46
48
42
49
43
40
41

Fig 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 2008074561 A **[0007]**