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(54) Benævnelse: **STYRESYSTEM TIL ET LANDBRUGSKØRETØJSSÆT, SOM OMFATTER EN TRAKTOR OG EN SLÅMASKINE, SLÅMASKINE OG KØRETØJSSÆT**

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CONTROL SYSTEM FOR AN AGRICULTURAL VEHICLE SET COMPRISING A TRACTOR AND A MOWER, MOWER AND VEHICLE SET

The invention relates to a control system for an agricultural tractor-trailer assembly consisting of a towing vehicle and a mower. The invention further relates to a mower and a tractor-trailer assembly. The invention further relates to a method for calibrating a control system.

A device is known from DE 101 40 383 A1 for controlling or regulating the position of an implement which is attached to a three-point mounting device of a tractor, wherein an inclination sensor is provided that is attachable to the tractor, the inclination of the tractor relative to a horizontal plane being measurable using the sensor, and a further inclination sensor is provided on the implement, the inclination of the implement relative to a horizontal plane being measurable using said further sensor, and wherein an open-loop or closed-loop control unit is provided for linking the two inclination sensors, and wherein the compensation for a change in inclination is discontinued by forming a difference between the inclination of the tractor and the inclination of the implement.

It has long been known in practice that when harvested crops, such as grass, are mowed, a mower is attached to an agricultural towing vehicle, in particular a tractor. A combination of an agricultural towing vehicle and a mower is also called an agricultural tractor-trailer assembly. In order to mow the harvested crops to be mowed with sufficient quality, a defined cutting height must be adjusted for mowing elements of the mower. The setting of a cutting height so defined has aways been a complicated process that is prone to error since the driver must get out after every adjustment of the upper link length and measure the cutting height since it cannot be estimated from the vantage point of the cab of the towing vehicle. In particular, difficulties arise in adapting an exactly-defined cutting height for the mowing elements when the agricultural tractor-trailer assembly is being operated at an incline, for example on an uphill or a downhill grade. There is a need to easily and reliably adapt a cutting height for mowing elements of a mower attached to an agricultural towing vehicle, in particular when the agricultural tractor-trailer assembly is being operated at an incline.

WO 2013/02661 A1 discloses a control system for an agricultural towing vehicle which has an attachment attached to the agricultural towing vehicle. This attachment is a cultivator. From WO 2013/026661 A1, it is known that a first angle sensor is mounted on the towing vehicle and a second angle sensor is mounted on the cultivator. Both angle sensors provide measurement values to a control unit of the towing vehicle. An inclination

of the cultivator or of the towing vehicle can be determined as a function of the measurement values of these angle sensors.

Proceeding from this vantage point, the object of the present invention is to provide a novel control system for an agricultural tractor-trailer assembly consisting of a towing vehicle and a mower, a method for calibrating the control system, a mower and a tractor-trailer assembly.

This object is achieved by a control system according to claim 1.

According to the invention, the control system comprises a first inclination sensor which is able to be mounted on the mower and which detects a first inclination angle, a second inclination sensor which is able to be mounted on the towing vehicle and which detects a second inclination angle, and a control unit which receives the first inclination angle from the first inclination sensor and the second inclination angle from the second inclination sensor and which ascertains an actual cutting height of the mower as a function of the actual angle difference between the first inclination angle and the second inclination angle. The invention proposes, for the first time, to ascertain an actual cutting height of the mower, specifically of mowing elements of the mower, as a function of the inclination angles which are detected using two inclination sensors, in fact as a function of the actual angle difference between the two detected inclination angles. In this way, the actual cutting height can be detected and adapted in a simple and reliable way. This is also possible in particular when the tractor-trailer assembly is operated on an uphill or a downhill grade.

It is especially preferable for the control unit to be part of the mower.

According to an advantageous refinement of the control system, the control unit ascertains a manipulated variable by means of which the mower can be displaced relative to the towing vehicle such that the actual angle difference is adapted to a setpoint angle difference and thereby the actual cutting height of the mower is adapted to a setpoint cutting height of the mower. In this way, the actual cutting height can be easily and reliably, as well as automatically, adapted to match the setpoint cutting height of the mower.

According to an advantageous refinement of the control system, the first inclination sensor is part of the mower and is permanently installed on the mower. The second inclination sensor is part of the mower and is removably mountable on the towing vehicle, wherein the second inclination sensor is connected to the mower via a cable, and is displaceable relative to the mower so that it can be mounted on the towing vehicle.

It is especially preferred if both the first inclination sensor and the second inclination sensor are part of the mower. The first inclination sensor is permanently installed on the mower, the second inclination sensor of the mower is connected to the mower via a cable and can be displaced relative to the mower as it hangs on the cable, such that the second inclination sensor can be mounted on the towing vehicle or can be attached easily removably to the towing vehicle. In an attaching procedure, the second inclination sensor can be rapidly and comfortably mounted on or attached to the towing vehicle by the driver. There is no need to permanently install inclination sensors on the towing vehicle. The driver does not have to couple any plug connectors. Such plug connectors can become dirty very fast and are thus subject to faulty operation.

The method for calibrating the control system is defined in claim 4. The mower is defined in claim 5 and the tractor-trailer assembly is defined in claim 9 or claim 10.

According to an advantageous refinement of the mower, the same has a holder for the second inclination sensor, it being possible to mount the second inclination sensor removably to a guide rail of the attachment apparatus of the towing vehicle using the holder. It is preferable for the holder to have magnets and centering discs, wherein the magnets hold the holder on the guide rail, and wherein the centering discs engage with a groove of the guide rail and are matched to the width of the groove. Using such a holding device, the second inclination sensor, which is part of the mower, can be quickly and reliably mounted or attached to the towing vehicle in an orientation which is always repeatably the same.

Preferred refinements of the invention arise from the dependent claims and the following description. Exemplary embodiments of the invention are described here in a non-limiting manner on the basis of the drawings. In the drawings:

Fig. 1 shows a section of an agricultural tractor-trailer assembly consisting of a towing vehicle and a mower;

Fig. 2 shows a detail of Fig. 1 in a perspective view;

Fig. 3 shows a detail of Fig. 1, 2 in a perspective view.

Fig. 1 shows a section of an agricultural tractor-trailer assembly 10 comprising a towing vehicle 11 and a mower 12 attached to the towing vehicle 11. A rear wheel 13, an attachment apparatus 14 designed as a three-point power lifting device, a hitch 15 and a guide rail 16 of the towing vehicle 11 are shown. The attachment apparatus 14 designed as a three-point power lifting device has an upper link 17 and two lower links 18. The three-point power lifting device is also known as a three-point hydraulic system.

The mower 12 includes a mower support frame 19 which has a coupling apparatus 20 for attaching the mower 12 to the attachment apparatus 14 of the towing vehicle 11. The mower 12 may be coupled to the lower links 18 of the attachment apparatus 14 of the towing vehicle 11 by way of a first section 20a of the coupling apparatus 20. The mower 12 may be coupled to the upper link 17 of the attachment apparatus 14 of the towing vehicle 11 by way of a second section 20b of the coupling apparatus 20.

As can be seen from arrow I of Fig. 1, the upper link 17 can be retracted and extended, in particular telescopically. In the retracting and extending of the upper link 17 in the direction of arrow I, the mower 12 is tilted or inclined about an axis 21 designed between the first section 20a of the coupling apparatus 20 and the lower links 18 of the attachment apparatus 14. In the process, the mower 12 is tilted or inclined in the sense of the double arrow II of Fig. 1. If the upper link 17 is further extended, the mower 12 is inclined downward at its rear end. This causes a knife 22a of a mowing element 22 to rotate upward, whereupon the cutting height X increases. If the upper link 17 is further retracted, i.e., shortened, the mower is inclined upward at its rear end, i.e., raised. This causes the knife 22a of the mowing element 22 to rotate downward, whereupon the cutting height X is reduced, and a lower cutting height setting results.

The mower 12 is a disc mower.

Now, in order to simply and reliably be able to adjust the cutting height X of the mower 12, i.e., mowing elements 22 of the mower 12, even when the agricultural tractor-trailer assembly 10 is being operated on an uphill or a downhill grade – in other words when the tractor-trailer assembly 10 is traveling upslope or downslope –, a control system for the agricultural tractor-trailer assembly 10 is proposed, as is a mower, an agricultural tractor-trailer assembly and a method for calibrating the control system.

The control system further includes a first inclination sensor 23.

The first inclination sensor 23 is mounted on the mower 12 and detects a first inclination angle, namely an inclination angle of the mower 12. The first inclination sensor 23 is part of the mower 12 and is permanently installed on the mower 12, in particular on the mower support frame 19.

The control system further includes a second inclination sensor 24.

The second inclination sensor 24 may be mounted to the towing vehicle 11 and detects a second inclination angle. The second inclination sensor 24 is preferably also part of the mower 12 and is removably mountable on the towing vehicle 11. To this end, the second inclination sensor 24, which is part of the mower 12, is connected to the mower 12 via a

cable 25 and is displaceable relative to the mower 12 so that the second inclination sensor 24 may be mounted on the towing vehicle 11.

The control system further consists of a control unit 26 in addition to the two inclination sensors 23 and 24, the control unit being arranged on the mower 12.

The control unit 26 of the mower 12 receives the first inclination angle from the first inclination sensor 23 and the second inclination angle from the second inclination sensor 24. An arrow 27 visualizes the first inclination angle detected by the first inclination sensor 23 as an input variable for the control unit 26, an arrow 28 visualizes the second inclination angle detected by the second inclination sensor 24 as a further input variable for the control unit 26. The control unit 26 is connected to the inclination sensors 23 and 24 for data purposes.

The control unit 26 ascertains an actual angle difference between the first inclination angle of the first inclination sensor 23 and the second inclination angle of the second inclination sensor 24 as a function of the two inclination angles of the two inclination sensors 23, 24, wherein the control unit 26 ascertains an actual cutting height, specifically of the mowing elements 22 of the mower 12, as a function of the geometry of the mower 12. The control unit 26 can output the ascertained actual cutting height as an output variable 29 and transmit it, for example via conventional data interfaces, to a display terminal - for example an ISO Bus terminal - in order to display the actual cutting height to a driver of the towing vehicle 11.

It is also possible for the control unit 26 to compare the ascertained actual angle difference to a setpoint angle difference stored in the control unit 26, and thereby to compare the actual cutting height of the mower 12 to a setpoint cutting height of the same, in order to generate a manipulated variable, for example for the upper link 17 of the attachment apparatus 14 of the towing vehicle 11, the upper link 17 being controllable using said manipulated variable, and the mower 12 being displaceable relative to the towing vehicle 11 such that the actual angle difference is automatically adapted to match the setpoint angle difference, and thereby the actual cutting height of the mower 12 is automatically adapted to match the setpoint cutting height of the mower 12. To perform an automatic adaptation - i.e., to control the upper link 17 using the control unit 26 of the mower, the control unit 26 may be coupled to a corresponding control unit of the towing vehicle 11, or connected to it for data purposes. However, it is also possible to connect the upper link 17 to the oil supply of the mower. In this case, the control unit 26 of the mower can itself directly control the upper link 17 and there is no need for a coupling or

a data connection to a control unit of the towing vehicle 11. Fig. 1 and 2 visualize a manipulated variable of this kind as a further output variable 30 of the control unit 26.

As already explained, the first inclination sensor 23 is permanently attached, in particular on the mower support frame 19 of the mower 12, whereas the second inclination sensor 24 is connected to the mower 12 via the cable 25, and can be displaced relative to the mower 12 in order to mount the second inclination sensor 24 removably on the towing vehicle 11.

In the preferred embodiment shown, the mower 12 includes a holder 31 for the second inclination sensor 24 by means of which the second inclination sensor 24 may be removably mounted on the guide rail 16 of the towing vehicle 11. Here, in the exemplary embodiment shown, the holder 31 for the second sensor 24 includes a first section 31a and a second section 31b. The first section 31a, in the exemplary embodiment shown, is used for mounting to the guide rail 16 of the towing vehicle 11, the second section 31b is used for receiving the second inclination sensor 24. The holder 31 for the second inclination sensor 24 has magnets 32 and centering discs 33. Here, in the exemplary embodiment shown the magnets 32 and centering discs 33 engage with the first section 31a of the holder 31. The magnets 32 and the centering discs 33 may be introduced into a groove 34 of the guide rail 16 of the towing vehicle 11 for mounting purposes (see Fig. 2), wherein the magnets 32 hold the holder 31 and thereby the second inclination sensor 24 on the guide rail 16, and wherein the centering discs 33 are matched to the width of the groove 34 in order to align the holder 31 exactly on the guide rail 16 and to prevent the same from tilting as a result of play between the centering discs 33 and the groove 34 of the guide rail 16. In this way, the second inclination sensor 34 can be quickly and reliably mounted on the towing vehicle 11 in an orientation which is always repeatably the same.

As shown in Fig. 3, the two sections, i.e., parts, 31a and 31b of the holder 31 may be displaced and aligned relative to one another for the second inclination sensor 24, slots 35 which are formed on a tab 36 of the section 31b of the holder 31 being used for this purpose. After loosening the fastening screws which extend through these slots 35, the sections 31a and 31b of the holder 31 may be aligned relative to one another. This allows the holder 31 to be advantageously adapted to the available design space on the towing vehicle 11.

Instead of the guide rail 16, of course a different fixed point on the towing vehicle 11 can be provided which is unchanging for mounting the second inclination sensor 34.

The invention relates to the control system of an agricultural tractor-trailer assembly, as well as the mower, described above.

Furthermore, the invention relates to a tractor-trailer assembly 10 consisting of the towing vehicle 11 and the attached mower 12, wherein the agricultural tractor-trailer assembly 10 contains the control system describe above and the mower 12 is designed as described above.

The invention further relates to a method for calibrating the control system described above. To this end, in a first position of the tractor-trailer assembly 10, first measurement values of the two inclination sensors 23 and 24 are ascertained in order to determine a first angle difference. Then, in a second position of the tractor-trailer assembly 10 which is rotated or turned by 180° relative to the first position of the tractor-trailer assembly 10, second measurement values of the two inclination sensors 23 and 24 are ascertained in order to determine a second angle difference. In the second position, the tractor-trailer assembly is located at the same point as in the first position, but is simply turned or rotated by 180°. The control system can then be calibrated on the basis of these two angle differences, i.e., on the basis of the first and second measurement values. This calibration makes it unnecessary for the tractor-trailer assembly to be on a flat base in order to perform the calibration. It is also not necessary for assemblies of the control system to be exactly aligned relative to one another during the mounting.

List of references

10 Tractor-trailer assembly
11 Towing vehicle
12 Mower
13 Rear wheel
14 Attachment apparatus
15 Hitch
16 Guide rail
17 Upper link
18 Lower link
19 Mower support frame
20 Coupling apparatus
20a Section
20b Section
21 Axis of rotation

22 Mowing element
22a Knife
23 Inclination sensor
24 Inclination sensor
25 Cable
26 Control unit
27 Input variable
28 Input variable
29 Output variable
30 Output variable
31 Holder
31a Section
31b Section
32 Magnet
33 Centering disc
34 Groove
35 Slot
36 Tab

STYRESYSTEM TIL ET LANDBRUGSKØRETØJSSÆT, SOM OMFATTER EN TRAKTOR OG EN SLÅMASKINE, SLÅMASKINE OG KØRETØJSSÆT

Patentkrav

1. Styresystem til en landbrugs-trækkombination (10) bestående af et trækkende køretøj (11) og en slåmaskine (12), som kan tilkobles via en tilkoblingsanordning (20) på en trækstang (18) og på en topstang (17) på en anhængeranordning (14), der er udformet som en trepunkts-lift, på det trækkende køretøj (11).

   med en første hældningssensor (23), der kan monteres på slåmaskinen (12) og registrerer en første hældningsvinkel,

   med en anden hældningssensor (24), der kan monteres på det trækkende køretøj (11) og registrerer en anden hældningsvinkel,

   med en styreenhed (26), der er datateknisk forbundet med hældningssensorerne (23, 24), modtager den første hældningsvinkel fra den første hældningssensor (23) og den anden hældningsvinkel fra den anden hældningssensor (24) og afhængigt af de to hældningsvinkler beregner en målt vinkeldifference mellem den første hældningsvinkel fra den første hældningssensor (23) og den anden hældningsvinkel fra den anden hældningssensor (24),

   kendetegnet ved, at styreenheden (26) afhængigt af den målte vinkeldifference og afhængigt af geometrien på slåmaskinen (12) beregner en målt snithøjde på slåmaskinen (12).

2. Styresystem ifølge krav 1, **kendetegnet ved, at** styreenheden (26) beregner en korrektionsværdi, via hvilken slåmaskinen (12) i forhold til det trækkende køretøj (11) kan forskydes således, at den målte vinkeldifference tilpasses til en reference-vinkeldifference og den målte snithøjde på slåmaskinen (12) tilpasses til en reference-snithøjde på slåmaskinen (12).

3. Styresystem ifølge krav 1 eller 2, **kendetegnet ved, at**

   den første hældningssensor (23) er indrettet til at blive fast monteret på slåmaskinen (12),

   den anden hældningssensor (24) kan monteres løsbart på det trækkende køretøj (11), hvorved den anden hældningssensor (24) er indrettet til at blive bundet fast via

et kabel (25) til slåmaskinen (12) og i forhold til slåmaskinen (12) kan forskydes til montage på det trækkende køretøj (11).

4. Fremgangsmåde til kalibrering af et styresystem ifølge et af kravene 1 til 3, **kendetegnet ved, at**

der i en første position på trækkombinationen (10) beregnes første måleværdier for de to hældningssensorer (23, 24);

der i en i forhold til den første position på trækkombinationen (10) 180° drejet eller vendt anden position på trækkombinationen (10) beregnes anden måleværdier for de to hældningssensorer (23, 24);

styresystemet kalibreres afhængigt af de første og anden måleværdier.

5. Slåmaskine (12),

med et bærestel (19) til slåmaskinen, som har en tilkoblingsanordning (20) til påhægtning af slåmaskinen (12) på en anhængeranordning (14) på et trækkende køretøj (11),

med flere optagne slåenheder (22) på bærestellet (19) til slåmaskinen,

og med et styresystem ifølge et af kravene 1 til 3,

hvorved den første hældningssensor (23) er fast monteret på bærestellet (19) til slåmaskinen;

hvorved den anden hældningssensor (24) kan monteres på det trækkende køretøj (11);

hvorved den anden hældningssensor (24) kan forskydes til løsbar montage på det trækkende køretøj (11) i forhold til bærestellet (19) til slåmaskinen.

6. Slåmaskine ifølge krav 5, **kendetegnet ved**

en holder (31) til den anden hældningssensor (24), via hvilken den anden hældningssensor (24) kan monteres løsbart på en styreskinne (16) på det trækkende køretøj (11).

7. Slåmaskine ifølge krav 6, **kendetegnet ved, at**

holderen (31) har magneter (32) og centreringsskiver (33),

magneterne (32) er indrettet til at holde holderen (31) på styreskinnen (16),

centreringsskiverne (33) er indrette til at gribe ind i en not (34) på styreskinnen (14) og tilpasses til bredden på noten (34).

8. Slåmaskine ifølge krav 7, **kendetegnet ved, at**

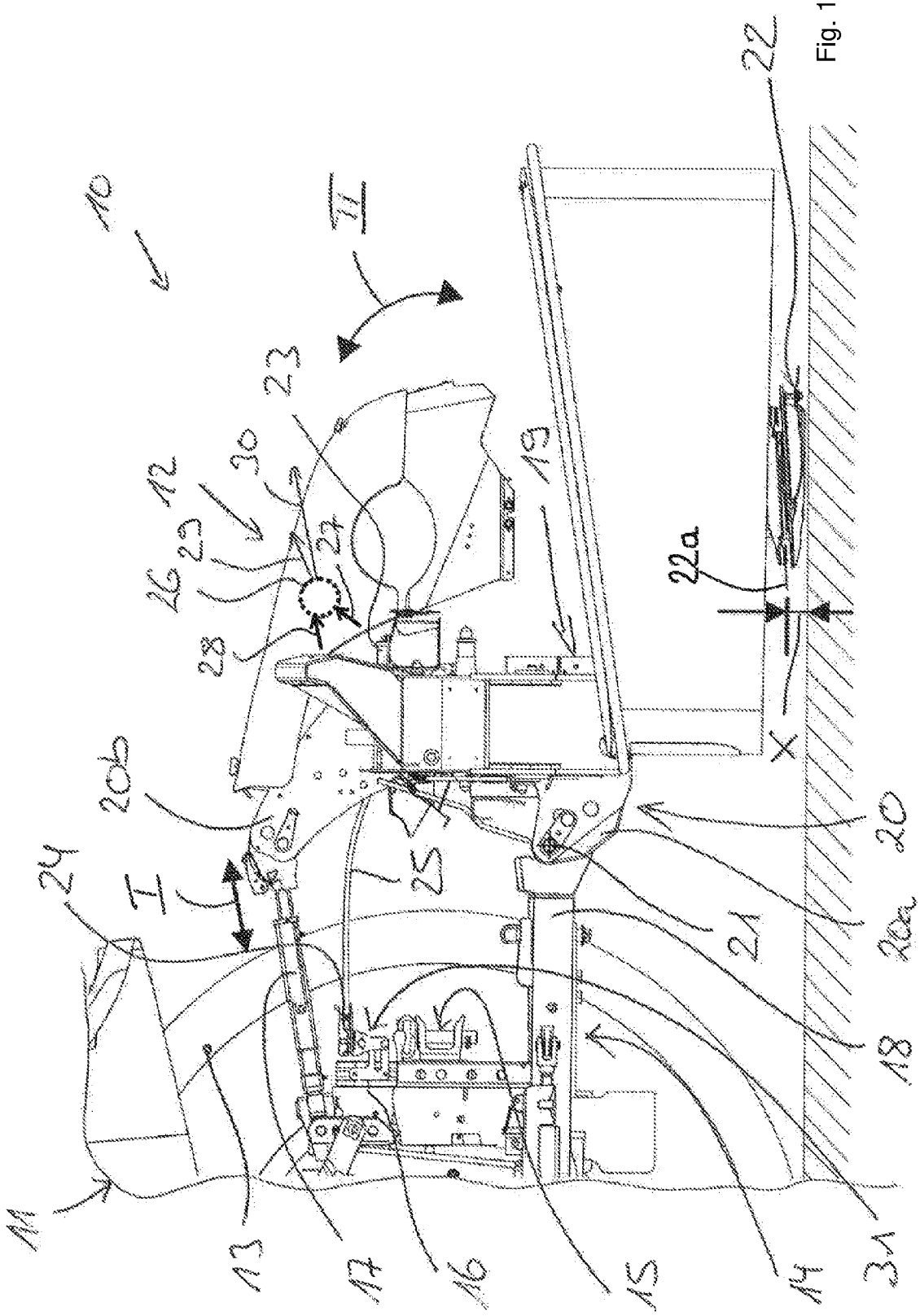
holderen (31) har et afsnit (31b) til optagelse af den anden hældningssensor (24),

holderen (31) har et yderligere afsnit (31a) til optagelse af magneterne (32) og centreringsskiverne (33),

de to afsnit (31a, 31b) kan justeres i forhold til hinanden.

9. Landbrugstrækkombination (10), med et trækkende landbrugskøretøj (11), der især er udformet som en traktor, og en slåmaskine (12), der er påhægtet på det trækkende køretøj (11), **kendetegnet ved** et styresystem ifølge et af kravene 1 til 3.

10. Landbrugstrækkombination (10), med et trækkende landbrugskøretøj (11), der især er udformet som en traktor, og en slåmaskine (12), der er påhægtet på det trækkende køretøj (11), og især trækkombination (10) ifølge krav 9 **kendetegnet ved, at** slåmaskinen er udformet ifølge et af kravene 5 til 8.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20a
20b
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22a
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25
26
27
28
30
31
T
X
Rear

Fig. 1

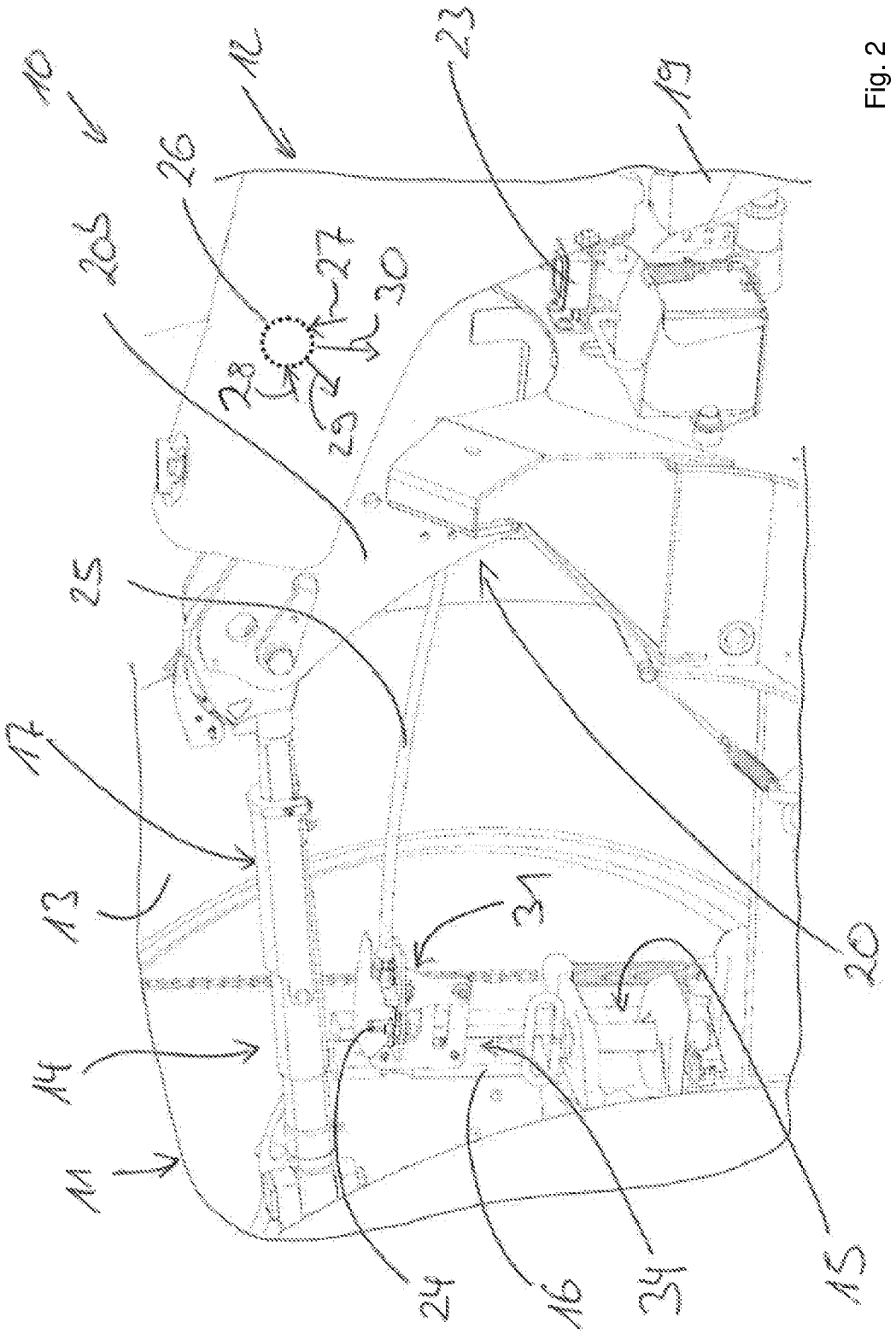

Fig. 2

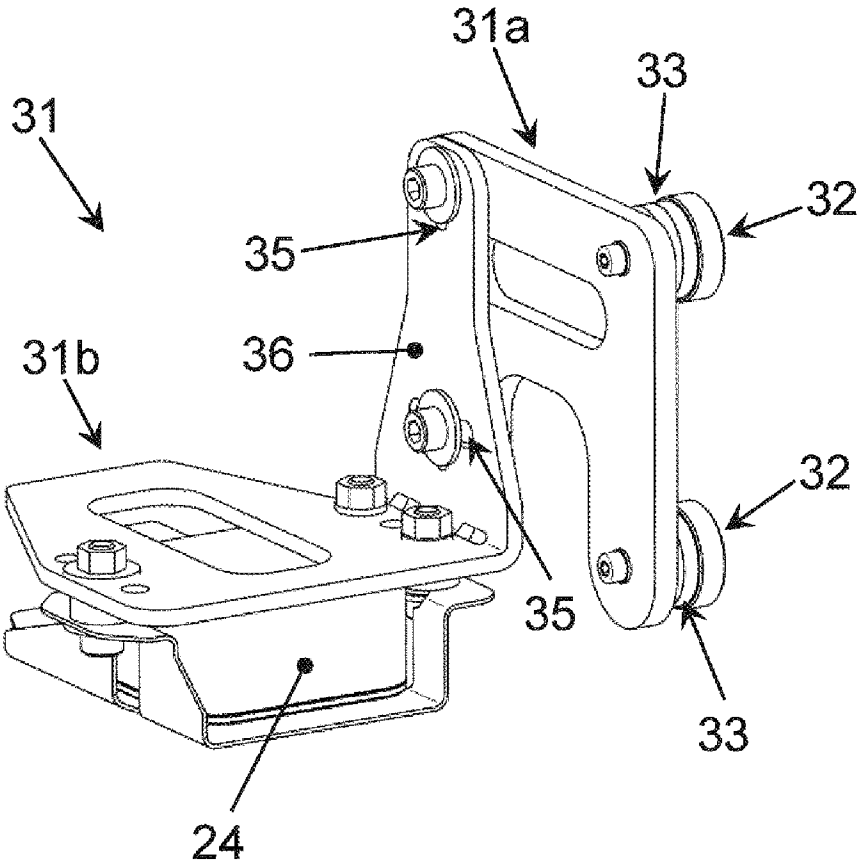

Fig. 3