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(71) Applicant:

**Alois Pöttinger Maschinenfabrik GmbH,
Grieskirchen, AT**

(74) Representative:

**Rechts- und Patentanwälte Lorenz Seidler Gossel,
80538 München**

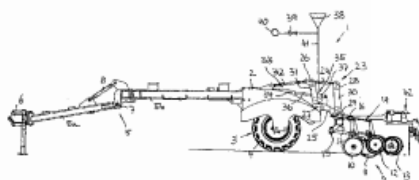
(72) Inventor:

Preimeß, Hans-Jörg, Dipl.-Ing., Lendorf, AT

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(54) Title: **Agricultural Machine**

(57) Summary: The present invention relates to an agricultural machine, in particular a semi-mounted seed drill, with a machine frame supported on the ground by a running gear, and at least one work unit, in particular a sowing unit comprising seed coulter and a depth control roller and/or pressure roller, which is mounted on the machine frame in a vertically adjustable manner, wherein the work unit is mounted in a vertically adjustable manner by a first four-bar linkage on a cross-member, which in turn is mounted in a vertically adjustable manner by a second four-bar linkage on the machine frame. According to the invention, the agricultural machine is characterized in that the second four-bar linkage is formed in such a way that, during lifting movements of the second four-bar linkage, the cross-member undergoes a rotary movement which gives a section of the work unit further away from the running gear a greater lifting movement than a section of the work unit less far away from the running gear.



Description

[0001] The present invention relates to an agricultural machine, in particular a semi-mounted seed drill, with a machine frame supported on the ground by a running gear, and at least one work unit, in particular a sowing unit comprising at least one seed coulter and a depth control roller or pressure roller, which is mounted on the machine frame in a vertically adjustable manner, wherein the work unit is mounted in a vertically adjustable manner by a first four-bar linkage on a cross-member, which in turn is mounted in a vertically adjustable manner by a second four-bar linkage on the machine frame.

[0002] Particularly with seed drills, but also with other agricultural machines in which the work units rest on the ground with a predetermined ground pressure or have to cultivate the ground at a certain depth, the ground adaptation of the work units is an aspect that is difficult to solve, especially if the terrain is hilly with depressions and hills or is otherwise uneven. This problem is exacerbated by work units with a greater engagement length in the direction of travel, as is the case with multi-row sowing units that have several seed coulters staggered one behind another and ground pressure rollers or such, arranged behind or ahead, since here the ground is not touched at one point or line, but at several points one behind the other in the direction of travel. In order to achieve the most even ground pressure possible, even on uneven ground, or a constant penetration depth, various suspensions for the sowing unit with more or less complex kinematics have already been proposed for seed drills. DE 199 47 991 A1, for example, shows a semi-mounted seed drill in which the actual sowing unit with seed coulters and depth control roller is mounted on a cross-member by a first parallelogram-like four-bar linkage, mounted on the semi-mounted frame in a vertically adjustable manner by a second linkage arrangement and can be raised by means of a hydraulic cylinder in order to lift the sowing unit off the ground. The sowing unit runs behind the wheels of the running gear of the semi-mounted frame and protrudes a considerable distance to the rear beyond the contact point of the running gear of the semi-mounted frame. The kinematics are such that, during an upward movement, the front depth control roller is lifted a little more than the seed coulters arranged in the back. Even if a certain degree of ground adaptation can be achieved with the double articulation provided on this seed drill, this reaches its limits on steeply inclined slopes or bumps. A similar seed drill is shown in WO 2006/031182 A1,

in which the actual sowing unit with seed coulter and depth control roller is suspended by a parallelogram-like four-bar linkage on a cross-member, which can be pivoted by an actuator in the form of a threaded spindle or a hydraulic cylinder in order to be able to increase the vertical adjustment range of the sowing unit. Although this makes it possible to better preset the working range to different ground or other parameters, it does not solve the aforementioned problem of ground adaptation to steeper slopes or bumps.

[0003] The present invention is therefore based on the object of creating an improved agricultural machine of the type mentioned at the beginning, which avoids the disadvantages of the prior art and further develops the latter in an advantageous manner. In particular, improved ground adaptation is to be achieved even with coarser ground unevenness.

[0004] According to the invention, this object is achieved by an agricultural machine according to claim 1. Preferred embodiments of the invention are the subject of the dependent claims.

[0005] It is therefore proposed that at least the second four-bar linkage, by which the vertically adjustable cross-member is suspended from the machine frame, is formed differently from the usual parallelogram form in order to achieve a high/low movement of the work unit that is better adapted to inclined ground contours. According to the invention, the second four-bar linkage is formed in such a way that, during lifting movements of the second four-bar linkage, the cross-member undergoes a rotary movement which gives a section of the work unit further away from the undercarriage of the machine frame a greater lifting movement than a section of the work unit less far away from the said undercarriage. The kinematics of the second four-bar linkage is therefore formed in such a way that, in the case of a sowing unit that is arranged to trail the running gear of the machine frame, the part located further back is lifted more than the part located further forward, closer to the running gear. This leads to improved ground adaptation, especially when the running gear of the semi-mounted frame reaches the summit of a more steeply inclined slope or reaches the bottom after crossing a more downwardly inclined bump or slope edge, as in the former case the parts further back that have not yet reached the summit are lowered more, while in the latter case the rear parts that have not yet reached

the bottom are raised even more. Additionally, greater ground clearance is achieved, particularly with regard to the angle of the slope that can be driven on, if the second four-bar linkage is used to lift the work unit mounted on it.

[0006] In a further development of the invention, the said second four-bar linkage is formed to be adjustable in order to make the ground adaptation made possible by this variable. In particular, at least one of the two articulated points of the second four-bar linkage on the machine frame side can be assigned to an adjustable articulated point in order to bring the articulated point into different positions and hold it there. This can be used in particular to adjust the working depth, i.e. to adjust the sowing depth when the agricultural machine is formed as a seed drill.

[0007] Advantageously, the said adjustable articulated point on the machine frame-side of the second four-bar linkage can be adjusted in such a way that the geometry of the second four-bar linkage does not change and the kinematics of the up/down movement effected by the second four-bar linkage in the aforementioned manner are retained. In an advantageous further development of the invention, a guidance device is provided for the adjustable articulated point on the machine frame-side for this purpose, which guides the said articulated point on a circular path around the other articulated point of the second four-bar linkage on the machine frame-side during its adjustment. This articulated point guidance can be formed in different ways, for example, it can consist of a guide groove that acts like a link and in which the said articulated point is displaceable. Advantageously, however, the adjustable articulated point on the machine frame-side is attached to a pivoting arm, pivotably mounted about the other articulated point of the second four-bar linkage on the machine frame-side. This means that there is no change in the geometry of the four-bar linkage itself when the said articulated point on the machine frame-side is displaced; instead, the second four-bar linkage as such is pivoted upwards or downwards, whereby a corresponding working depth adjustment can be achieved. The ground adjustment movement of the cross-member attached to the articulated joint and the work unit attached to it remains unchanged.

[0008] In order to impose a pivoting movement on the cross-member mounted on the second four-bar linkage in the aforementioned manner during up/down movements of

the second four-bar linkage, which raises or lowers different sections of the work unit mounted on it to different degrees in the desired manner, different forms of the four-bar linkage can generally be used. In a particularly simple way, the desired kinematics can be achieved by ensuring that the two articulated points of the second four-bar linkage on the machine frame-side are at a smaller distance from one another than the two articulated points of the second four-bar linkage on the cross-member side. The corresponding links of the four-bar link thus spread slightly, as it were, away from the machine frame towards the cross-member, whereby the desired tilting movement of the cross-member and the work unit attached to it is brought about when the two links of the four-bar linkage are aligned roughly speaking in a central position. Depending on how much the lifting movement is to change over the length of the work unit, the said distance ratio of the articulation points on the machine frame side on the one hand and the articulation points on the cross member side on the other hand can be selected differently. According to an advantageous embodiment of the invention, the said distance between the two articulated points on the machine frame-side of the second four-bar linkage can be approximately in the range of 0.6 to 0.95 times the distance between the two articulated points on the cross-member-side, wherein according to an advantageous embodiment the distance between the two articulated points on the machine frame-side is approximately 0.75 to 0.90 times the distance between the two articulated points on the cross-member-side.

[0009] In order to achieve further improved variability of the ground adaptation, a link of the aforementioned second four-bar linkage, which connects a pivot point on the machine frame side with a pivot point on the cross member side, is formed to be length-adjustable. For this purpose, the link can be telescopic or have a fastening device for one of the pivot points that can be moved in a longitudinal guide. According to a preferred embodiment of the invention, the link can comprise a longitudinally adjustable threaded spindle. Alternatively, a pressure-actuated cylinder unit can also be provided, which can be locked in various positions, for example by blocking the hydraulic inflow and outflow.

[0010] The first four-bar linkage, by means of which the work unit itself is suspended from the adjustable cross-member, can in principle be of different forms. According to a preferred embodiment of the invention, the first four-bar linkage forms at least approxi-

mately a parallelogram, so that the work unit can perform up and down movements relative to the cross member without undergoing any significant rotation.

[0011] In a further development of the invention, the two four-bar linkages are not freely movable or the work unit suspended on the first four-bar linkage is biased downwards towards the ground not only by its own weight. In a further development of the invention, a ground pressure adjusting device and/or spring device is assigned to the first and/or the second four-bar linkage, which applies a certain force, in particular spring force, to the respective four-bar linkage in order to affect, i.e. increase or minimize, the ground pressure of the work unit. To achieve the latter, part of the sowing unit's own weight is absorbed, as it were, while in the opposite case the four-bar linkage is pressed downwards to increase the contact pressure.

[0012] In an advantageous further development of the invention, the force of the ground pressure adjusting device and/or pressure device acting on the first and/or second four-bar linkage is adjustable in order to be able to adjust the necessary ground pressure force to the respective conditions, in particular the ground conditions or the work to be carried out.

[0013] In order to create a particularly compact arrangement with few components, according to an advantageous embodiment of the invention, said ground pressure adjusting device is integrated into an excavation device by means of which the work unit can be excavated from the ground. The said excavation device can in particular have a multi-acting adjusting cylinder unit, which can be acted upon on the one hand by an excavating pressure and on the other hand by a ground contact pressure or ground relief pressure.

[0014] Regarding the form of the aforementioned actuating cylinder unit, an advantageous form may consist of two pressure cylinders, one of which is provided for lifting the work unit into a headland position and/or a transport position and the other for relieving the weight and/or increasing the ground contact pressure of the work unit in the lowered working position guided above the ground, being connected to one another by a common piston rod. The two hydraulic cylinders share a piston rod, as it were, and are each seated on the common piston rod, so that they form a series-connected unit. The two pressure

cylinders are connected to one another by the common piston rod, which can extend and retract into both the one and the other pressure cylinder. Advantageously, by using two such separate pressure cylinders on a common piston rod, commercially available, pre-fabricated cylinders can be used so that no custom-made products are necessary.

[0015] Advantageously, the ground pressure adjusting device and excavation device formed in this way engages with the second four-bar linkage, so that the cross-member carrying the first four-bar linkage and the work unit can on the one hand be lifted into a headland or transport position and on the other hand can only be relieved or pressed downwards by the two-cylinder adjusting cylinder unit in order to ensure the ground pressure in the working position at the desired height.

[0016] The links of the first four-bar linkage, which connects the work unit to the cross-member, are advantageously spring-loaded and/or spring-mounted, so that they can be deflected from a neutral position against a defined spring force. In a preferred embodiment of the invention, the links of the first four-bar linkage can be mounted in rubber suspensions, which form the pivot joint on the cross-member-side of the respective link or are integrated into it.

[0017] The arrangement of the work unit relative to the machine frame can generally be arranged in different ways. According to a preferred embodiment of the invention, the cross-member is arranged behind the running gear of the machine frame, wherein the work unit in turn is preferably arranged behind said cross-member.

[0018] When the agricultural machine is formed as a seed drill, the work unit advantageously comprises at least one seed coulter or a row of seed coulters as well as at least one depth control roller band/or pressure roller, advantageously arranged behind said at least one seed coulter. The depth control roller and/or pressure roller can be subdivided in the manner of a packer roller into individual roller sections which are arranged coaxially to one another. In a preferred embodiment of the invention, several rows of seed coulters can also be arranged offset to one another in the direction of travel, wherein at least one depth control roller or pressure roller is provided.

[0019] The described suspension of the work unit on a semi-mounted implement is particularly advantageous. The machine frame forms a semi-mounted frame supported on the ground by the aforementioned running gear and carries the work unit by the aforementioned two four-bar linkages.

[0020] The invention is explained in more detail below with reference to a preferred embodiment and associated drawings. The drawings show:

[0021] **Fig. 1:** a side view of a semi-mounted seed drill according to a preferred embodiment of the invention in a working position on level ground,

[0022] **Fig. 2:** a side view of the seed drill from **Fig. 1**, wherein the sowing unit is in an upwardly deflected position,

[0023] **Fig. 3:** a side view of the seed drill from the previous Figures, wherein the sowing unit is shown in a downwardly deflected position, and

[0024] **Fig. 4:** an enlarged side view of the sowing unit and the first four-bar linkage supporting it.

[0025] The seed drill **1** shown in the Figures comprises a machine frame **2** supported on the ground by a running gear **3**, which in the illustrated version is single-axle and has wheels **4**. The machine frame **2** can be attached to an undrawn tractor by a drawbar **5** by means of a coupling piece **6** at the front end of the drawbar, which allows the drawbar **5** to pivot about an upright pivoting axle. In the illustrated embodiment, the drawbar **5** also comprises a front drawbar section **5a** connected to a rear drawbar section **5b** so that it can pivot about a horizontal transverse axle **7**, so that the inclination of the machine frame **2** can be adjusted independently of the height of the tractor-side coupling piece by bending the drawbar about the transverse axle **7** by means of an actuator **8**.

[0026] A sowing unit **9** is attached to the rear end of the machine frame **2** and is arranged behind the running gear **3**. Although not shown in the drawings, at least one further work unit, such as a disk harrow or the like, can be provided in front of the running

gear **3** and mounted on the machine frame **2**.

[0027] In the embodiment shown, the said sowing unit **9** comprises two rows of seed coulters **10** and **11** arranged one behind the other, each of which is associated with trailing depth control rollers **12** and **13**. A soil post-processing device in the form of a harrow **42** is also provided behind the depth control rollers **12** and **13**.

[0028] The sowing unit **9** is articulated by a first four-bar linkage **14** to a cross-member **15** trailing the running gear **3**, so that the sowing unit **9** can move up and down relative to the cross-member **15**. As shown in Fig. 1 and Fig. 4, the first four-bar linkage **14** is essentially formed in the shape of a parallelogram. It comprises two approximately parallel, horizontally arranged links **16** and **17** which slope slightly backwards in an undeflected operating position and which are articulated on the one hand to the cross-member **15** at a respective cross member-side articulation point **18** or **19** (see Fig. 4) so that they can pivot about horizontal transverse axle and on the other hand are connected to a seed coulter carrier **22** at articulated points **20** or **21** on the coulter carrier-side so that they can pivot about horizontal transverse axle, to which the seed coulters, the depth control rollers and the harrow device are attached.

[0029] As shown in Fig. 4, the articulated points **19** and **21** of the lower link **17** are formed as rubber articulated suspensions which can be rotationally deflected from an initial position in both directions and thereby generate elastic restoring forces back to the initial position. The rubber suspensions mentioned thus form a spring device which acts on the first four-bar linkage **14** and attempts to return it to an initial position when it has been deflected. In addition, the rubber suspensions mentioned naturally also form a damping device which can dampen shocks introduced to the seed coulters or the depth control rollers.

[0030] The cross-member **15**, to which the first four-bar linkage **14** is attached, is, as shown in Fig. 1, articulated to the machine frame **2** by a second four-bar linkage **23**. This second four-bar linkage **23** has a geometry that differs from a parallelogram. In the embodiment shown, the two links **24** and **25** of the second four-bar linkage **23** are arranged in a slightly diverging manner toward the sowing unit **9**. The two articulated points **26** and

27 on the machine frame-side, to which one of the links **24** and **25** is articulated, are slightly closer to one another than the two articulated points **28** and **29** on the cross-member-side, which are provided on a cross-member arm **30** that is connected in a rotationally fixed manner to the cross-member **15**. The two links **24** and **25** have a comparable, i.e. approximately equal, length, but one of the two links - in the illustrated version, the upper link **24** - is formed to be length-adjustable in order to enable the geometry of the second four-bar linkage to be adjusted. The two links **24** and **25** are - roughly speaking - arranged in a horizontal position, with them sloping slightly backwards in the undeflected working position, wherein the lower link **25** is in turn arranged so as to slope more down.

[0031] In order to be able to adjust the working depth without changing the geometry of the four-bar linkage **23**, the upper articulated point **26** on the machine frame-side is adjustable. As shown in **Fig. 1**, the upper articulated point **26** on the machine frame-side is provided on a pivoting arm **31**, pivotably connected to the machine frame **2** about a transverse axle aligned with the lower articulated point **27** on the machine frame-side. As a result, the upper articulated point **26** on the machine frame-side can be pivoted on a circular path about the lower articulated point **27** on the machine frame-side. For this purpose, an actuator **32** is provided pivotably attached to the pivoting arm **31** and on the other hand to the machine frame **2** and in the illustrated embodiment consists of a screw spindle of which the length can be adjusted. If the actuator **32** is shortened, the second four-bar linkage **23** is pivoted with the geometry otherwise unchanged in such a way that the cross-member **15** is slightly lifted. Conversely, the cross-member **15** can be lowered by extending the actuator **32**.

[0032] To excavate the sowing unit **19**, an excavation device **33** is provided which comprises a pressure cylinder **34** which acts on the machine frame **2** on the one hand and on one of the links **25** of the second four-bar linkage **23** on the other hand in order to pivot the four-bar linkage upwards and thus lift the sowing unit **9** from the ground.

[0033] A ground pressure adjusting device **35** is also integrated into the excavation device **33**, which comprises a pressure cylinder **37**, which advantageously sits on the same piston rod **36** as the pressure cylinder **34** of the excavation device **33**. The two pressure

cylinders **34** and **37** are located on opposite ends of the common piston rod **36** and each can be formed as single-acting cylinders.

[0034] The pressure cylinder **37** controlling the ground contact pressure can advantageously be connected, as shown in **Fig. 1**, to a pressure accumulator **38**, which applies a corresponding pressure to the pressure cylinder **37** in order to achieve the desired level of ground contact pressure of the sowing unit **9**. The pressure prevailing in the pressure accumulator **38** or the pressure circuit connected to it can advantageously be adjusted. This can be achieved, for example, by a pump **40** that can be connected by a valve **39**.

[0035] This results in the following function: In the operating position shown in **Fig. 1** on level ground, the sowing depth of the sowing unit **9** can be adjusted by changing the length of the actuator **32** and/or by changing the length of the upper link **24** of the second four-bar linkage **23**. The ground contact pressure can be varied by adjusting the preload pressure in the pressure cylinder **38**.

[0036] As shown in **Fig. 2**, the sowing unit **9** can pivot upwards relative to the machine frame **2** when driving into a ground depression in order to follow the sloping contour of the ground depression. Advantageously, when the second four-bar linkage **23** pivots upwards, which occurs in particular when crossing larger uneven surfaces, the part of the sowing unit **9** further back, formed by the depth control rollers **12** and **13**, is raised more than the part of the sowing unit **9** further in front, formed by the seed coulters **10** and **11**.

[0037] Conversely, the sowing unit **9** can sink relative to the machine frame **2** when driving onto a ground elevation. In this case, the back of the sowing unit **9** is lowered more than the front part of the sowing unit **9**, thereby achieving an overall improved adaptation to the ground.

[0038] The combination of the first four-bar linkage **14**, which is essentially formed like a parallelogram, with the second four-bar linkage **23**, which deviates from the parallelogram shape, proves to be advantageous in this case. Smaller ground adjustments can be made by pivoting the first four-bar linkage **14**, whereby the sowing unit **9** is raised and lowered evenly. If, however, larger uneven ground is crossed, the adjustment movement

by the second four-bar linkage **23** is added, which provides for an increased raising or lowering of the rear sowing unit section as mentioned.

Claims

1. Agricultural machine, in particular a semi-mounted seed drill, with a machine frame (**2**) supported on the ground by a running gear (**3**), and at least one work unit (**9**), in particular a sowing unit comprising a seed coulter (**10, 11**) and a depth control roller and/or pressure roller (**12, 13**), which is mounted on the machine frame (**2**) in a vertically adjustable manner, wherein the work unit (**9**) is mounted in a vertically adjustable manner by a first four-bar linkage (**14**) on a cross-member (**15**), which in turn is mounted in a vertically adjustable manner by a second four-bar linkage (**23**) on the machine frame (**2**), **characterized in that** the second four-bar linkage (**23**) is formed in such a way that, during lifting movements of the second four-bar linkage (**23**), the cross-member (**15**) undergoes a rotary movement which, in the working position, gives a section of the work unit (**9**) further away from the running gear (**3**) a greater lifting movement than a section of the work unit (**9**) less far away from the running gear (**3**).
2. Agricultural machine according to the preceding claim, wherein the second four-bar linkage (**23**) has a geometry deviating from the parallelogram shape.
3. Agricultural machine according to any one of the preceding claims, wherein the two articulated points (**26, 27**) of the second four-bar linkage (**23**) on the machine frame-side have a smaller distance from one another than the two articulated points (**28, 29**) of the second four-bar linkage (**23**) on the cross-member-side.
4. Agricultural machine according to the preceding claim, wherein the distance between the two articulated points (**26, 27**) on the machine frame-side corresponds to approximately 0.6 to 0.95 times, preferably approximately 0.75 to 0.90 times the distance between the two articulated points (**28, 29**) on the cross-member-side.

5. Agricultural machine according to any one of the preceding claims, wherein at least one of the two articulated points **(26, 27)** of the second four-bar linkage **(23)** on the machine frame-side is formed to be adjustable and/or can be brought into different positions and fixed by an actuator **(32)**.
6. Agricultural machine according to the preceding claim, wherein the adjustable articulated point **(26)** is guided on an arc of a circle around the other articulated point **(27)** of the second four-bar linkage **(23)** on the machine frame-side by an articulated point guide, in particular a pivoting arm **(31)** which can be rotated about the other articulated point **(27)** of the second four-bar linkage **(23)** on the machine frame-side.
7. Agricultural machine according to any one of the preceding claims, wherein at least one link **(24)** of the second four-bar linkage **(23)**, which connects one machine frame-side articulated point **(26)** with a cross-member-side articulated point **(28)** of the second four-bar linkage **(23)**, is formed to be length-adjustable.
8. Agricultural machine according to any one of the preceding claims, wherein the first four-bar linkage **(14)** forms at least approximately a parallelogram.
9. Agricultural machine according to any one of the preceding claims, wherein the first and/or the second four-bar linkage **(14; 23)** can be acted upon by a ground pressure spring and/or ground pressure adjusting device **(35)** the spring force and/or hardness of which is formed to be adjustable.
10. Agricultural machine according to the preceding claim, wherein the ground pressure spring and/or ground pressure adjusting device **(35)** is integrated into a excavation device **(33)** for excavating the work unit **(9)**.
11. Agricultural machine according to the preceding claim, wherein the excavating device **(33)** and the ground pressure spring and/or ground pressure adjusting device **(35)** have a common multiple-action actuating cylinder unit which on the one hand can be

acted upon by an excavating pressure and on the other hand by a ground contact pressure.

12. Agricultural machine according to the preceding claim, wherein the actuating cylinder unit comprises a first pressure cylinder (34) for excavating the work unit (9) and a second pressure cylinder (37) for affecting the ground contact pressure of the work unit (9), which are connected to one another by a common piston rod (36).

13. Agricultural machine according to the preceding claim, wherein the pressure cylinder (37) for affecting the ground contact pressure can be connected by a pressure circuit (41) to a pressure accumulator (38) which has a filling/relief connection (39) which can be shut off by a shut-off valve and has connection means for connection to a hydraulic pressure supply on the tractor side.

14. Agricultural machine according to claim 12, wherein the pressure cylinder (37) can be connected to a controllable pressure supply for affecting the ground contact pressure, a sensor device for detecting an actual value of the ground contact pressure of the work unit (9) is provided and the pressure supply can be controlled by an electronic control device as a function of a signal from the sensor device.

There are 4 subsequent pages of drawings

Appended Drawings

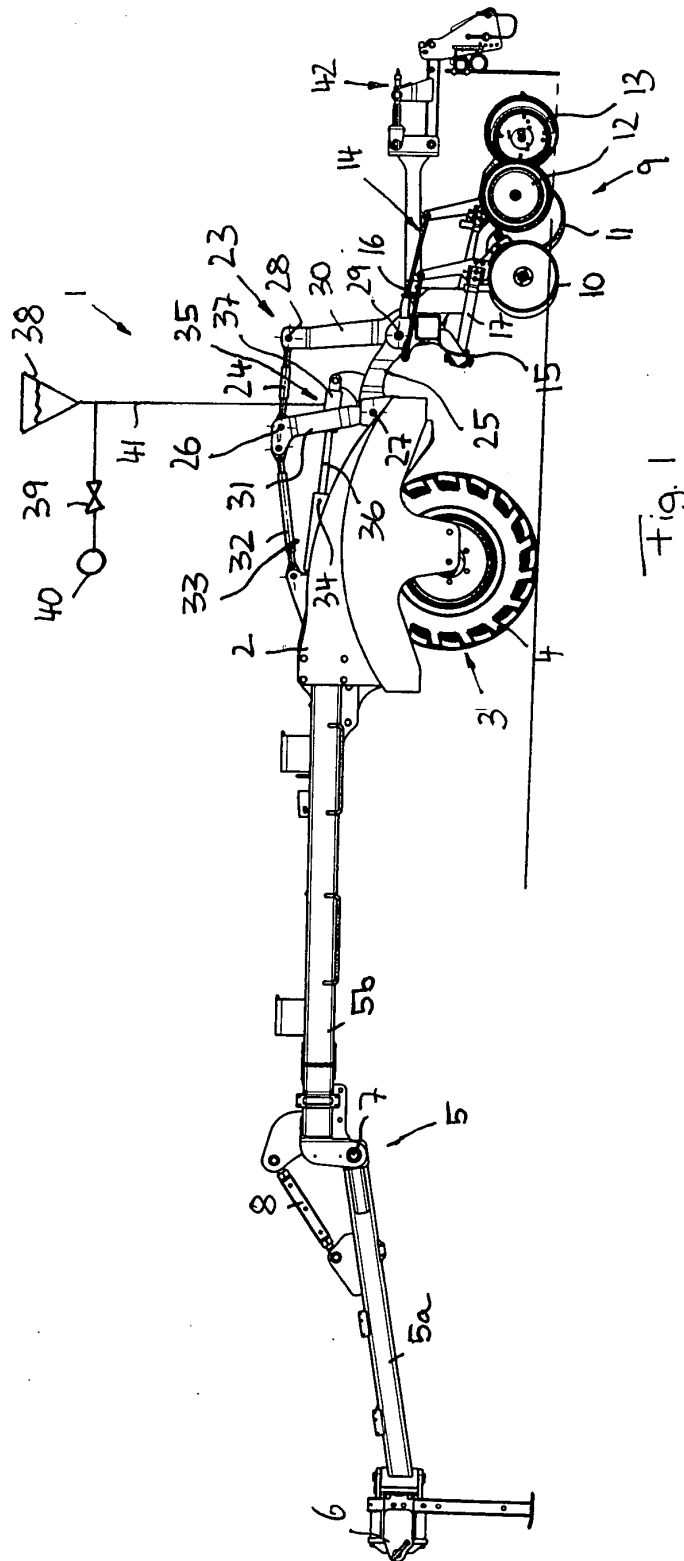


Fig. 1

