(19) DANMARK

(10) **DK/EP 4256917 T3**

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: ***A 01 B 63/11 (2006.01)*** ***E 02 F 9/22 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2025-03-10**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2024-12-25**

(86) Europæisk ansøgning nr.: **23166672.8**

(86) Europæisk indleveringsdag: **2023-04-05**

(87) Den europæiske ansøgnings publiceringsdag: **2023-10-11**

(30) Prioritet: **2022-04-07 FR 2203199**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **LANDBRUGSMASKINE MED SIKRINGSSYSTEM**

(56) Fremdragne publikationer:
EP-A1- 2 316 256
DE-U1- 202012 000 880
FR-A1- 2 923 349

Description

Title of the invention: Haymaking machine with a safety system

[0001] The present invention relates to the field of agricultural machinery and in particular agricultural haymaking machines.

[0002] The invention relates more specifically to an agricultural machine intended to be coupled to a tractor vehicle and comprising a work unit connected to a chassis of the tractor vehicle relative to which the work unit can be moved, the machine being able to take up a work configuration in which the work unit rests at least partially on the ground and a transport configuration in which the work unit is raised from the ground. The machine comprises a lightening device having at least one lightening cylinder connected to the chassis by a flexible compression tie-rod on one side and to the work unit at a front articulation on the other side, the lightening cylinder being able to transfer, in the work configuration, at least some of the weight of the work unit onto the chassis, the flexible compression tie-rod being attached with the lightening cylinder at an anchoring point and with the chassis at a fastening point.

[0003] A machine of the type mentioned in the introduction is known from document EP2316256. On this machine, the distance between the fastening point and the front articulation is greater in the work configuration than in the transport configuration. When lifting the machine to move to the transport configuration in particular, the lightening cylinder reaching the travel limit, after a certain time, no longer transfers, even partially, the weight of the work unit onto the chassis, such that the flexible compression tie-rod relaxes, gravity then causing the lightening cylinder to pivot about the front articulation. Depending on the model of the tractor vehicle, the shape and height of the fastening points may vary such that if the lightening cylinder has not retracted, or not completely, when the lightening cylinder is pivoted about the front articulation, the anchoring point may move closer to the tractor vehicle. In some cases, the lightening cylinder, respectively the anchoring point,

may then hit the tractor vehicle, causing damage to the vehicle and/or the machine.

[0004] The main objective of the present invention is to overcome at least partially the above-mentioned problem, and in particular avoid damaging the machine and the tractor vehicle.

[0005] Thus, the invention relates to an agricultural machine intended to be coupled to a tractor vehicle and comprising at least one work unit connected to a chassis of the tractor vehicle relative to which the work unit can be moved, the machine being able to take up a work configuration in which the work unit rests at least partially on the ground and a transport configuration in which the work unit is raised from the ground. The machine comprises a lightening device having at least one lightening cylinder connected to the chassis by a flexible compression tie-rod on one side and to the work unit at a front articulation on the other side, the lightening cylinder being able to transfer, in the work configuration, at least some of the weight of the work unit onto the chassis, the flexible compression tie-rod being attached with the lightening cylinder at an anchoring point and with the chassis at a fastening point, the machine being characterized in that at least one deflection system makes it possible to move the lightening cylinder by pivoting the anchoring point about the front articulation so as to move the anchoring point away from the midplane of the work unit.

[0006] The invention will be better understood from the following description, which refers to a preferred embodiment given as a non-limiting example and explained with reference to the attached schematic drawings, in which:

[0007] [Fig. 1] is a side elevation view of an agricultural machine according to the invention, coupled to the front of a tractor vehicle and in the work configuration;

[0008] [Fig. 2] is a perspective view of the object shown on Figure 1,

[0009] [Fig. 3] is a side elevation view of an agricultural machine according to the invention, coupled to the front of a tractor vehicle and in the transport configuration,

[0010] [Fig. 4] represents a partial view of a machine according to the invention, coupled to the front of a tractor vehicle not shown, seen from the rear, some components of the machine having been concealed,

[0011] [Fig. 5A] symbolically represents a hydraulic circuit of the lightening device of the machine according to the invention,

[0012] [Fig. 5B] symbolically represents another possible hydraulic circuit of the machine according to the invention, and,

[0013] [Fig. 5C] symbolically represents yet another possible hydraulic circuit of the machine according to the invention.

[0014] Figures 1 et 2 show an agricultural machine (1) intended to be coupled to a tractor vehicle (15). The machine (1) comprises a work unit (3) connected to a chassis (2) of the tractor vehicle (15) relative to which the work unit (3) can be moved. The machine (1) can take up a work configuration in which the work unit (3) rests at least partially on the ground (S). The machine (1) can also take up a transport configuration in which the work unit (3) is raised from the ground (S). The machine (1) comprises a lightening device (9) having at least one lightening cylinder (5) connected to the chassis (2) by a flexible compression tie-rod (17) attached with the lightening cylinder (5) on one side. The lightening cylinder (5) is connected to the work unit (3) at a front articulation (20) on the other side. The lightening cylinder (5) can transfer, in the work configuration, at least some of the weight of the work unit (3) onto the chassis (2). The flexible compression tie-rod (17) is attached to the lightening cylinder (5) at an anchoring point (24). The flexible compression tie-rod (17) is attached to the chassis (2) at a fastening point (18). The fastening point (18) is located higher than the front articulation (20) in the work configuration of the machine (1).

[0015] In the embodiment shown on Figure 1, the anchoring point (24) is located at the rear end of the lightening cylinder (5), at least in the work configuration. As shown on Figures 1 and 3, the distance between the fastening point (18) and the front articulation (20) is greater in the work configuration than in the transport configuration. In the work configuration, since the lightening cylinder (5) exerts a traction force between the work unit (3) and the chassis (2),

the flexible compression tie-rod (17) is taught. In the transport configuration, the distance between the fastening point (18) and the front articulation (20) is such that the flexible compression tie-rod (17) is relaxed. Thus, in the transport configuration, the lightening cylinder (5) does not transfer some of the weight of the work unit (3) onto the chassis (2). In fact, when changing from the work configuration to the transport configuration, as soon as the lightening cylinder (5) no longer transfers force between the work unit (3) and the chassis (2), the lightening cylinder (5) is only subjected to the force due to its weight. When changing from the work configuration to the transport configuration, the lightening cylinder (5) then pivots downwards about the front articulation (20), and, since the distance between the fastening point (18) and the front articulation (20) decreases, the anchoring point (24) could hit the chassis (2).

[0016] According to the invention, at least one deflection system (25) can be used to move the lightening cylinder (5) by pivoting the anchoring point (24) about the front articulation (20) so as to move the anchoring point (24) away from the midplane (PM) of the work unit (3).

[0017] Thanks to these arrangements, when the machine (1) is raised, for example when changing from the work configuration to the transport configuration, the lightening cylinder (5) is thus pivoted in such a way that it does not hit the chassis (2), respectively the tractor vehicle (15), even if it remained extended. Pivoting the anchoring point (24) outwards about the front articulation (20) amounts to moving the anchoring point (24) away from the midplane (PM) of the work unit (3). In particular as it moves from the work configuration to the transport configuration, the deflection system (25) thus makes it possible to move the lightening cylinder (5) by moving the anchoring point (24) away from a midplane (PM) of the work unit (3). Thus, the deflection system (25) advantageously prevents damage to the tractor vehicle (15) and the machine (1). Pivoting the anchoring point (24) outwards also makes it possible to prevent contact between the anchoring point (24) and the upper arm (44) of the coupling device (16). In addition, if the machine (1) has two lightening cylinders (5), in particular mounted symmetrically with respect to the midplane (PM), pivoting the respective anchoring points (24)

outwards makes it possible to prevent the lightening cylinders (5) from colliding with each other.

[0018] Preferably, the lightening device (9) comprises a pressure control valve (6) connected to an active chamber (5') of the lightening cylinder (5) by a first pipe (7), the pressure control valve (6) taking up, when the pressure in the first pipe (7) is less than a set value, a first position (61) in which it allows hydraulic fluid to flow between the first pipe (7) and a second pipe (8) connecting the pressure control valve (6) to a hydraulic pump (P) in the work configuration of the machine (1), the pressure control valve (6) taking up, when the pressure in the first pipe (7) is greater than the set value, a second position (62) in which it allows hydraulic fluid to flow between the first pipe (7) and a third pipe (11) connecting the pressure control valve (6) to a tank (T) in the work configuration of the machine (1). Thus, the pressure in the active chamber (5') is kept constant, resulting in constant lightening and involving better work quality as well as less damage to the plant cover, without the need for a hydropneumatic pressure accumulator. Furthermore, since fluid is only injected in the first position (61) of the pressure control valve (6), the lightening device (9) does not permanently require the use of the pump (P), thus reducing the power required to operate the machine (1). Indeed, in the second position (62) of the pressure control valve (6), the pump (P) does not have to supply pressure to the lightening device (9), fluid being thus less likely to heat up, thereby retaining its properties for a longer period of time, and reducing the risk of lowering the performance of the machine (1) as well as the necessary oil change frequency.

[0019] When the machine (1) is operating, it is moved by the tractor vehicle (15) in a direction of advance (A). According to the preferred embodiment shown on Figures 1 to 3, the machine (1) comprises a frame (1'). The frame (1') carries the work unit (3). The frame (1') is configured to connect the work unit (3) to the chassis (2). In the preferred embodiment, the chassis (2) is an integral part of the tractor vehicle (15). In the preferred embodiment, the work unit (3) is articulated with the frame (1') at least about a pendular axis (AP) substantially parallel to the direction of advance (A). In a simple manner, the pendular axis (AP) is advantageously located in the midplane (PM) of

the work unit (3). In an alternative embodiment, the work unit (3) is not articulated, such that the frame (1') is part of the work unit (3).

[0020] The work unit (3) is connected to the chassis (2) by two lower arms (4, 4') and one upper arm (44). The machine (1), respectively the frame (1'), comprises two lower hitching points (14, 14') making it possible to hitch the lower arms (4, 4'). The midplane (PM) of the work unit (3) is equidistant from the lower hitching points (14, 14'). The machine (1) also comprises an upper hitching point (14") making it possible to hitch the upper arm (44) to the machine (1). In the preferred embodiment, it is the frame (1') of the machine (1) which comprises the hitching point (14") making it possible to hitch the upper arm (44) to the machine (1). The midplane (PM) passes through the upper hitching point (14"). The midplane (PM) is vertical when the machine (1) is on horizontal ground (S). In addition, the midplane (PM) is parallel to the direction of advance (A). At least one of the lower arms (4, 4') is connected to the chassis (2) by a lifting cylinder (4"). The tractor vehicle (15) comprises a coupling device (16). The coupling device (16) comprises at least two lower arms (4, 4'), an upper arm (44) and a lifting cylinder (4"). Each arm (4, 4', 44) is articulated with the work unit (3) on one side, and with the chassis (2) on the other side, at least about substantially horizontal axes, allowing the vertical displacement of the work unit (3) relative to the chassis (2). Preferably, the upper arm (44) and each lower arm (4, 4') is articulated with the work unit (3) by a ball joint at the respective hitching point (14, 14', 14").

[0021] The lightening cylinder (5) is connected, directly or indirectly, to the chassis (2) on one side. In other words, the chassis (2) is connected, directly or not, either to the rod or to the body of the lightening cylinder (5). The lightening cylinder (5) is connected to the work unit (3) on the other side. In other words, the work unit (3) is connected to that one of the cylinder rod or body of the lightening cylinder (5) which is not connected to the chassis (2). According to an alternative embodiment not shown, the lightening cylinder (5) can also be connected to the chassis (2) on one side and to the work unit (3) via the coupling device (16), respectively via one of the arms (4, 4', 44).

[0022] Preferably, the second pipe (8) is connected to the hydraulic circuit of the tractor vehicle (15) via a control valve (19). The control valve (19) is preferably part of the tractor vehicle (15). The hydraulic circuit of the tractor vehicle (15) comprises the pump (P) and the tank (T). In the work configuration of the machine (1), the control valve (19) is in a first position (191). In its first position (191), the control valve (19) connects the second pipe (8) to the pump (P).

[0023] In the embodiment shown on Figure 5B, the third pipe (11) is also connected to the hydraulic circuit of the tractor vehicle (15) via the or a control valve (19). On this figure, in its first position (191), the control valve (19) connects the third pipe (11) to the tank (T). In the embodiment shown on Figure 5B, an operating error of the control valve (19) can lead not only to the lightening cylinder (5) no longer exerting an upward force on the work unit (3), such that the work unit (3) is more likely to damage the plant cover of the ground (S), but also to the or each lightening cylinder (5) coming into contact with the tractor vehicle (15), thus damaging the tractor vehicle (15) and/or the lightening cylinder (5).

[0024] In the preferred embodiment shown on Figure 5C, the third pipe (11) is connected directly to the or a tank (T). As a result, a user cannot connect the third pipe (11) to the pump (P), even in case of incorrect operation of the control valve (19). Thus, in the preferred embodiment, there is never any pressure in the third pipe (11).

[0025] According to the embodiment shown on Figure 5B, the second pipe (8) and the third pipe (11) are connected to the hydraulic circuit of the tractor vehicle (15) via a control valve (19). In the work configuration of the machine (1), the control valve (19) is in a first position (191). In the present description, unless indicated otherwise, the control valve (19) must be considered as being in the first position (191) and the machine (1) in the work configuration. The control valve (19) is, for example, a selective distribution slide valve, that can preferably be actuated from the tractor vehicle (15).

[0026] In order to be able to bring the pressure in the hydraulic circuit of the lightening device (9), respectively in the hydraulic circuit of the machine (1), to atmospheric pressure, the control valve (19) can be placed in a floating

position (192). In its floating position (192), the control valve (19) makes it possible to connect the second pipe (8) to the tank (T). In the floating position (192), the control valve (19) also connects the tank (T) and the third pipe (11), if any.

[0027] In the work configuration of the machine (1), the lifting cylinder (4") is in floating mode. In floating mode, the length of the cylinder can vary when the cylinder is subjected to external forces. The floating mode of the lifting cylinder (4") allows the work unit (3) to move relative to the chassis (2) depending on the relief of the ground (S). Preferably, placing the lifting cylinder (4") in floating mode amounts to connecting its chambers to the tank (T).

[0028] The active chamber (5') of the lightening cylinder (5) can be connected to the or a hydraulic pump (P). The active chambre (5') of the lightening cylinder (5) can also be connected to the or a tank (T). When the active chamber (5') of the lightening cylinder (5) is connected to the pump (P), the lightening cylinder (5) exerts on the frame (1'), respectively on the work unit (3), a force of which at least one component is directed upwards, at least after a certain period of time. The force of the lightening cylinder (5) exerted on the work unit (3) depends on the pressure in the active chamber (5'). Once the set value has been reached in the active chamber (5'), the pressure control valve (6) keeps the pressure in the active chamber (5') constant in the work configuration, such that the lightening cylinder (5) exerts on the work unit (3) a constant force, of which at least one component is directed upwards. On Figure 1, the work unit (3) is therefore only resting partially on the ground (S), since some of the weight of the machine (1) is transferred onto the chassis (2), respectively onto the front axle of the tractor vehicle (15).

[0029] In the transport configuration, as shown on Figure 3, the work unit (3) is raised from the ground (S). The work configuration can be obtained, from the transport configuration, by connecting the active chamber (5') to the tank (T) and by extending the lifting cylinder (4") until the work unit (3) reaches the ground (S), after which the lifting cylinder (4") must be placed in floating mode, and then the active chamber (5') connected to the pump (P). However,

with such a transposition method between the transport and work configurations, the machine (1) reaches the ground (S) violently, which may damage the machine (1) and/or the plant cover of the ground (S). The work configuration is thus preferably obtained, from the transport configuration, by placing the lifting cylinder (4") in floating mode until the work unit (3) reaches the ground (S), and by connecting the active chamber (5') to a pump (P). In order to benefit from a certain stroke of the lightening cylinder (5) when the work unit (3) moves up and down relative to the tractor vehicle (15) from a reference position, the active chamber (5') of the lightening cylinder (5) is connected to the pump (P) when the machine (1) and the tractor vehicle (15) are resting on flat ground (S). As long as the pressure in the active chamber (5') has not reached the set value, the pressure control valve (6) is in its first position (61). After a period of time, the pressure in the active chamber (5') reaches the set value such that the pressure control valve (6) moves to the second position (62).

[0030] Referring to Figure 5A, when operating the machine (1), when the pressure in the active chamber (5') becomes less than the set value, for example when the lightening cylinder (5) retracts because the working unit (3) is on a bump, the pressure control valve (6) moves to the first position (61) and remains in this position until the pressure in the active chamber (5') becomes greater than the set value. When the pressure in the active chamber (5') exceeds the set value, for example when the lightening cylinder (5) extends because the work unit (3) is in a hole, the pressure control valve (6) moves to the second position (62) and remains in this position until the pressure in the active chamber (5') becomes less than the set value. The pressure control valve (6) therefore tends to oscillate between these two positions, keeping the pressure in the active chamber (5') of the lightening cylinder (5) substantially constant.

[0031] As shown on Figure 5A, the pressure in the first pipe (7) is measured via a control pipe (60) which is part of the pressure control valve (6). Since the first pipe (7) connects the active chamber (5') to the pressure control valve (6), the pressure in the first pipe (7) is equal to the pressure in the active chamber (5'). The set value is specific to the pressure control valve (6). To

adjust the force exerted by the lightening cylinder (5) on the work unit (3), the set value can be adjusted, preferably using a spring (68) of the pressure control valve (6). Using a spring (68) whose force can be adjusted avoids the need for any electronics, thereby reducing the development cost and the cost price and simplifying maintenance. The pressure control valve (6) may for example be of the type known by the designation DR10-01 sold by the company Hydac, or a similar control valve. In an alternative embodiment not shown, the pressure control valve (6) could also be controlled electronically or hydraulically, in particular to adjust the set value when operating the machine (1), and in particular from the cab of the tractor vehicle (15).

[0032] As shown on Figures 5B and 5C, the machine (1) may comprise a hydraulic actuator (12) connected to the second pipe (8) by a fourth pipe (8'). The hydraulic actuator (12) can also be connected to the third pipe (11) by a fifth pipe (11'), preferably at its outlet. The hydraulic actuator (12) performs a function external to the lightening device (9). Such an arrangement makes it possible to perform several functions using a single control valve (19), making it possible to reduce the number of control valves required to operate the machine (1). Such a feature is interesting for a front-mounted machine (1), especially when the tractor vehicle (15) has only one control valve (19) at the front. The hydraulic actuator (12) preferably comprises at least one hydraulic motor or cylinder. In the examples shown, the work unit (3) comprises a pick-up roller (121) configured to lift a haymaking product such as mowed grass, and throw it backwards with respect to the direction of advance (A). In these examples shown, the hydraulic actuator (12) is the hydraulic motor driving the pick-up roller (121) in rotation. The machine (1) could also be intended to mow a standing plant product, and possibly also to gather it on one side of the machine (1) as it advances.

[0033] As shown on Figures 5B and 5C, a pressure limiting valve (46) can be assembled to the terminals of the hydraulic actuator (12) to prevent damage to the latter. Preferably, the pressure limiting valve (46) is connected to the fourth pipe (8') and the fifth pipe (11') so as to limit the pressure in the fourth pipe (8'). The calibration value above which this pressure limiting valve (46) allows hydraulic fluid to flow between the fourth pipe (8') and the fifth pipe

(11') can be adjusted. To avoid limiting the pressure in the hydraulic circuit of the lightening device (9), respectively throughout the hydraulic circuit of the machine (1), the calibration value of the pressure limiting valve (46) is greater than the set value of the pressure control valve (6). Such an embodiment makes it possible to limit the pressure in the hydraulic actuator (12) without however limiting the pressure in the lightening cylinder (5), while using a same control valve (19) for the hydraulic actuator (12) and the lightening cylinder (5). Furthermore, the position of the pressure limiting valve (46) on the terminals of the hydraulic actuator (12) makes it possible for the force exerted by the lightening cylinder (5) on the work unit (3) to remain constant. Indeed, if such a pressure limiting valve (46) was connected to the first pipe (7), the pressure in the active chamber (5') of the lightening cylinder (5) would be limited by the smaller value between the set value of the pressure control valve (6) and the calibration value of the pressure limiting valve (46).

[0034] As shown on Figures 5B and 5C, to avoid disturbing the operation of the or each hydraulic actuator (12) when the pressure control valve (6) is in its second position (62), a non-return valve can be fitted on the fifth pipe (11') so as to block the flow of hydraulic fluid to the hydraulic actuator (12).

[0035] The machine (1) comprises a drain pipe (13) fitted with a stop valve (13'), closed in the work configuration. This drain pipe (13) connects the first pipe (7) to the third pipe (11). In the present description, unless otherwise indicated, the stop valve (13') is considered as being closed. Such an arrangement makes it possible, by opening the stop valve (13'), to drain the lightening cylinder (5) easily and quickly, without the control valve (19). So that the user can know the pressure in the active chamber (5') of the lightening cylinder (5), a pressure gage is fitted in series on the first pipe (7) or on the drain pipe (13).

[0036] In the preferred embodiment, the pump (P), the tank (T) and the control valve (19) are integral parts of the tractor vehicle (15). To avoid placing too much stress on the hydraulic circuit of the tractor vehicle (15), which could disturb one or more of the functions of the machine (1), the pump (P), the tank (T) and the control valve (19) can nevertheless be integrated in the machine (1), especially if the machine (1) comprises several work units (3).

In addition, with a machine (1) comprising the pump (P) and the tank (T), it is easier to control the cleanliness of the hydraulic fluid.

[0037] In the preferred embodiment shown on Figures 1 to 3, the lightening cylinder (5) is connected to the chassis (2) by a flexible compression tie-rod (17). The flexible compression tie-rod (17) is attached to the chassis (2) at a fastening point (18). The flexible compression tie-rod (17) is for example a cable (Figure 3) or a chain (Figure 1). It could also be a device comprising a pin attached to either the chassis (2) or the lightening cylinder (5) and being able to move freely in the oblong hole of a part attached with that one of the chassis (2) or of the lightening cylinder (5) which is not attached to the pin. In a simple manner and as shown on Figures 1 to 3, the flexible compression tie-rod (17) is a chain, it being advantageously possible to use each link to attach the lightening cylinder (5) to the chassis (2) at the fastening point (18). Thus, regardless of the tractor vehicle (15) to which the machine (1) is connected, the work unit (3) can rest on the ground (S). The lightening cylinder (5) is rigidly fastened to the work unit (3) at a front articulation (20). If necessary, the lightening cylinder (5) is attached to the work unit (3) via the frame (1') at this front articulation (20). The length between the fastening point (18) and the front articulation (20) can be modified thanks to the various fasteners of the flexible compression tie-rod (17). The machine (1) can thus be easily coupled to tractor vehicles (15) of different types and/or different heights, without having to adapt the stroke of the lightening cylinder (5) to them. At least in the work configuration, since the fastening point (18) is further away from the ground (S) than the front articulation (20) of the lightening cylinder (5) with the frame (1'), the force exerted by the lightening cylinder (5) on the work unit (3) is at least partially directed upwards. As shown on Figure 4, the fastening point (18) can be integrated into the anchoring point of the upper arm (44) of the coupling device (16) with the tractor vehicle (15).

[0038] As shown on Figure 5A, the lightening cylinder (5) comprises an active chamber (5') connected to the first pipe (7). The lightening cylinder (5) also comprises a passive chamber (5") separated from the active chamber (5') by a piston. The passive chamber (5") is connected to the open air. The passive chamber (5") is preferably connected to the open air by a venting

pipe (58). The venting pipe (58) is a plug allowing air to pass through, and preferably filtering it.

[0039] The lightening cylinder (5) can be of the single-acting type. Thus, the work unit (3) of a machine (1) as described above can be lowered by the weight of the work unit (3) and gravity. Such an embodiment makes it possible to save at least one hydraulic pipe, thereby making the machine (1) simpler to produce and to connect to the control valve (19).

[0040] Since the lightening cylinder (5) is connected to the chassis (2) by a flexible compression tie-rod (17), the lightening cylinder (5) only transmits a force between the chassis (2) and the work unit (3) as it retracts. The active chamber (5') is preferably located on the side of the rod of the lightening cylinder (5). The passive chamber (5") is preferably located on the side of the body of the lightening cylinder (5). It would be possible to connect the rod of the lightening cylinder (5) to the work unit (3) and the side of the body of the lightening cylinder (5) to the chassis (2). However, the mass distribution would be disadvantageous, since the side of the body is heavier than the side of the rod. In addition, connecting the rod of the lightening cylinder (5) to the frame (1') does not make it possible to position the front articulation (20) anywhere other than at the end of the lightening cylinder (5), respectively at the free end of its rod, without limiting its stroke. As shown on Figure 1, the rod of the lightening cylinder (5) is preferably connected to the chassis (2). Similarly, the side of the body of the lightening cylinder (5) is for its part connected to the work unit (3) and articulated with the frame (1'), respectively with the work unit (3), anywhere other than at the end of the lightening cylinder (5), without limiting the stroke of the lightening cylinder (5) (see Figures 3 and 4). The lightening cylinder (5) therefore operates like a single-acting cylinder whose chamber connected to the open air is the one on the side of its body, in other words the passive chamber (5"). It is clear from the above that when the pump (P) is connected to the active chamber (5'), this involves that the lightening cylinder (5) exerts a force on the work unit (3), of which at least one component is directed upwards. In addition, since the machine (1) comprises a lightening cylinder (5) that can only be actuated in retraction, in the transport configuration, the lightening cylinder (5) cannot

be extended, as otherwise it could hit the chassis (2), respectively the tractor vehicle (15), and cause damage.

[0041] According to an interesting feature, the deflection system (25) is such that it implies a resultant force on the lightening cylinder (5) less than the force transferred by the lightening cylinder (5) onto the chassis (2) in the work configuration. In other words, the deflection system (25) is such that the resultant force on the lightening cylinder (5) is less than the force due to the weight of the work unit (3) which is transferred onto the chassis (2) in the work configuration. Thanks to this arrangement, even if the deflection system (25) also exerts a force on the lightening cylinder (5) in the work configuration, the lightening cylinder (5) is not pivoted by the deflection system (25) in the work configuration. In addition, the more the force to apply on the lightening cylinder (5) to move it is limited, the cheaper and easier it is to manufacture the deflection system (25). Lastly, a large force applied to the lightening cylinder (5) so as to make it pivot outwards in the work configuration could reduce the efficiency of the lightening device (9), and therefore lead to a reduced quality of work or more damage to the plant cover.

[0042] In order to use a standard cylinder, the front articulation (20) can be located at the front end of the lightening cylinder (5) in the work configuration. However, for a front-mounted machine (1), the closer the work unit (3) is to the tractor vehicle (15), respectively to the front axle of the tractor vehicle (15), the better the field tracking of the work unit (3) and therefore its work quality. In addition, the closer the work unit (3) of a front-mounted machine (1) is to the tractor vehicle (15), the better the maneuverability of the machine (1) and its field tracking. To ensure greater proximity between the work unit (3) and the tractor vehicle (15), in the preferred embodiment, the front articulation (20) is located further back, seen in the direction of advance (A), than the front end of the lightening cylinder (5). So that gravity makes the lightening cylinder (5) pivot downwards and backwards when moving from the work configuration to the transport configuration, the front articulation (20) is also located closer to the front end of the lightening cylinder (5) than to its rear end, at least when the machine is in the work configuration. In

other words, the pitch axis (AT) is positioned relative to the lightening cylinder (5) such that its center of gravity is located between the pitch axis and the tractor vehicle (15).

[0043] In order to use a standard cylinder, according to a simple and economic variant, the front articulation (20) comprises or consists of a ball joint articulation.

[0044] As shown on Figure 4, to ensure that the lightening cylinder (5) pivots quickly enough about the front articulation (20), and/or to ensure that the lightening cylinder (5) pivots if the machine (1) rests on a sloping ground (S), the deflection system (25) may comprise a retraction actuator (26) connected on one side to the work unit (3) and on another side to the lightening cylinder (5). Preferably, the retraction actuator (26) is attached to the work unit (3) via the frame (1'). The retraction actuator (26) is arranged to exert a force moving the anchoring point (24) away from the midplane (PM).

[0045] The retraction actuator (26) could in particular be a compression or tension spring, preferably oriented substantially horizontally and perpendicularly to the direction of advance (A). A drawback of a compression spring is that its deformation must be guided in order to transmit the force between the frame (1') and the lightening cylinder (5). In the preferred embodiment, the retraction actuator (26) is a tension spring connected to the frame (1') at a point further away from the midplane (PM) than the point where the retraction actuator (26) is connected to the lightening cylinder (5). The retraction actuator (26) could consist of any type of spring or elastomer material. A drawback of a deflection system (25) having a retraction actuator (26) consisting of a spring is that it complicates the coupling of the flexible compression tie-rod (17) to the chassis (2), respectively at the fastening point (18). Moreover, if the flexible compression tie-rod (17) is not properly coupled to the chassis (2), the lightening cylinder (5) may move back towards the user who is trying to couple it, which may cause injuries. The stiffer the spring of the retraction actuator (26), the greater the risk.

[0046] In the preferred embodiment, to make it easier to produce the articulation of the or each lightening cylinder (5) with the frame (1'), the front articulation (20) comprises a clevis (27) pivotally mounted with the work unit (3). The

clevis (27) has in particular two sides (29) between which the lightening cylinder (5), respectively the body of the lightening cylinder (5), extends. In this way, the stroke of the lightening cylinder (5) is advantageously not limited by the location of the front articulation (20), while ensuring greater proximity between the work unit (3) and the tractor vehicle (15). The clevis (27) is pivotally mounted on the frame (1'). The clevis (27) is thus pivotally mounted with the work unit (3), respectively with the frame (1'), about a yaw axis (AL). The yaw axis (AL) is substantially perpendicular to the direction of advance (A). In addition, the yaw axis (AL) is tilted relative to the vertical such that the top of the yaw axis (AL) is further away from the midplane (PM) than the bottom of the yaw axis (AL). In other words, the yaw axis (AL) is tilted outwards. In this document, "outwards" means moving away from the midplane (MP) of the work unit (3).

[0047] In addition, in the preferred embodiment, the lightening cylinder (5) is pivotally mounted with the clevis (27) about a pitch axis (AT). The pitch axis (AT) is substantially perpendicular to the direction of advance (A). The pitch axis (AT) is substantially horizontal. To facilitate the construction, the pitch axis (AT) is perpendicular to the yaw axis (AL). Consequently, the pitch axis (AT) can be slightly tilted relative to the horizontal, preferably so that it is further away from the ground (S) on the side of the midplane (PM) than on the outer side of the machine (1). The front articulation (20) is thus preferably a cardan joint articulation.

[0048] It is clear from the above that the deflection system (25) comprises a front articulation (20) of the cardan joint type allowing the lightening cylinder (5) to pivot along a yaw axis (AL) substantially perpendicular to the direction of advance (A) and tilted towards the outside of the machine (1), the front articulation (20) also allowing the lightening cylinder (5) to pivot about a pitch axis (AT) substantially perpendicular to the direction of advance (A) and to the yaw axis (AL). Thanks to such a deflection system (25), when the weight of the lightening cylinder (5) causes it to pivot downwards about the front articulation (20), respectively about the pitch axis (AT), the lightening cylinder (5) is also forced to pivot about the yaw axis (AL).

[0049] A front articulation (20) of the cardan joint type allows greater angular movement, about a central position, than a standard ball joint articulation. The pivoting amplitude of the lightening cylinder (5) about the yaw axis (AL) and the pitch axis (AT) can thus be greater than with a standard ball joint connection. A front articulation (20) of the cardan joint type can thus prevent the lightening cylinder (5) from hitting the chassis (2) with a tractor vehicle (15) that is wider at the front than a front articulation (20) of the ball joint type. The pitch axis (AT) may not pass through the lightening cylinder (5). According to a variant embodiment not shown, the pitch axis (AT) is located under or above the lightening cylinder (5). Similarly, the yaw axis (AL) could extend on either side of the lightening cylinder (5).

[0050] A deflection system (25) comprising a retraction actuator (26) consisting of a spring and a front articulation (20) of the cardan joint type makes it possible to reduce the stiffness of the spring of the retraction actuator (26), thereby reducing the risk of injuries.

[0051] In the embodiment shown on Figure 4, the clevis (27) is rigidly fastened to a support rod (28) pivotally mounted relative to the work unit (3), respectively to the frame (1'), along the yaw axis (AL). Such an embodiment makes it possible to guide the pivoting of the clevis (27), respectively of the lightening cylinder (5), relative to the frame (1') along the yaw axis (AL) in a simple way, without disturbing the pivoting of the lightening cylinder (5) about the pitch axis (AT) relative to the clevis (27), and without crossing the lightening cylinder (5), thus reducing its cost price.

[0052] In addition, each of the sides (29) of the clevis (27) is crossed by a respective pivot pin (31) rigidly fastened to the lightening cylinder (5) and pivotally mounted relative to the clevis (27) about the pitch axis (AT). Such an embodiment makes it possible to guide the pivoting of the lightening cylinder (5) along the pitch axis (AT) in a simple way, while allowing the pivoting of the lightening cylinder (5) about the pitch axis (AT) relative to the clevis (27) without disturbing the pivoting of the lightening cylinder (5) and of the clevis (27) about the yaw axis (AL) relative to the frame (1').

[0053] To reduce wear of the pivot pins (31) due to friction with the sides (29), a ring is mounted around the pivot pins (31) at the respective side (29). Advantageously, the ring can be replaced in case of excessive wear. As a complement, a cover containing lubricant can be mounted on the outside of the sides (29). In particular, a cover containing lubricant can be mounted on the outer sides (29). Indeed, since the clevis (27) being tilted towards the outside, these outer sides (29) are more likely to accumulate dust and impurities than the inner sides (29). The covers can include in particular lubricating devices to renew the lubricant and drive out the impurities.

[0054] As shown on Figure 4, the yaw axis (AL) forms an angle of less than 30° with the midplane (PM), seen along the direction of advance (A). The angle, seen along the direction of advance (A), formed by the yaw axis (AL) and the midplane (PM) is preferably less than 20°. It is even more preferably about 10°.

[0055] In the preferred embodiment, the machine (1) has side stops to limit the pivoting of the lightening cylinder (5) about the front articulation (20), respectively about the yaw axis (AL). In a simple embodiment, the side stops consist of the sides (29) of the clevis (27). In addition, a lower stop (30) can limit the pivoting of the lightening cylinder (5) about the front articulation (20). More precisely, the lower stop (30) limits the pivoting of the lightening cylinder (5) about the pitch axis (AT). The lower stop (30) is located under the lightening cylinder (5), preferably close to it. The lower stop (30) is located behind the front articulation (20), and more precisely between the anchoring point (24) and the front articulation (20). When the lightening cylinder (5) is in contact with the lower stop (30), it can only move about the yaw axis (AL), thereby favoring this pivoting allowing it to be moved by pivoting the anchoring point (24) about the front articulation (20) so as to move the anchoring point (24) away from the midplane (PM).

[0056] As it appears from the above, the deflection system (25) makes it possible to induce a resultant force on the lightening cylinder (5) oriented substantially orthogonally to the midplane (PM) and in the direction opposite to the midplane (PM), at least in the transport configuration of the machine (1).

By exerting on the lightening cylinder (5) a force that is substantially orthogonal to the midplane (PM), it is possible to use a retraction actuator (26) exerting a relatively low force, in particular a force that can be less than the force due to the weight of the retraction actuator (26). A force oriented substantially orthogonally to the midplane (PM) also results in a low risk of damage and/or injury when attaching the flexible compression tie-rod (17) to the chassis (2) at the fastening point (18).

[0057] In the preferred embodiment, the machine (1) comprises two lightening cylinders (5). The two lightening cylinders (5) are identical and assembled substantially symmetrically with respect to the midplane (PM). As shown on Figures 5B and 5C, the active chamber (5') of each of the lightening cylinders (5) is connected to the first pipe (7). Everything described above for the lightening cylinder (5) is valid for both lightening cylinders (5), respectively for each of the lightening cylinders (5). The cylinders (5) are arranged on either side of the pendular axis (AP) seen in the direction of advance (A), therefore making it possible to equally distribute the lightening on either side of the pendular axis (AP), regardless of the relief of the ground (S).

[0058] Obviously, the invention is not limited to the embodiments described and shown in the attached drawings. Modifications remain possible, in particular as regards the composition of the various elements. The scope of protection of the invention is defined in the attached claims.

Patentkrav

1. Landbrugsmaskine (1), der er beregnet til at blive koblet til et traktorkøretøj (15), og som omfatter en arbejdsenhed (3), der er beregnet til at blive forbundet med et chassis (2) på traktorkøretøjet (15), i forhold til hvilket arbejdsenheden (3) kan forskydes, idet maskinen (1) kan indtage en arbejdskonfiguration, hvor arbejdsenheden (3) i det mindste delvist hviler på jorden (S), og en transportkonfiguration, hvor arbejdsenheden (3) er hævet fra jorden (S), idet maskinen (1) omfatter en løfteanordning (9), der omfatter mindst en løftedonkraft (5), der er beregnet til at blive forbundet med chassiset (2) ved hjælp af en fleksibel kompressionsstang (17) på den ene side og med arbejdsenheden (3) ved et forreste led (20) på den anden side, idet løftedonkraften (5) i arbejdskonfigurationen kan overføre mindst en del af vægten af arbejdsenheden (3) til chassiset (2), idet den fleksible kompressionsstang (17) er fastgjort til løftedonkraften (5) ved et fastgørelsespunkt (24), maskine (1), kendetegnet ved, at mindst et afbøjningssystem (25) gør det muligt at forskyde løftedonkraften (5) ved at dreje fastgørelsespunktet (24) rundt om det forreste led (20) for at flytte fastgørelsespunktet (24) væk fra arbejdsenhedens midterplan (PM).

2. Landbrugsmaskine ifølge krav 1, kendetegnet ved, at afbøjningssystemet (25) er af en sådan art, at det medfører en resulterende kraft på løftedonkraften (5), som er mindre end den kraft, der overføres af donkraften (5) til chassiset (2) i arbejdskonfigurationen.

3. Landbrugsmaskine ifølge et hvilket som helst af kravene 1 eller 2, kendetegnet ved, at det forreste led (20) er placeret længere tilbage, set i kørselsretningen (A), end den forreste ende af løftedonkraften (5).

4. Landbrugsmaskine ifølge et hvilket som helst af kravene 1 til 3, kendetegnet ved, at det forreste led (20) er et kugleled.

5. Landbrugsmaskine ifølge et hvilket som helst af kravene 1 til 4, kendetegnet ved, at afbøjningssystemet (25) omfatter en returaktuator (26), der på den ene side er forbundet med arbejdsenheden (3) og på den anden side med løftedonkraften (5).

6. Landbrugsmaskine ifølge krav 5, kendetegnet ved, at maskinen (1) omfatter en ramme (1'), der er konfigureret til at forbinde arbejdsenheden (3) med chassiset

(2), og at returaktuatoren (26) er en trækfjeder, der er forbundet med en ramme (1') i et punkt, der er længere væk fra midterplanet (PM) end det punkt, hvor returaktuatoren (26) er forbundet med løftedonkraften (5).

7. Landbrugsmaskine ifølge et hvilket som helst af kravene 1 til 6, kendetegnet ved, at afbøjningssystemet (25) omfatter et forreste led (20) af kardantypen, der gør det muligt for løftedonkraften (5) at dreje om en drejningsakse (AL), der i det væsentlige er vinkelret på kørselsretningen (A) og hælder mod ydersiden af maskinen (1), idet det forreste led (20) også gør det muligt for løftedonkraften (5) at dreje om en hældningsakse (AT), der i det væsentlige er vinkelret på kørselsretningen (A) og på drejningsaksen (AL).

8. Landbrugsmaskine ifølge et hvilket som helst af kravene 1 til 7, kendetegnet ved, at det forreste led (20) omfatter et gaffelled (27), der er drejeligt monteret med arbejdsenheden (3), idet gaffelleddet (27) omfatter to flanker (29), mellem hvilke løftedonkraften (5) strækker sig.

9. Landbrugsmaskine ifølge krav 6 og 7, kendetegnet ved, at gaffelleddet (27) er integreret med en støttestang (28), der er monteret således, at den kan dreje i forhold til arbejdsenheden (3) langs drejningsaksen (AL).

10. Landbrugsmaskine ifølge et af kravene 7 til 9, kendetegnet ved, at hver af flankerne (29) på gaffelleddet (27) krydses af en respektive drejetap (31), der er integreret med løftedonkraften (5) og monteret således, at den kan dreje i forhold til gaffelleddet (27) omkring hældningsaksen (AT).

11. Landbrugsmaskine ifølge et af kravene 7 til 10, kendetegnet ved, at drejningsaksen (AL) danner en vinkel på mindre end 30° med midterplanet (PM) set i kørselsretningen (A).

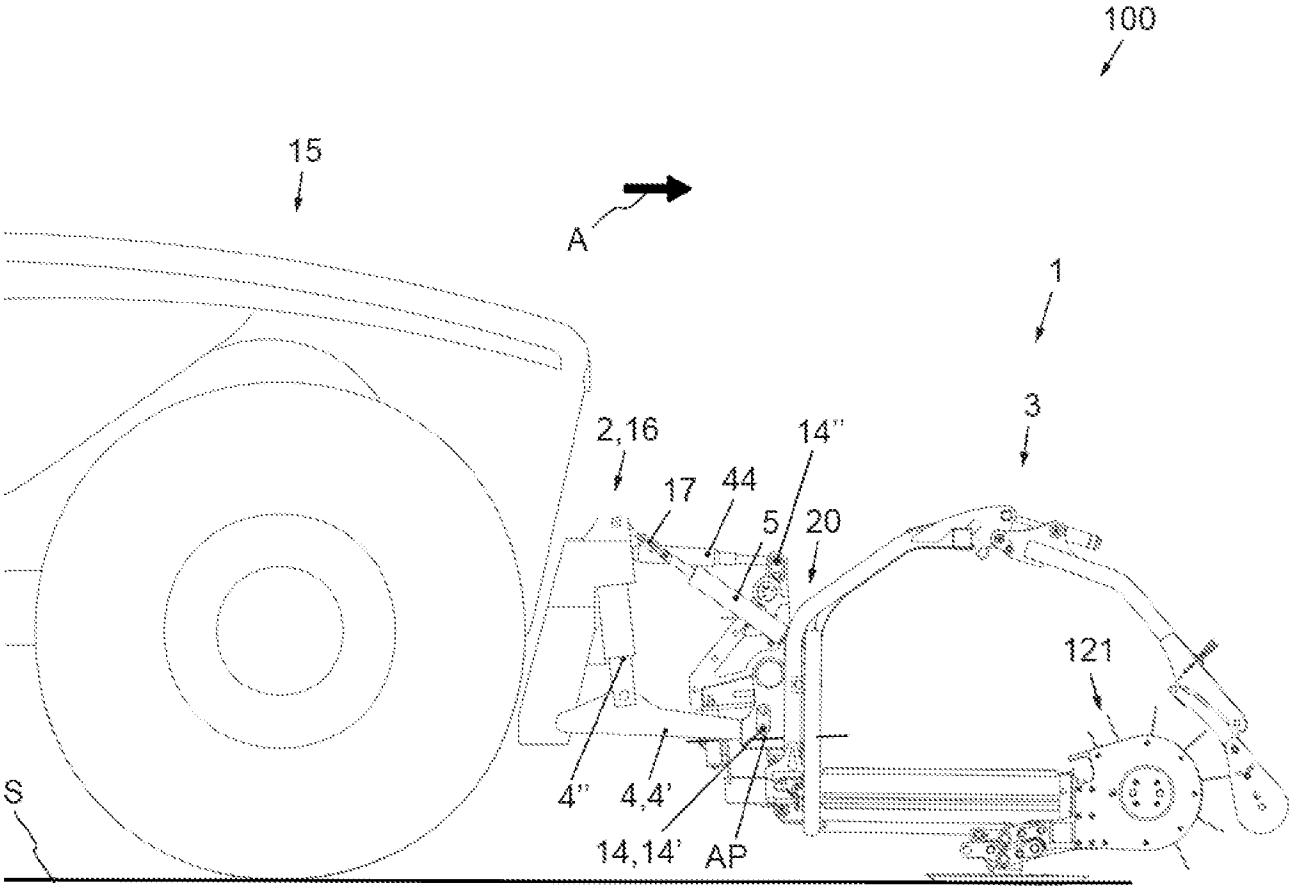
12. Landbrugsmaskine ifølge et hvilket som helst af kravene 7 til 11, kendetegnet ved, at et lavt stop (30) begrænser drejningen af løftedonkraften (5) omkring hældningsaksen (AT), idet det lave stop (30) er placeret under løftedonkraften (5).

13. Landbrugsmaskine ifølge et hvilket som helst af kravene 1 til 12, kendetegnet ved, at det forreste led (20) er placeret tættere på den forreste ende af løftedonkraften (5) end på dens bageste ende, i det mindste når maskinen er i

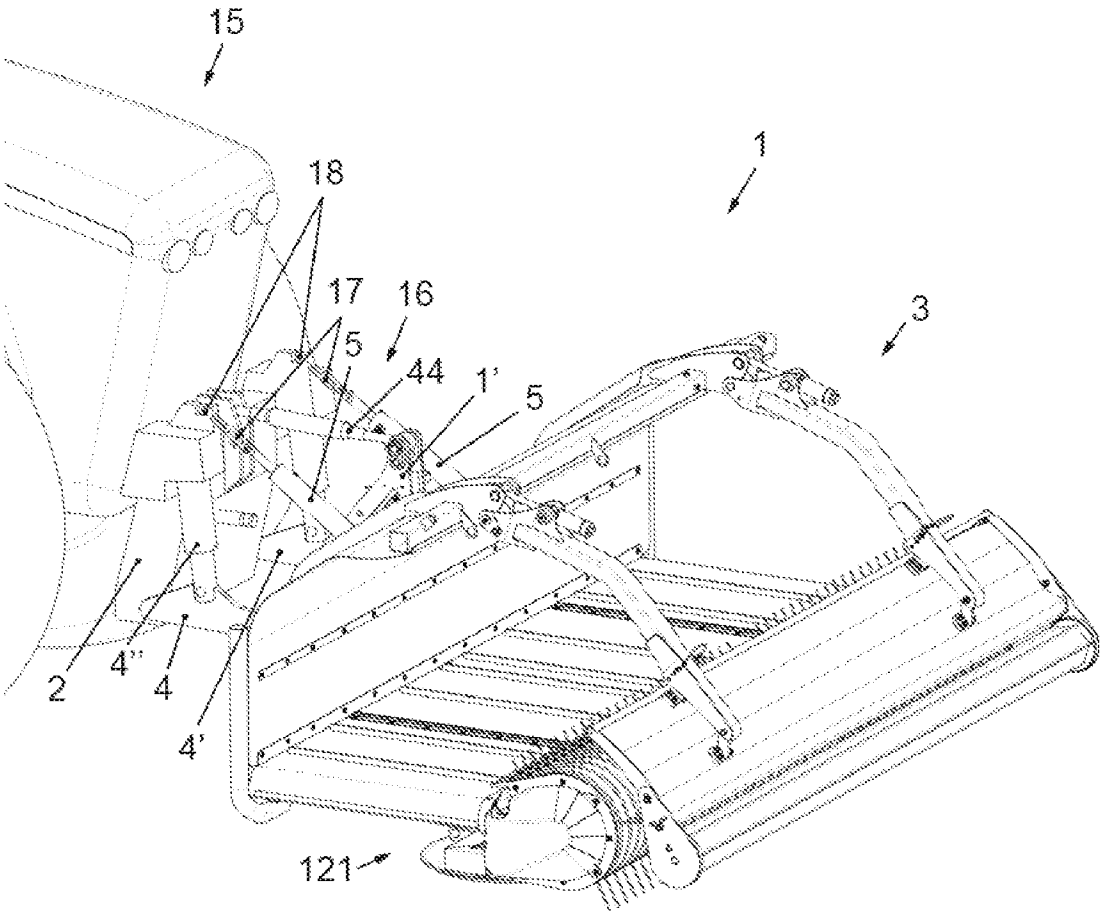
arbejdskonfiguration.

14. Koblingskombination (100), kendetegnet ved, at den omfatter et trækkende køretøj (15) og en maskine (1) ifølge til et af kravene 1 til 13.

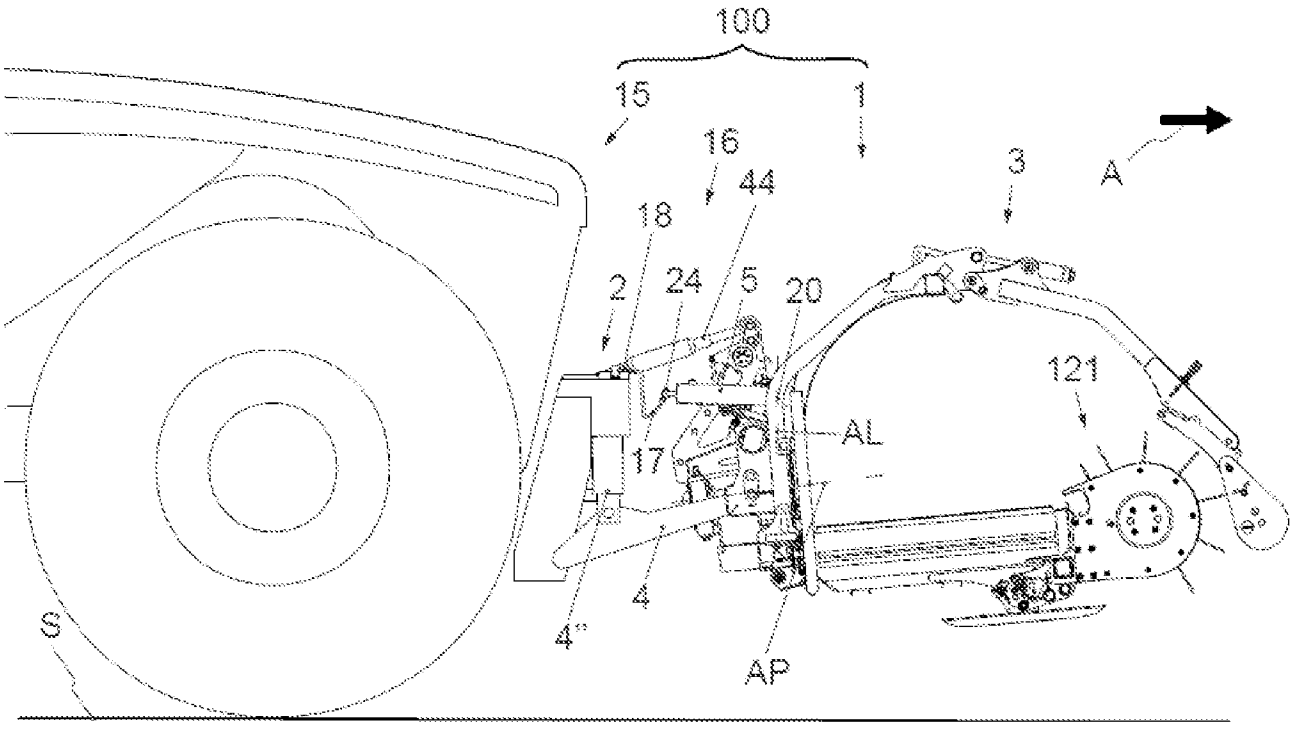
[Fig 1]



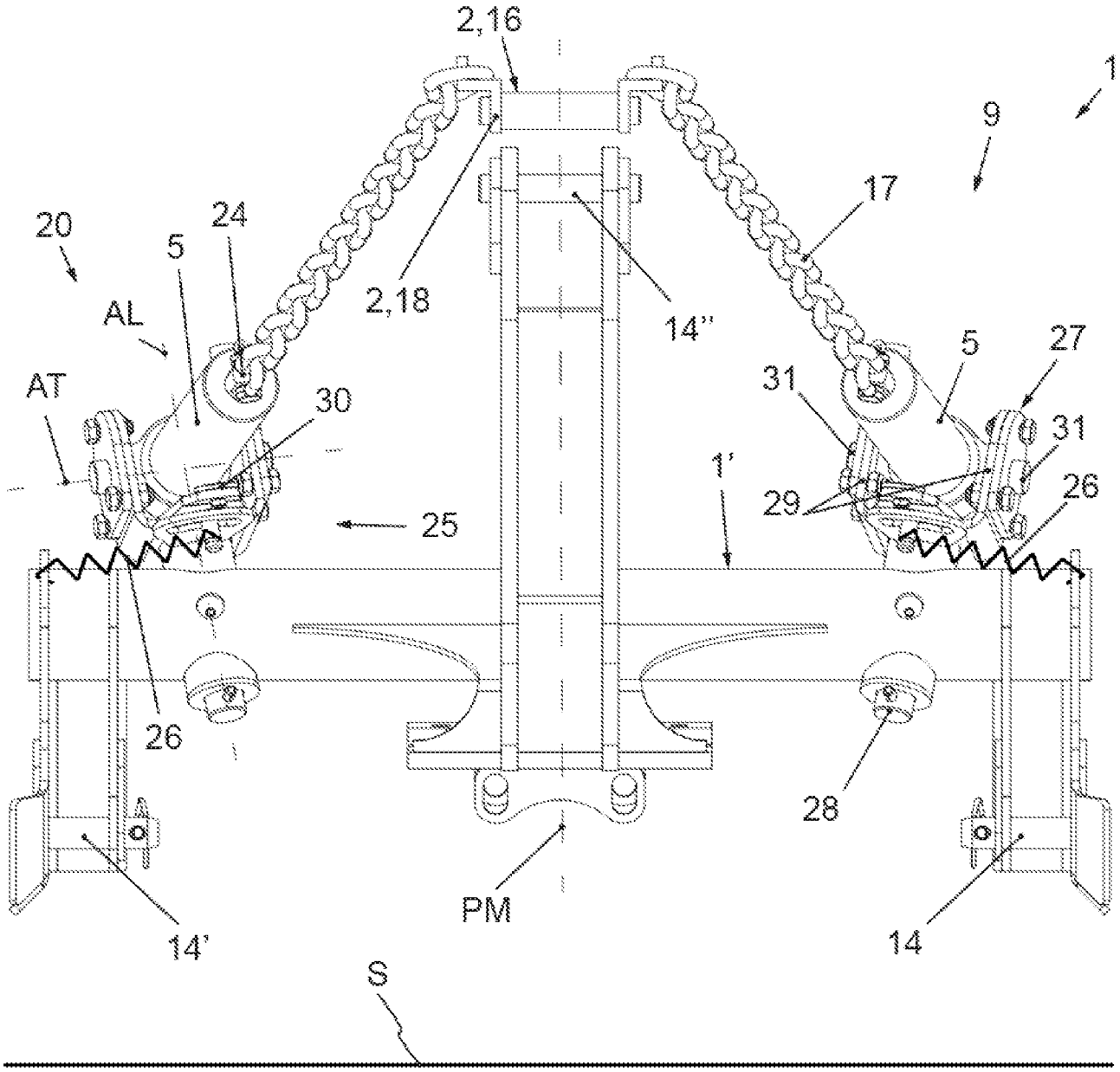
[Fig 2]


15
18
1
17
16
5
44
1'
5
3
2
4''
4
4'
121

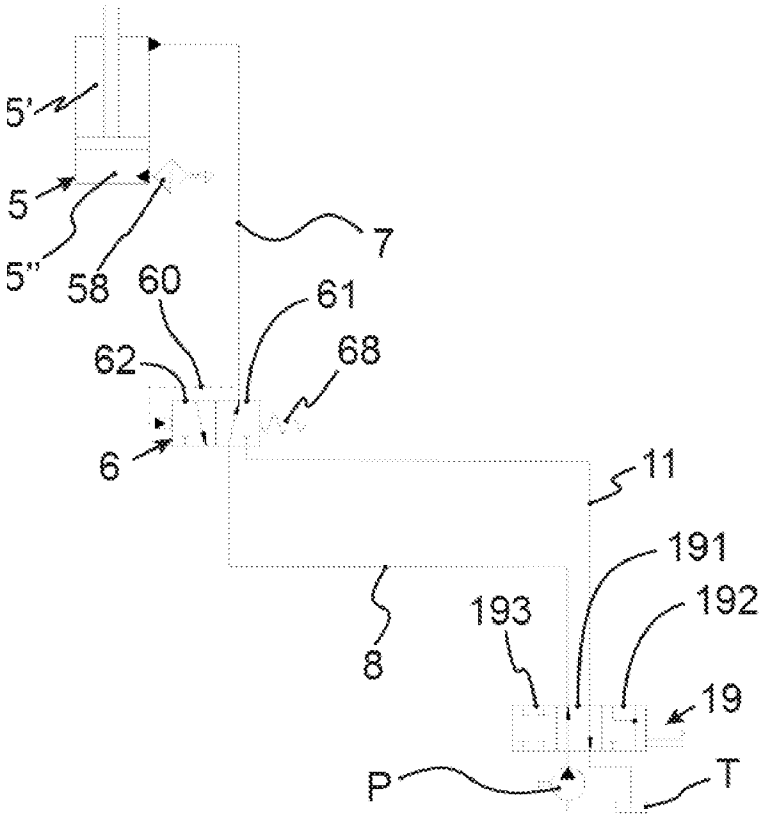
[Fig 3]


100
15
1
16
44
3
A
18
2
24
5
20
121
AL
17
4
4''
S
AP

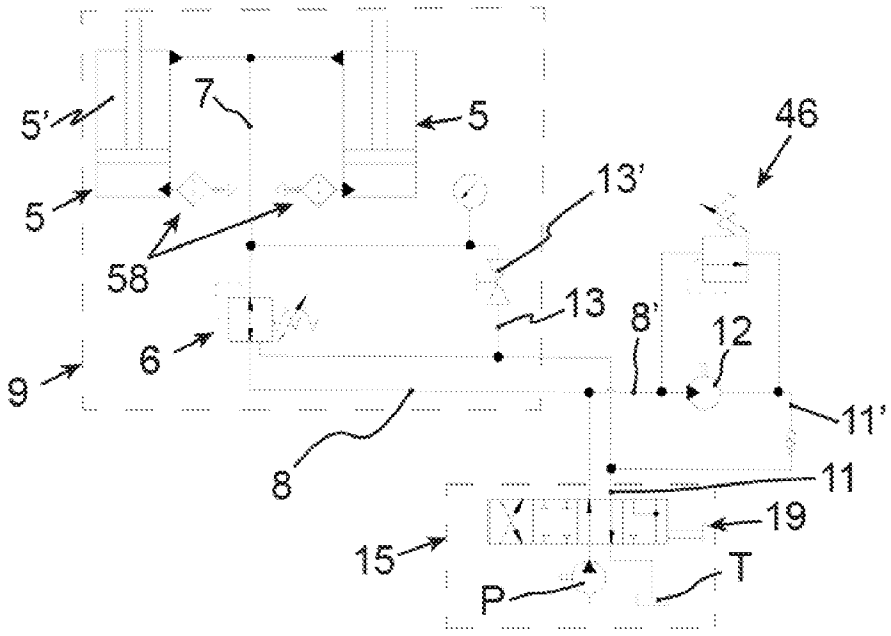
[Fig 4]



[Fig 5A]


5'
5
5''
58
60
7
61
62
68
6
11
191
193
192
8
19
P
T

[Fig 5B]


5'
7
5
46
5
13'
58
13
8'
12
9
6
11'
8
11
19
15
T
P

[Fig 5C]