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## Description

[0001] The present invention relates to the field of agricultural machinery, in particular the soil-working equipments hitched to a tractor in use, and its purpose is a mounted or semi-mounted plough with an additional onboard soil-working device.

[0002] Generally, ploughing has four functions:

- loosen the topsoil layer to speed up draining (since the penetration of air and heat is improved) and make it easier for roots to grow,
- bury and mix crop residues with the soil so that they do not hinder the seedbed preparation and the sowing,
- destroy the vegetation and some parasites by burying,
- facilitate the seedbed preparation.

[0003] Then, to avoid drying out the ploughed soil, an additional soil-working action (in addition to ploughing by the plough bodies) can be planned, which makes it possible to tamp the soil and complete the crumbling (reduction of the size of the clods and formation of fine earth) to improve the contact between the seeds and the particles of earth. A soil-working device such as a roller is thus used directly behind the plough, this roller sometimes being coupled to the plough, or even carried on it.

[0004] A plough with an additional soil-working device or roller is known from document EP 2 793 542 (corresponding to WO-A-2013 091608). The roller is designed to be used with the plough, it rolls over the strip of land that has just been turned over. The rings or wheels are mounted in pairs on a beam which is attached via connecting arms to the frame of the plough, the beam being substantially parallel to the frame of the plough and the structural assembly formed by the frame, the beam and the articulated arms forming a (large) deformable parallelogram.

[0005] Each connecting arm consists of a top leg or bar and a lower leg or bar forming together a (small) deformable parallelogram. Each of these parallelograms is controlled by a tamping cylinder (of the double-acting hydraulic cylinder type) which makes it possible to control the pressure of the roller on the soil. Each cylinder is arranged outside the parallelogram concerned and acts centrally on the ends of the two legs connected to the frame, the symmetrical deformation of the

parallelogram (for ploughing on the right or on the left) being carried out by means of a mechanical device comprising a linkage and cams in the shape of stop plates. This results in a complex construction that can be subjected locally to high stresses.

[0006] The plough of this EP document is reversible and the tamping cylinders must allow alternative ploughing of the left and right bodies, and also propose a neutral position (preferably horizontal) for transport. The tamping cylinders must also allow the roller to retract if an obstacle is encountered.

[0007] Depending on the ploughing depth, the user hydraulically adapts the contact pressure of the roller on the soil to obtain a good rolling action. He must therefore adjust the length of the tamping cylinder and ensure that the result is acceptable after working over a few meters. If the roller penetration is too deep or not deep enough, the user must correct the adjustment so as to obtain ideal tamping of the seedbed. An additional disadvantage is that excessive stress on the plough structure may occur in the event of uncontrolled pressure or variation in the plough verticality.

[0008] Whenever the ploughing depth is modified, the user must therefore adjust the roller and make sure that the tamping is correct. In practice, such adjustments are tedious and most users do not adapt the adjustment of the roller tamping pressure. In addition, in the event of a plot with heterogeneous soil, the user is obliged to make a compromise, which is then not ideal for any of the soil types encountered during ploughing.

[0009] The invention aims to remedy the limitations of the above-mentioned state of the art and in particular to provide a plough with an additional soil-working device of the roller type which soil contact takes place at constant pressure regardless of the ploughing depth of the plough, even if the soil of the plot to be ploughed is uneven or of varying levels, and therefore independently of the roller position. Ideally, the invention must provide such an additional device without the need for any adjustment by the user and by implementing a simple construction.

[0010] The invention therefore relates to a plough according to the independent claim 1.

[0011] The invention will be better understood on reading the following description, which refers to preferred embodiments, given as non-limiting examples, and explained with reference to the attached schematic drawings, in which:

[0012] [Fig. 1] is a top view of a mounted reversible plough comprising an additional onboard soil-working device (roller) according to a first embodiment of the invention;

[0013] [Fig. 2] is a perspective view of the mounted reversible plough of Figure 1 (plough represented in the ploughing position on the right);

[0014] [Fig. 3] is a top view of a semi-mounted plough equipped with two additional soil-working devices (rollers) according to a second embodiment of the invention (one roller is associated with each of the two parts of the plough);

[0015] [Fig. 4A] and

[0016] [Fig. 4B] are side elevation views of a combination [tractor + mounted reversible plough according to Figure 2] leaving a furrow (Fig. 4A) and entering a furrow (Fig. 4B);

[0017] [Fig. 5A] and

[0018] [Fig. 5B] are rear views of a connecting arm of the mounted reversible plough of Figures 1, 2 and 4, showing the positioning of a pair of wheels forming part of the roller when the ploughing depth PL is deep (Fig. 5A) and shallow (Fig. 5B);

[0019] [Fig. 6] is a partial view of the object represented on Figure 5, in particular showing more precisely the structure of the connecting arm;

[0020] [Fig. 7A] and

[0021] [Fig. 7B] are cross-sectional views along a longitudinal plane of a first constructive variant of an actuator that can form part of the connecting arm of Figures 5 and 6 (reversible plough), the two double-acting cylinders with double rod being in different states between the two Figures 7;

[0022] [Fig. 8] is a cross-sectional view along a longitudinal plane of a second constructive variant of an actuator that can form part of a connecting arm (non-reversible plough), and,

[0023] [Fig. 9] is a schematic representation of an example embodiment of a hydraulic control circuit for the various actuators of an additional soil-working device of a plough as represented on Figures 1 or 2 in particular.

[0024] Figures 1 to 4, and partially at least Figures 5 and 6, show a plough 1 comprising at least one additional device 2 for working the soil S, which includes a rolling means 3 assembly 3' forming a roller and which is connected to the longitudinal frame 4 of the plough 1 by at least two controlled connecting arms 5, 5'.

[0025] Each connecting arm 5, 5' comprises, on one hand, at least two legs 6 and 6' mounted articulated and arranged so as to form a parallelogram 5'' that is deformable by means of angle joints 12, 12' and is arranged along a vertical plane PV in the soil S working position of the plough 1, and, on the other hand, at least one linear actuator 7 designed and arranged so as to be able to carry out, by moving the legs 6 and 6', varied configurations of the parallelogram 5'', corresponding to respective varied positions of the additional soil-working device 2.

[0026] According to the invention, the or each actuator 7 consists of at least one double-acting cylinder 8 with double rod 9, 9' and with a blind space 10, the said or each cylinder 8 comprising two chambers 11, 11' with equivalent working sections, preferably substantially identical, the said actuator 7 acting as tamping cylinder for the roller 3' considered (each roller 3' thus having at least two tamping cylinders 7).

[0027] As shown more precisely as examples on Figures 7 and 8, the blind space 10 is a volume not opened to the outside, integrated in the cylinder 8 (where applicable, common to the two cylinders of the actuator and separating them) and wherein the unconnected rod 9' can extend freely (it forms a clear space for this rod).

[0028] By implementing an actuator 7, as defined above, the articulated coupling with controlled forces (between the or each roller 3' and the frame 4) provided by the invention, makes it possible to guarantee a constant ground pressure at the or each roller 3' regardless of the ploughing depth PL, and automatic adaptation if the soil is uneven or of varying levels, allowing the soil structure to be preserved. With such an actuator 7, even an unexpected command of excessive verticality, due for

example to an accidental adjustment error, does not overload the front part of the roller 3'. The verticality adjustment allows the plough 1, in particular at its legs, to be perpendicular to the soil S when the tractor 21 is moving with two wheels in the ploughing furrow.

[0029] In addition to the improved comfort of use since the user no longer has to make repeated adjustment and checking operations, the control of the forces to be provided for the tamping, possible thanks to the invention, limits the stresses on the frame 4 of the plough 1, and more globally on the entire structure of the plough and on its device for hitching with the tractor 21.

[0030] Since the chambers 11 and 11' of each actuator 7 composed of a double-acting cylinder have identical volumes, the actuator makes it possible to position the roller 3' concerned with an equal tamping force on the soil to plough on the right or on the left. The way they are sized also makes it possible to ensure an equivalent tamping force on each roller 3'.

[0031] For constructive simplification purposes, it is advantageously provided that the said at least one actuator 7 of each connecting arm 5, 5' is mounted so as to connect the frame 4 directly to one 6 of the legs 6, 6' forming part of the connecting arm 5, 5' considered.

[0032] According to the invention, the said at least one actuator 7 of each connecting arm 5, 5' is mounted in the deformable parallelogram 5" forming the said arm 5, 5', and extends between the two legs 6, 6' of the arm considered. Thus, this actuator is integrated into the structure itself of the arm concerned and is arranged inside the parallelogram defined by the latter, while being substantially coplanar with the aforementioned legs.

[0033] According to a first feature of the invention, allowing a constructive simplification by grouping the articulated assembly points and optimizing the effect of the force provided by the or each cylinder, the said at least one actuator 7 of each connecting arm 5, 5' is rigidly fastened to one of the joints 12, 12' of the deformable parallelogram 5" forming the said arm 5, 5'. These angle joints (in other words located at the angles) of the parallelogram 5" comprise two joints 12 each connecting one end of the legs 6 and 6' to the frame 4 and two joints 12' each

connecting the other end of the said legs to the roller 3', each time by means of an additional articulated connection 13' or 14'.

[0034] According to an advantageous construction of each of the connecting arms 5, 5', shown on Figures 5 and 6, the said at least one actuator 7 of each connecting arm 5, 5' is rigidly fastened, at one of its ends, to one of the joints 12, 12' of the deformable parallelogram 5" forming the said arm, preferably one of the joints 12 located on the side of the longitudinal frame 4 and, at its other end, to the leg 6 of the parallelogram 5" not concerned by the above-mentioned joint 12, preferably on the side of or near the roller 3', before its joint 12' with the said roller 3'. The closer the elongated linear actuator 7 is attached to the joint 12' (on the side of the roller 3'), the greater the lever arm effect will be. Advantageously, this actuator 7 can extend almost along a diagonal of the parallelogram 5".

[0035] Preferably, the two legs 6 and 6' of each connecting arm 5, 5' are connected, at their respective opposite ends, by swivel joints 12, 12', on one side, to a bearing 13 of a pivot connection 13' with the frame 4 and, on the opposite side, to a bearing 14 of a pivot connection 14' with a beam 15 carrying the rolling means 3, the axes ALP1, ALP2 of the two pivot connections 13' and 14' and the axes ALR, ALR' of the four swivel joints 12, 12' being mutually perpendicular. According to an alternative construction, the connections 13' and 14' may consist of ball joint connections.

[0036] According to a very favorable embodiment of an additional working device 2 and its articulated and controlled coupling with the frame 4, and as shown on Figures 1 to 6, the various rolling means 3 forming the roller(s) 3' consist of disc or ring wheels, possibly arranged or not in pairs 3" or triads, each one being mounted (for example by means of a connecting bar 16) on a beam 15 with a longitudinal offset between the various wheels 3, or, where applicable, between the various pairs 3" or triads. Where applicable, the beam 15 concerned can be equipped with a guide and orientation linkage for the wheels 3.

[0037] According to an alternative not shown, the rolling means can be individual wheels 3 arranged with a longitudinal offset between them.

[0038] According to another alternative not shown, the rolling means 3 can consist of several arrangements of three (triads) or more wheels 3.

[0039] The beam 15 is advantageously connected (preferably near each of its two ends) by two articulated and controlled connecting arms 5 and 5' to the frame 4, the latter thus forming with the said two connecting arms 5 and 5' and the beam 15, a deformable parallelogram which conformation is controlled by a linear actuator 17.

[0040] Preferably, the connecting bar 16 of each wheel 3, or of each triad or pair of wheels 3", is connected via a vertical axis pivot pin (relative to the soil S in the position in which the plough 1 is used) to a guide and control linkage 15' which ensures the alignment of the wheels 3 with respect to the direction of advance A of the plough 1 during use, like the landsides of the plough bodies 4'. The wheels 3 arranged individually, in pairs or triads, are follower wheels and align themselves with respect to the direction of advance A of the plough 1.

[0041] The articulated coupling of the additional working device 2 with the frame 4 is configured and arranged so as to be compatible with the various mechanical, operational and movement safety devices of the plough 1. It also allows the or each roller 3' to automatically adapt to the adjustable working width of the plough 1 during use.

[0042] In the transport position, the or each roller 3' ends up on the plough 1 and the folding cylinder 17 is in the maximum retracted position to limit the total height (the or each roller 3' with the or its associated beam 15 is moved closer to the frame 4 and therefore to the plough bodies 4').

[0043] The ploughs 1 equipped with one or more rolling means 3 assemblies 3' can be of various types, i.e. made in one piece (Figures 1, 2, 4) or in several segments (Figure 3), reversible or non-reversible (the latter type is not represented, but can easily be derived by those skilled in the art from Figures 1 and 3 in particular - Fig. 1: mounted plough 1 with an additional working device 2 / Fig. 3: semi-mounted plough 1 with two additional working devices 2, one device 2 being onboard on each segment of the plough 1).

[0044] In the case of a non-reversible plough 1, each linear actuator 7 integrated in the connecting arms 5, 5' is a (unique) double-acting cylinder 8 with double rod (Figure 8).

[0045] In a preferred variant, however, and as shown on Figures 1, 2, 4 and 5, the plough 1 is advantageously of the reversible type.

[0046] In this case, the linear actuator 7 integrated in each connecting arm 5, 5' consists of an actuating element composed of two double-acting cylinders 8 each with double rod, aligned opposite each other, mounted in the same body, sharing a common blind space 10 and each comprising two chambers 11, 11' with equivalent working sections, each actuating element 7 being connected by the ends of the two apparent rods 9 of the cylinders 8 forming it to corresponding anchoring points of the connecting arm 5, 5' considered (see Figures 6 and 7). Providing chambers 11 and 11' with equivalent working sections makes it possible to balance the action of the element 7 with two cylinders and to result in equal tamping between the two ploughing positions on the right and on the left. Since each cylinder 8 comprises two chambers 11 and 11', the actuator 7 has two chambers for ploughing on the left and two chambers for ploughing on the right.

[0047] With such a construction of the actuators 7, the latter can act similarly and symmetrically on each side of a horizontal plane passing between the two rows of ploughing bodies 4' (see Figures 5A and 5B), in the working position of the plough 1 concerned and depending on whether the plough is in the ploughing position on the right or on the left, with respect to the direction of advance A.

[0048] These actuating elements 7 with two double-acting cylinders 8 combined constructively and operationally, make it possible to define three configurations of the parallelogram 5" of each connecting arm 5, 5' corresponding to three positions/states of the roller 3', i.e.: the ploughing position (ploughing bodies on the left or on the right), the retracted position and the specific position when the plough 1 is turning.

[0049] For example, turning of the reversible plough 1 can be detected by a sensor of the inclinometer type, a proximity sensor or an incremental encoder and lead to automatic turning of the roller 3'.

[0050] Obviously, the actuators 7 can be of different natures and of various types (electric, hydraulic, pneumatic), while being sized for the functions to be performed.

[0051] Preferably, however, each actuator 7 is of the hydraulic or pneumatic type and is supplied by a suitable control circuit 18 including a regulation module 19 and possibly a surge tank 20.

[0052] The constructive arrangement of the actuator 7 as described previously, associated with such a control circuit, makes it possible to ensure an almost constant vertical tamping force on the soil, and this tamping pressure value is constant regardless of the travel of the active cylinder considered.

[0053] An example of a control circuit 18 when implementing hydraulic actuators 7 is shown on Figure 9.

[0054] In this context, the regulation module 19 is advantageously configured to generate by means of the controlled connecting arms 5, 5', a tamping pressure value of the or of each roller 3' on the soil S within a predetermined range of values, preferably substantially equal to a preset set value, the volume of excess fluid present in the control circuit 18 being, where applicable, evacuated to the surge tank 20 if present or to the tank of the tractor 21. For example, the pressure value can be regulated by means of a valve that can be adjusted by the operator. To this end, a potentiometer acting on the electronic control of this valve can be handled by the operator.

[0055] Advantageously, the set value is indicated from the tractor 21. The set value could be managed automatically via the electronics when at least the tractor 21 has a GPS navigation system. Thus, the set value can adapt automatically according to a recommendation map loaded in the terminal of the tractor 21 or of the plough 1.

[0056] According to another constructive alternative, the set value can be adapted according to the information received by various sensor technologies (ultrasonic, camera). These sensors will take into account the appearance of the soil S: moisture, texture or roughness (size of clods) and, advantageously, they are based on the information read on the soil turned over during the previous passage.

[0057] The circuit shown on Figure 9, onboard for example on a reversible plough 1, and supplied with pressurized hydraulic fluid by the tractor vehicle 21, can control two actuating elements 7 (controlling the configuration of the parallelograms 5" of

the two connecting arms 5 and 5', and each including two double-acting cylinders 8 of the above-mentioned type) and the folding cylinder 17.

[0058] In addition to the module 19, and possibly the tank 20, it also includes various solenoid valves 22 controlling the state of each of the cylinders 8 and 17.

[0059] The operation of such a circuit in the context of the invention can easily be deduced by those skilled in the art on examining the symbolic representation of Figure 9, and therefore requires no additional explanations.

[0060] By being coupled to the frame 4 by means of two articulated and controlled connecting arms 5 and 5', the or each roller 3' can be inclined to adapt to the varying levels of the land, with a uniformly distributed and constant contact pressure.

[0061] This inclination possibility is also beneficial when entering the ground (at start of furrow) and when leaving the ground (at end of furrow), in other words when the front of the plough 1 (and therefore of the roller 3') comes into contact with the soil S before the rear of the plough 1, and vice versa (see Figures 4A and 4B).

[0062] As shown on the attached figures, the plough 1 can consist of a mounted plough, reversible or not, having a single roller 3', or a semi-mounted plough having two rollers 3'.

[0063] According to a variant not shown, the plough 1 according to the invention can also be equipped with several rolling means 3 assemblies 3', these assemblies 3' all belonging to a single additional soil-working device 2, or each to a separate device 2 (which in this case are each time connected to each other in cascade by connecting arms 5, 5'). Thus, a plough 1 with five ploughing bodies 4', as shown on Fig.1, can be equipped with two, or even three, rollers 3', arranged one behind the other and offset longitudinally.

Obviously, the invention is not limited to the embodiments described and shown on the attached drawings, however, the field of protection of the invention is defined by the independent claim 1.

**Patentkrav**

1. Plov (1) med mindst en yderligere anordning (2) til bearbejdning af jorden (S), hvilken anordning omfatter en samling (3') af kørende midler eller rulningsmidler (3), der danner en valse og er forbundet med plovens (1) langsgående ramme (4) ved mindst to styrede forbindelsesarme (5, 5'), idet hver forbindelsesarm (5, 5') på den ene side omfatter mindst to arme (6 og 6'), der er monteret på en leddelt måde og anbragt således, at de danner et parallelogram (5"), der kan deformeres ved hjælp af vinkelled (12, 12') og er anbragt i et lodret plan (PV) i plovens (1) jordbearbejdningsposition (S), og på den anden side mindst en lineær aktuator (7), der er udformet og anbragt således, at den ved at bevæge armene (6 og 6') kan frembringe forskellige konfigurationer af parallelogrammet, der svarer til respektive forskellige positioner af den yderligere jordbearbejdningsanordning (2), den eller hver aktuator (7) består af mindst en dobbeltvirkende cylinder, plov (1), **kendetegnet ved, at** den eller hver dobbeltvirkende cylinder (8) har en dobbeltstang (9, 9') og et blindrum (10), idet den eller hver cylinder (8) omfatter to kamre (11, 11') med ækvivalente, fortrinsvis væsentligt identiske arbejdssektioner, den eller hver aktuator (7) danner en presse-cylinder til den pågældende valse (3'), og **ved at** den nævnte mindst en aktuator (7) på hver forbindelsesarm (5, 5') er monteret i det deformerbare parallelogram (5"), der udgør den nævnte arm (5, 5'), og strækker sig mellem de to arme (6, 6') af den pågældende arm (5, 5').

2. Plov ifølge krav 1, **kendetegnet ved, at** den nævnte mindst ene aktuator (7) på hver forbindelsesarm (5, 5') er monteret således, at den forbinder rammen (4) direkte med den ene (6) af de arme (6, 6'), der udgør en del af den pågældende forbindelsesarm (5, 5').

3. Plov ifølge et hvilket som helst af kravene 1 til 2, **kendetegnet ved, at** den mindst ene aktuator (7) på hver forbindelsesarm (5, 5') er gjort integreret med et af leddene (12, 12') i det deformerbare parallelogram (5"), der udgør armen (5, 5').

4. Plov ifølge et hvilket som helst af kravene 1 til 3, **kendetegnet ved, at** den mindst ene aktuator (7) på hver forbindelsesarm (5, 5') er fast forbundet ved den ene af sine ender til et af leddene (12, 12') i det deformerbare parallelogram (5"), der danner armen, fortrinsvis et af leddene (12), der er placeret på siden af den langsgående ramme (4), og ved sin anden ende med den arm (6) af

parallelogrammet (5"), der ikke påvirkes af det førnævnte led (12), fortrinsvis på siden af eller tæt på valsen (3'), før dens led (12') med nævnte valse (3').

5 5. Plov ifølge et hvilket som helst af kravene 1 til 4, **kendetegnet ved, at** de to ben (6 og 6') i hver forbindelsesarm (5, 5') er forbundet ved deres respektive modsatte ender med drejeled (12, 12') på den ene side til et leje (13) i en drejeforbindelse (13') med rammen (4), og på den modsatte side til et leje (14) i en drejeforbindelse (14') med en bjælke (15), der bærer rulle- eller valseanordningen (3), idet akserne (ALP1, ALP2) for de to drejeforbindelser (13' og 14') og akserne (ALR, ALR')

10 for de fire drejeled (12, 12') er indbyrdes vinkelrette.

6. Plov ifølge et hvilket som helst af kravene 1 til 5, **kendetegnet ved, at** de forskellige kørende eller rulningsmidler (3), der udgør valsen eller valserne (3'), er i form af skiveformede eller ringformede hjul, som hver er monteret på en bjælke

15 (15) med en langsgående forskydning mellem de forskellige hjul (3), og **ved, at** denne bjælke (15) er forbundet med to forbindelsesarme (5 og 5'), der er leddet og styret til rammen (4), idet sidstnævnte således med de to forbindelsesarme (5 og 5') og bjælken (15) danner et deformerbart parallelogram, hvis udformning styres af en lineær aktuator (17).

20 7. Plov ifølge et hvilket som helst af kravene 1 til 6, **kendetegnet ved, at** den er af den reversible plovtype, og **ved, at** den lineære aktuator (7), der er integreret i hver forbindelsesarm (5, 5'), består af et aktiveringselement, der er dannet af to dobbeltvirkende cylindre (8), hver med en dobbeltstang, justeret i modsatte retninger, monteret i det samme hus, der deler et fælles blindrum (10), og som hver omfatter to kamre (11, 11') med tilsvarende arbejdssektioner, hvor hvert aktiveringselement (7) er forbundet med enderne af de to synlige stænger (9) på de cylindre (8), der udgør det, til tilsvarende forankringssteder på den pågældende forbindelsesarm (5, 5').

30 8. Plov i henhold til et hvilket som helst af kravene 1 til 7, **kendetegnet ved, at** hver aktuator (7) er af den hydrauliske eller pneumatiske type og forsynes af et passende kontrolkredsløb (18), der indeholder et reguleringsmodul (19).

35 9. Plov ifølge krav 8, **kendetegnet ved, at** reguleringsmodulet (19) er konfigureret til ved hjælp af de styrede forbindelsesarme (5, 5') at generere en trykværdi til at trykke den eller hver valse (3') på jorden (S) inden for et forudbestemt værdiområde, fortrinsvis i det væsentlige lig med en forudindstillet referenceværdi, idet det

overskydende volumen af væske, der er til stede i styrekredsløbet (18), om nødvendigt evakueres til en buffertank (20) eller en traktortank (21).

5 10. Plov ifølge et hvilket som helst af kravene 1 til 9, **kendetegnet ved, at** den består af en monteret plov, reversibel eller ej, der omfatter en enkelt valse (3').

11. Plov ifølge et hvilket som helst af kravene 1 til 9, **kendetegnet ved, at den** består af en halvmonteret plov, der omfatter to valser (3'). 1

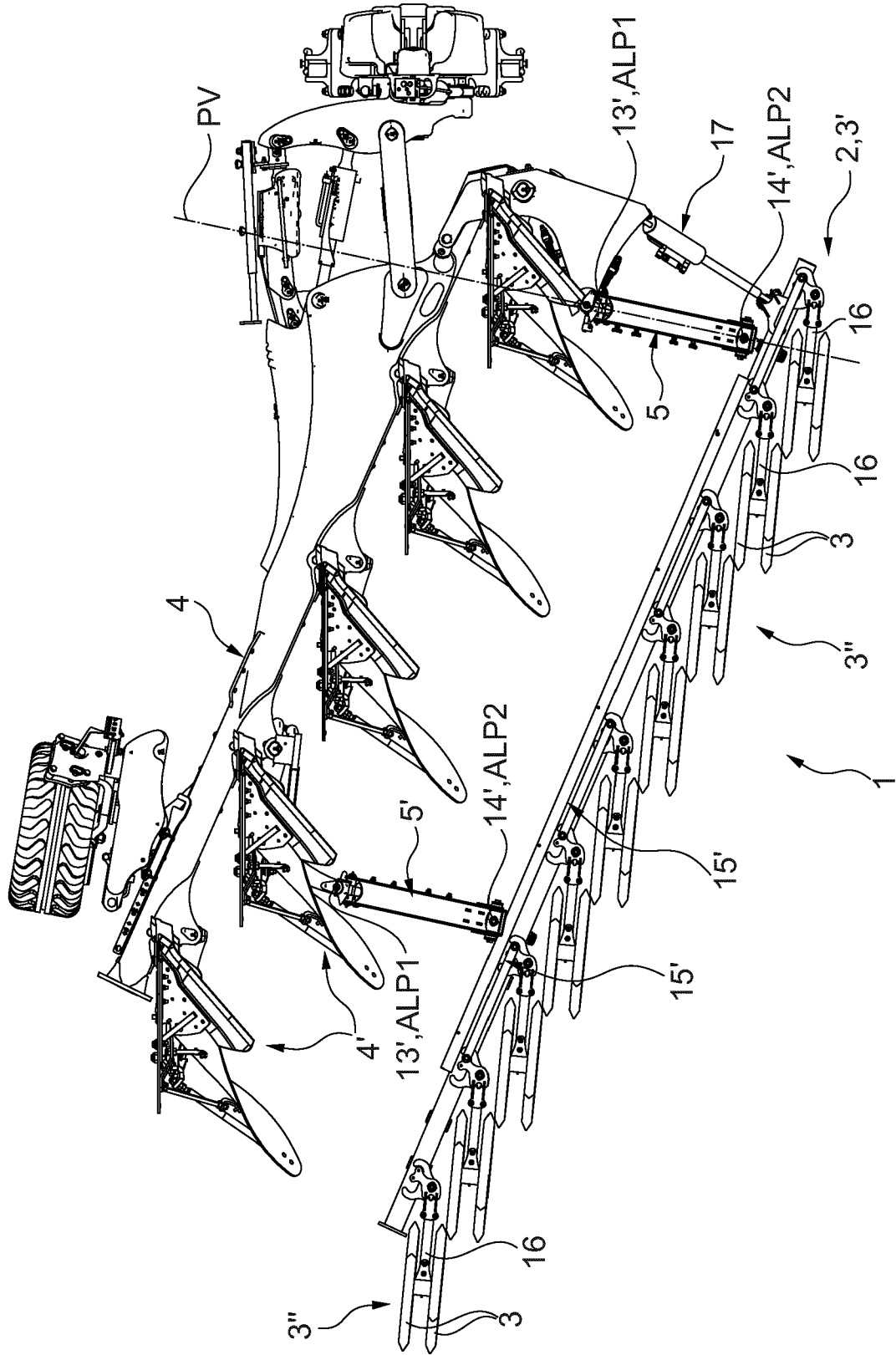


Fig. 1

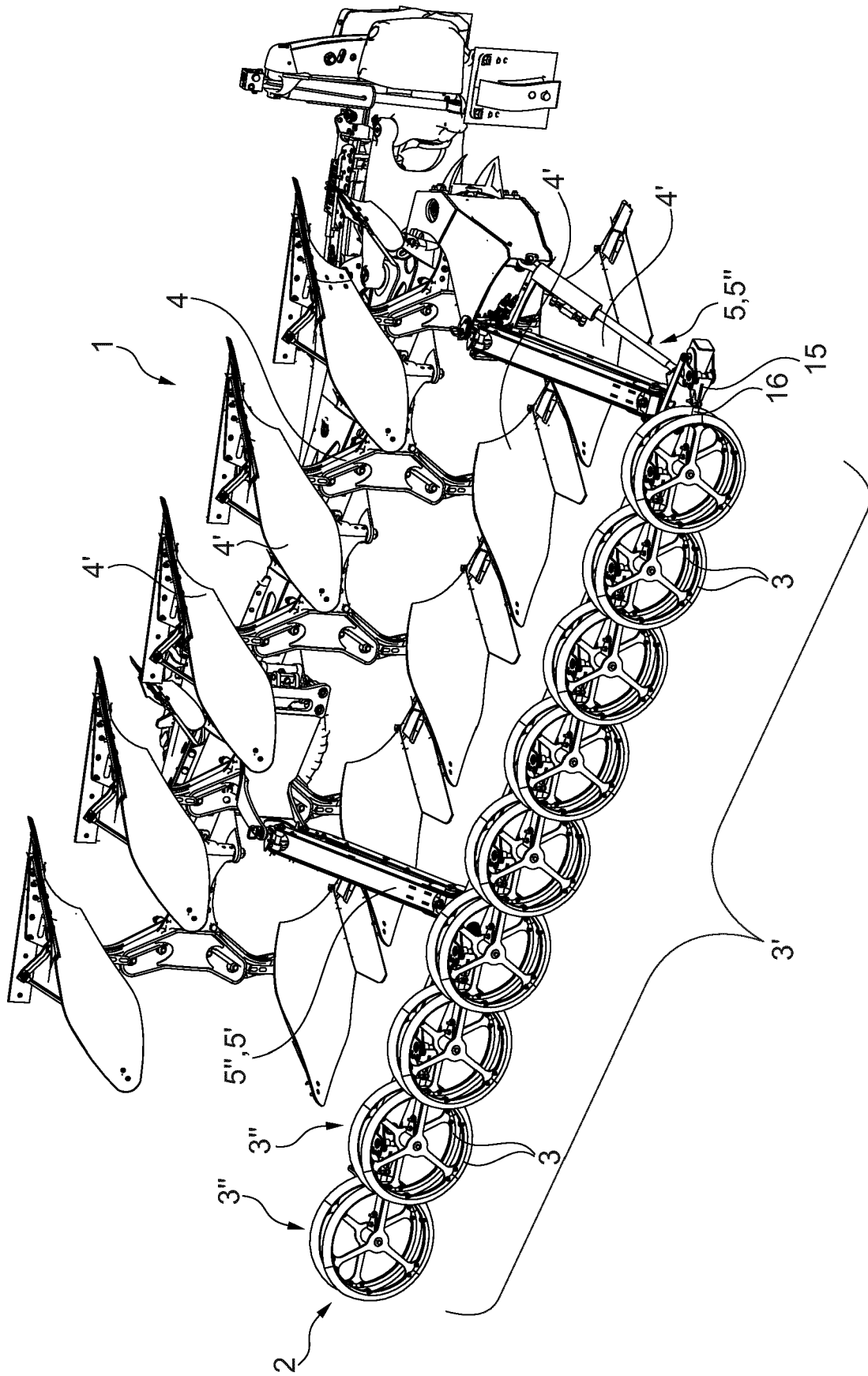


Fig. 2

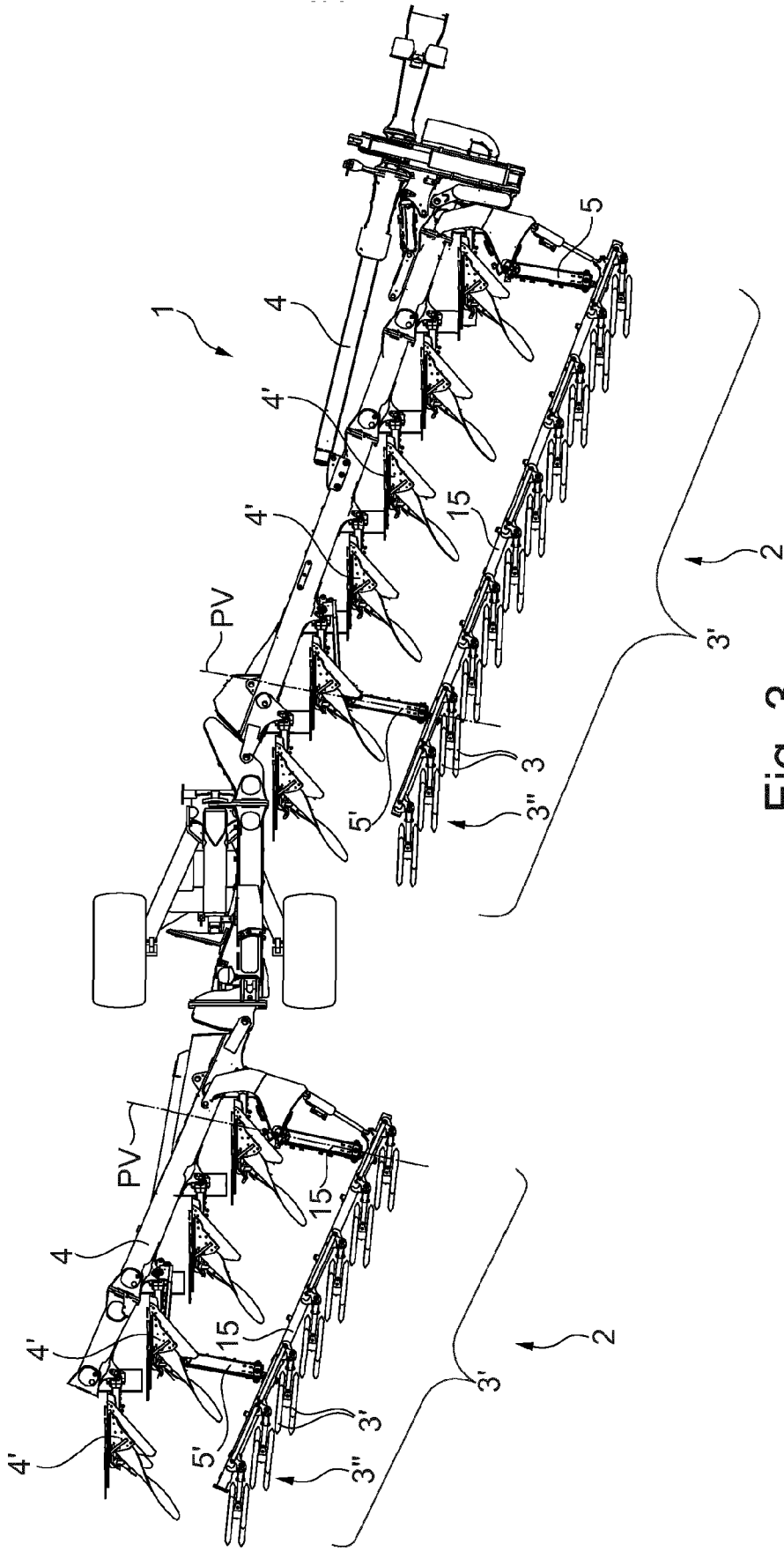


Fig. 3

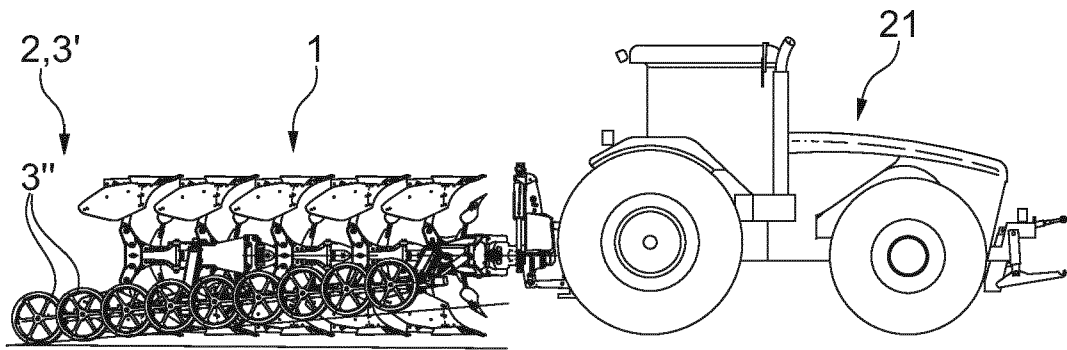


Fig. 4A

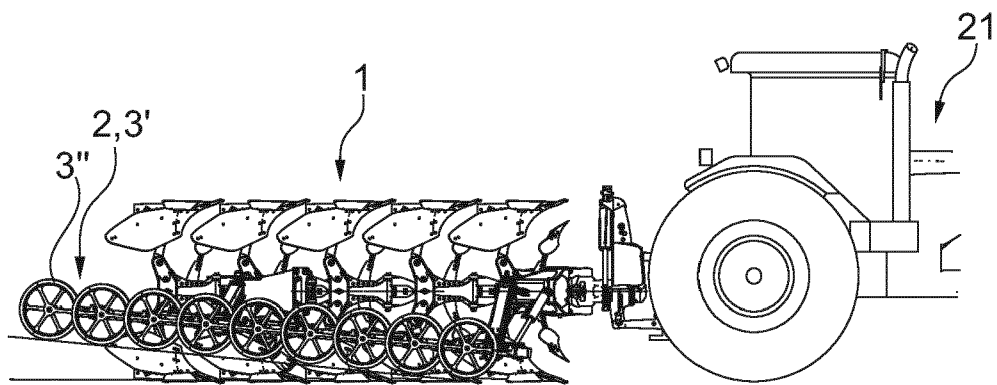


Fig. 4B

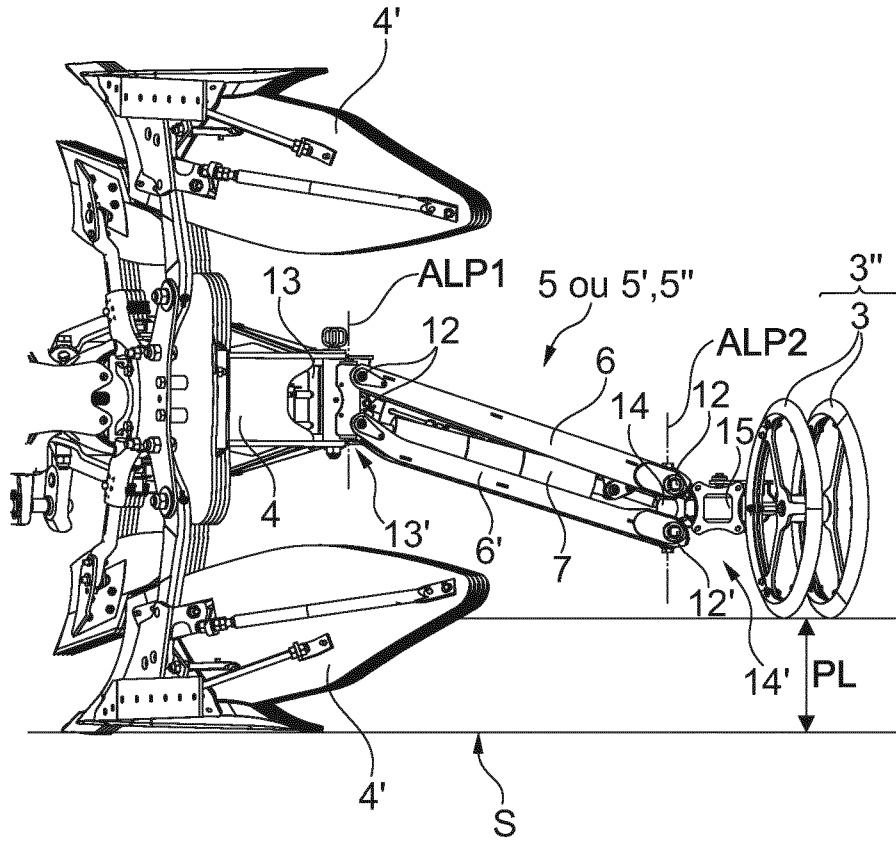


Fig. 5A

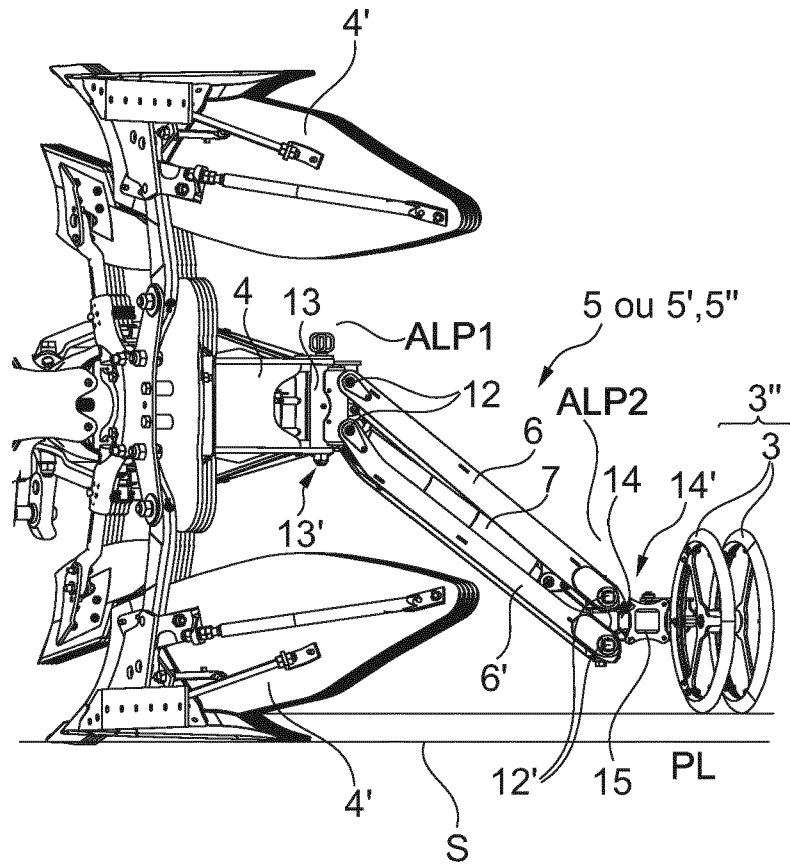


Fig. 5B

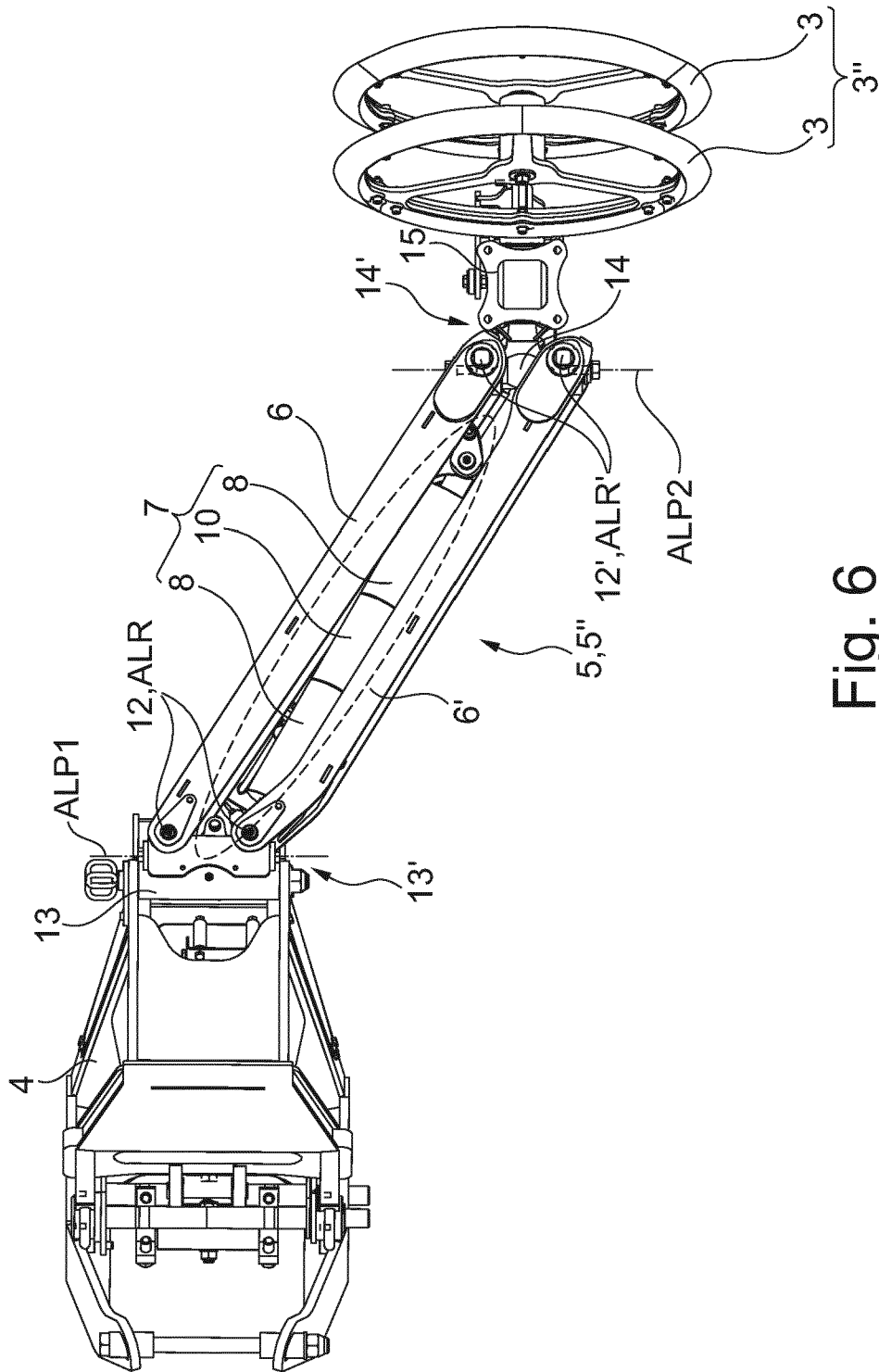


Fig. 6

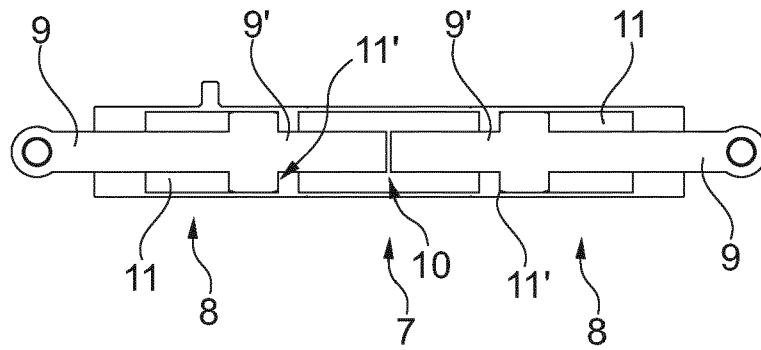


Fig. 7A

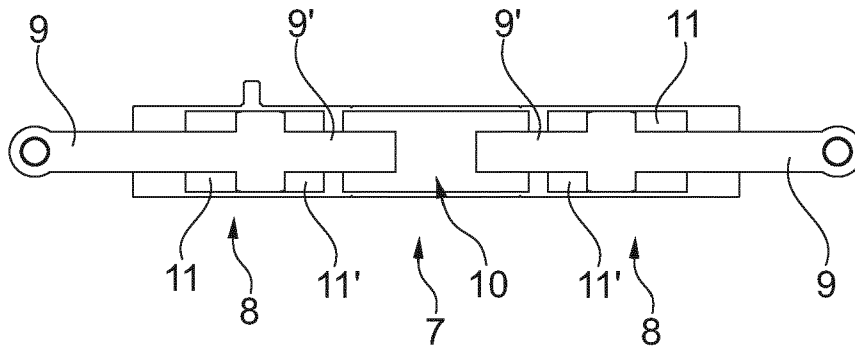


Fig. 7B

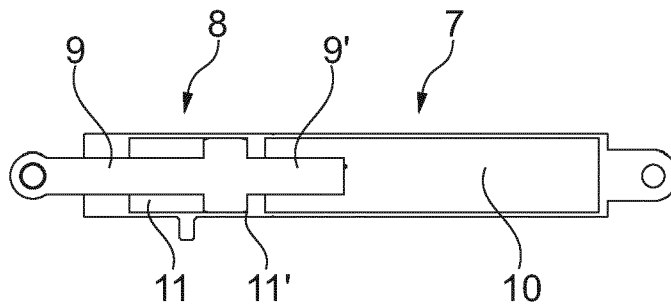


Fig. 8

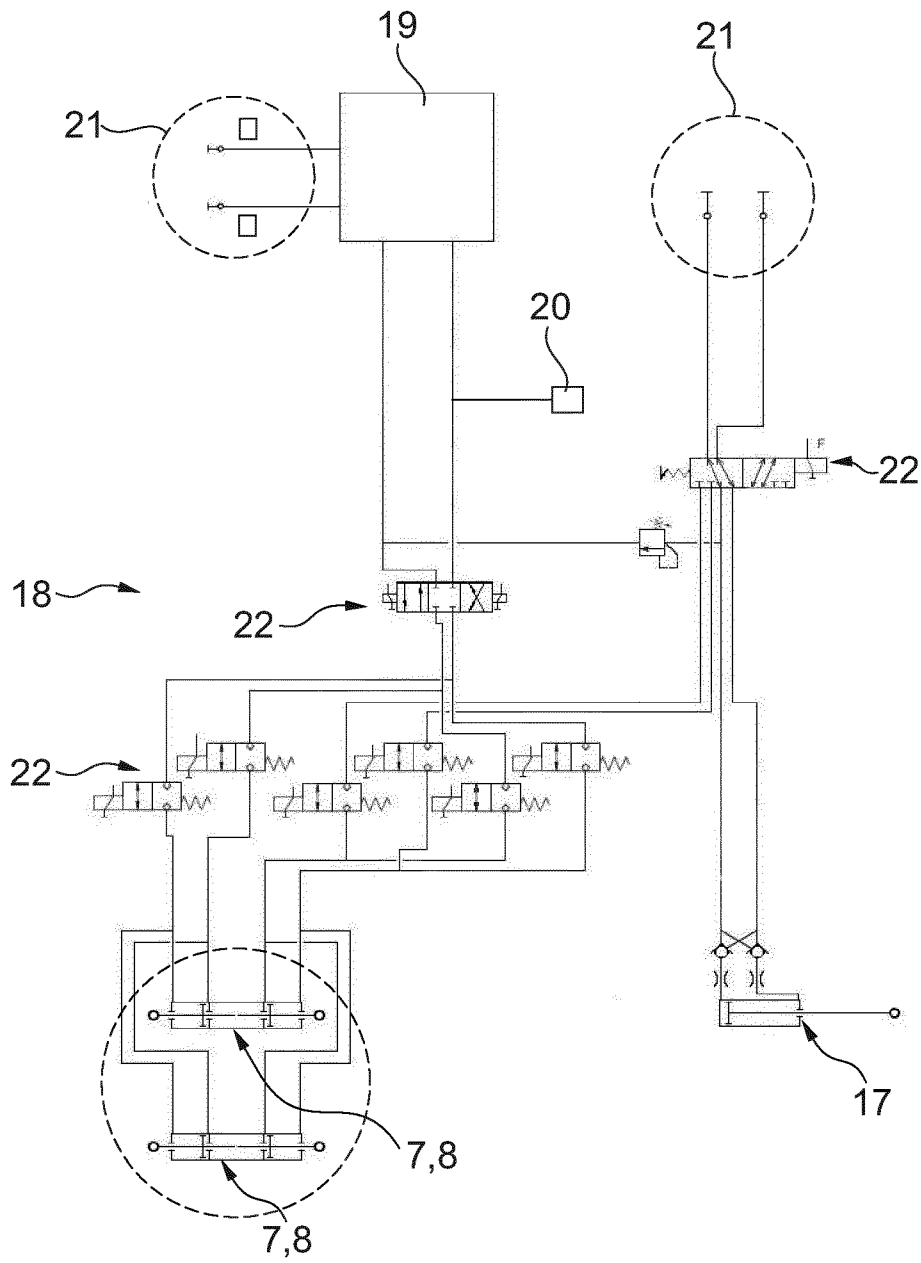


Fig. 9