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(71) Applicant: **FARMDROID APS** [DK/DK]; Mogelmosevej 54, 6630 Rodding (DK).

(72) Inventors: **VEST WARMING, Jens;** Rodding Bakkevej 6, 6630 Rodding (DK). **VEST WARMING, Kristian;** Dalgardsvej 112, 6600 Vejen (DK). **F0RBY-MADSEN, Peter;** Gellerupvej 117, 6800 Varde (DK).

(74) Agent: **TROPA APS;** Aagade 97, 1st floor, 8370 Hadsten (DK).

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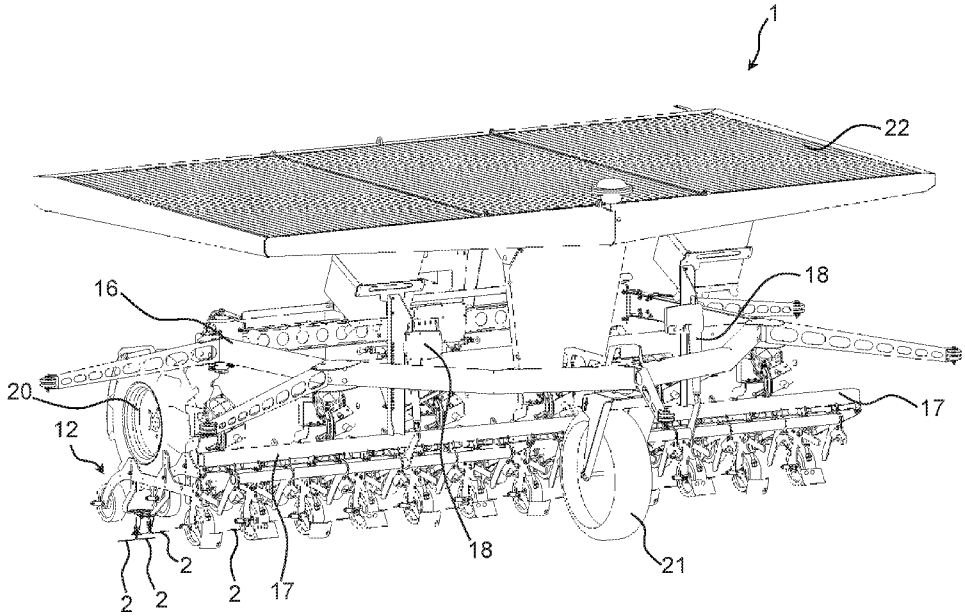

Fig. 2

(57) **Abstract:** A method for weeding between rows of crops and between individual plants in each row whereby a weeding rod (2) is suspended at a proximal portion (4) thereof and left un-suspended at a distal portion (6) thereof whereby the suspension keeps the distal portion (6) and proximal portion (4) in the same horizontal plane. The method further comprises the step of ensuring that the weeding rod has a rounded cross section in a transverse plane with respect to a length axis thereof between the proximal portion (4) and the distal portion (6) and the further step of advancing the weeding rod (2) below ground level in a direction along a ground plane.

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Method for weeding and a weeding rod

The present invention relates to a method for weeding in fields wherein the crop has been sowed in rows. The present invention also relates to a weeding rod.

It is known that weeding may be performed by weeding irons which are advanced below the surface to cut weed roots. Such known weeding irons usually comprise a sharpened edge portion to ensure the smallest possible resistance when the iron penetrates the soil and cut weed roots. However, it has been determined, that for weeding processes which are repeated often and as a result are directed at newly sprouted weeds, it is better to not cut the roots, but to pull the roots out of the ground as far as possible.

DE 32 46 527 discloses a weeding rod, which comprises an iron rod fastened to a shaft, which has an angled portion at its distal end adapted to be drawn or pushed below ground transversely to the length direction of the angled portion. No method for weeding whereby the speed of the weeding iron is kept within limits is disclosed.

Weeding implement comprising horizontally driven rods to be used alone or with well known cultivators such as harrows, which are to be drawn by tractors are widely known, and an illustrative example is provided in CA 1184 804. There are no methods associated with the such implements which suggest that they be used with lower or upper speed limits for purposes of restricted energy consumption or wear. On the contrary, the known implement usually are designed for use with tractors driven at highest possible speeds which commonly is well above 8 km/h.

Thus, there is a need for a method and a weeding iron, which will pull weeds out of the ground and continue to do so even when it has been

worn down. And a weeding method, which consumes less energy than prior art weeding methods is desired.

The object of the present invention can be achieved by a method as defined in claim 1 and by a weeding rod having the features as defined in claim 6. Preferred embodiments are defined in the dependent subclaims, explained in the following description and illustrated in the accompanying drawings.

In an aspect, the invention comprises a method for weeding between rows of crops whereby a weeding rod is suspended from a vehicle part at a proximal portion of the weeding rod and left un-suspended at a distal portion thereof whereby the suspension keeps the distal portion and proximal portion in the same horizontal plane whereby a step ensuring that the weeding rod has a rounded cross section in a transverse plane with respect to a length axis thereof between the proximal portion and the distal portion is performed and the further step of advancing the weeding rod below ground level in a direction along a ground plane is performed. The first step is performed in that it is initially ensured, that the rod has a rounded shape, and as wear will progress on surfaces facing the direction of movement such surfaces will wear down gradually and this will ensure that the shape remains rounded in any transverse cross section of the weeding rod. The second step of advancing the rod below surface but parallel hereto will ensure the mentioned wear, and at the same time the specified motion will root up most newly established weeds, which is the desired effect. Weeds which are not rooted up such as perennials like thistles may have stem parts broken below surface. The established suspension at one end of the weeding rod ensures, that at the not-suspended end, weed roots and other debris may slide off the rod during motion in the ground.

According to the invention the speed of the weeding rod in the motion

direction with respect to the ground is between 0,3 and 5 km/h preferably between 0,4 and 1,0 km/h and most preferred between 0,5 and 0,8 km/h.

This is a very moderate speed compared to speeds used at conventional weeding, and the low speed also ensures that the weeding rod may be made with a moderate cross section, as it is not exposed to high momentums due to reaction forces from its forced movement in the ground. Also, the lesser the thickness of the weeding rod, the lesser the forces, which are needed to propel it below the surface may be, and the lesser the energy consumption of the weeding process will be. This is of importance as the weeding process is adapted to be powered by sunlight through the solar cells mounted on a farm robot which carries arrays of weeding rods.

Above the chassis of the vehicle there is mounted a solar panel, which may provide electrical power for the driving motion. Also, the vehicle may comprise a number of batteries or other power releasing devices in order to ensure propulsion power to the driving wheels.

Electrical power is also needed for actuators and for electronic calculation and control units and a sensor pack, which are responsible for manoeuvring the vehicle. The sensor pack is a range of sensors adapted to allow the control unit to receive inputs relating to the surroundings, such that the vehicle may function as an autonomous vehicle.

To the sensor pack belongs antenna means capable of picking up GPS or local positioning signals, such that the vehicle shall know its exact location and orientation at any given time in the field.

For supplement or substitute of the GPS or like system, the vehicle may comprise one or more camera or other vision systems, which record images of the surroundings and gleans off the camera position or position changes from such images. In this way the vehicle shall also be able to work autonomously in locations where GPS signals are not readily at hand, such as inside buildings or under dense forest cover.

In an embodiment of the invention the weeding rod is intermittently moved in a direction transversely to the direction of motion. By performing such an additional step, the weeding rod may be introduced into the space between individual plants in a row of plants. Preferably the position of each plant in the row is known and when a robot equipped with the weeding rod knows its position and orientation, it may perform the weeding action between individual plants while advancing in the row and while weeding rods are kept in the ground between the crop rows.

In an embodiment, the weeding rod is advanced in a direction having an angle V with respect to a length axis between the proximal part and the distal part which angle is between 90 and 45 degrees, and more preferred between 90 and 65 degrees and even more preferred between 90 and 85 degrees and most preferred at 90 degrees. The lesser angles between the direction of advancement and the length axis of the weeding rod shall ensure that no roots or dirt particles accumulate on the weeding rood, however it has surprisingly been learned, that even with the movement direction perpendicular to the length axis of the weeding rod, no such accumulations will take place and thus it is preferred to advance the rod under the surface in a direction perpendicular to its length axis.

In yet another embodiment, the method comprises the following further steps: advancing the weeding rod along with several arrays of similar rods below ground level from a first end of a row of crops to a second

end of the row, and at the second end of the row elevating the weeding rods out of the ground and rotating the arrays of weeding rods about a vertical centre axis which is arranged within the arrays of rods. The rotation of the arrays and rods abut one common axis ensures that the robot shall not need enlarged space at the ends of the rows of crops in order to perform a turn about and continue weeding at adjacent rows.

In a further aspect of the invention a weeding rod adapted to be used in the above method is provided, which is made from a steel rod, and has a straight part with a length axis between a proximal part where it is suspended and a distal part where it is un-suspended and where the rod is arranged parallel to a ground surface plane when in use, whereby the weeding rod at the proximal part comprises a portion which extends upwards with respect to a length axis of the rod and a ground surface plane. According to the invention, the weeding rod is made from a round steel rod which has a diameter of between 1 mm and 5 mm and most preferred at 3 mm.

The preferred material for the rods is steel, and preferably a 3 mm DIN17224, AISI 302 grade round steel rod is used. When the rods lack a sharp edge, they will wear down without essentially losing their rounded shape during wear. The upwardly extending part at the proximal end allows the weeding rod to be fixated here, such that the part between the fixated proximal part and the distal part may be moved along the ground plane embedded in the soil. The suspension at only one end of the weeding rod is advantageous in that it allows weeds and roots to slide off the rod at the unsuspended end. Various different fixations of the upwardly extending part are possible, and a vertical or near vertical fixation is preferred, however, fixations where the upwardly extending part is angled with respect to a ground plane would also be possible.

In an embodiment the weeding rod is arranged to be moved underneath a ground level in a direction angled with respect to the length axis between its proximal and distal parts whereby the angle is between 90 and 45 degrees, and preferably between 90 and 65 degrees and more preferred between 90 and 85 degrees and most preferred at 90 degrees. It is to be mentioned that in order to weed between crop plants in a row, the weeding rod may be moved pivotally in a horizontal plane, and thus the angel between length axis and direction of motion will wary during the weeding operation. For other weeding rods this angle does not shift significantly and will stay within the specified limits, as long as the weeding rod is not subject to high strains. Excessive strains may result from accumulations on the weeding rod or objects like rocks and stones in the ground, and thus it is preferred to use a spring steel rod, which may yield backwards, and twist to pass by immovable objects without braking. The spring steel ensures, that the weeding rod shall resume its specified position after a spring action.

In an embodiment the weeding rod has a curved top at the proximal part thereof, and at the curved top it is connected to a further weeding rod which extends to a distal and unsuspended end thereof. Thus, the two weeding rods extend away from each other and are axially aligned but connected at the curved top. This allows convenient suspension of the two weeding rods at their common curved top.

In an embodiment, a weeding rod at its proximal part, is fixated to a wagon above ground, whereby the wagon has a ground supporting wheel at each end thereof and is arranged to extend in a direction between the wheels parallel to the direction of motion of the weeding rod. The wagon and the wheels make sure, that the intended working depth of the weeding rod may be maintained. This is ensured simply by the manual adjustment of a fixture between wagon and weeding rod,

where the fixture comprises a vertical slitformed opening and well-known nut and bolt connection.

In a further embodiment the weeding rod, at its proximal part, is fixated to an arm, which arm is movably connected to the wagon and adapted to move in a transverse direction relative to the forward motion of the wagon. This arrangement allows the movable arm to be guided in between the individual plants in the crop row controlled preferably by GPS signals to avoid that the weeding rod destroys the crop. This movement may alternatively or additionally be controlled by vision systems or other sensory detection of the crop plant.

In an embodiment, an array of weeding rods is attached to each wagon, and an array of wagons are provided side by side and the array of wagons has a set of ground engaging drive wheels at one end and a ground support castor wheel at the opposed end whereby the array of wagons is arranged and adapted to be moved relative to the drive wheels towards or away from the ground. The array of weeding rods on each wagon may all be fixed to the wagon, or a portion thereof may be movable with respect to the wagon. The motion of the wagons up and down with respect to the ground engaging drive wheels is used to move all weeding rods up and out of the ground, when the robot has to re¬locate in order to start weeding in another set of crop rows.

Description of the Drawings

The invention will become more fully understood from the detailed description given herein below. The accompanying drawings are given by way of illustration only, and thus, they are not limitative of the present invention. In the accompanying drawings:

Fig. 1 shows a schematic 3d partial view of an autonomic farm vehicle equipped with weeding rods according to the

invention;

Fig. 2 shows a schematic 3d representation of the entire autonomic farm vehicle shown in part in Fig. 1;

Fig. 3 shows a perspective view of the weeding rod and its suspension;

Fig. 4 shows a perspective view of the weeding rod in Fig. 3, but displayed from a different angle;

Fig. 5 is the weeding rod seen in plain view;

Fig. 6 is a sideview of the suspension and weeding rod without clutch irons;

Fig. 7 is a plane view of an alternative embodiment of the weeding rod and suspension;

Fig. 8 shows a further alternative embodiment of a weeding rod at a suspension thereof;

Fig. 9 shows a further embodiment of a weeding rod;

Fig. 10 is an enlarged sideview of the solution shown in Fig. 9;

Fig. 11A shows a schematic view of weeding rods from above,

Fig. 11B shows a schematic view of weeding rods from above,

Fig. llC shows a schematic view of weeding rods from above,

Fig. 11D shows a schematic view of weeding rods from above,

Fig. 12 shows a singled-out wagon 12 next to a crop row in a 3d view mode,

Fig. 13 shows the wagon 12 in Fig. 12 in a plane sideview and

Fig. 14 shows the wagon 12 from Fig. 12 in a plane view from a rearmost side.

Detailed description of the invention

Referring now in detail to the drawings for the purpose of illustrating preferred embodiments of the present invention, weeding rods 2 of the present invention is illustrated in Fig. 1 along with a farm robot 1 for the deployment of an automatic weeding action.

Fig. 1 shows a schematic 3d partial view of an autonomic farm vehicle or robot 1 equipped with weeding rods 2 according to the invention. Each weeding rod 2 comprise a horizontal part, which extends essentially perpendicular to the principal direction of movement of the vehicle 1, when it is performing a weeding operation. Each rod 2 further has a vertical or upright part 8 connected to the horizontal part at a proximal part 4 thereof, whereby the vertical or upright part 8 is suspended from a suspension iron 10, which is bolted to a wagon 12.

The entire horizontal part is to be embedded in the soil when at work and moved transversely to its length direction. This movement will impart a momentum on the supported part of the rod, and to keep this momentum low relative to the diameter of the rod, the diameter/length relation must be kept reasonable. It is preferred to have a diameter to length relation for the rod length between the proximal suspended part and the distal unsuspended part between 1:10 and 1:50 and preferably it should be around 1:26. When a 3 mm iron rod is used, the length between the distal part and the proximal part thus shall be around 80 mm. The length measure is not necessarily exact as production methods may leave some tolerances within which the rod is made. Present day highly resilient steel types will allow this length to diameter relation to function under most conditions and with the specified speed limits for the forward movement of the rods in the ground. Initially the weeding rod shall have a circular cross section, but with wear, this cannot be maintained. However, as wear is evenly distributed on the surface part facing the direction of movement, the shape shall remain rounded and possibly oval and this results in that there will not be any sharp edge part which could cut weed roots.

Each wagon 12 comprises a pair of wheels namely a leading front wheel 14 at a front end and a trailing rear wheel 15 at a back end, whereby the trailing wheel 15 is arranged to run in the track of the leading wheel

14, and whereby several weeding rods 2 are provided between the two wheels 14,15. The rods 2 thus protrude transversely towards both sides from a wagon length axis defined by the two wheels 14,15. Each wagon 12 is linked to a chassis of the vehicle and may be lifted with respect to the chassis part when the weeding rods 2 are to be lifted out of engagement with the ground. Preferably a linking mechanism establishes a parallel lifting action with respect to the chassis, such that wagon front and rear wheel 14,15 are lifted simultaneously away from the ground whenever a weeding action comes to an end.

Fig. 2 shows a schematic 3d representation of the entire autonomic farm robot vehicle 1 shown in part in Fig. 1. The chassis comprises among other parts, an upper frame 16 and attached thereto a front transverse bar 17 where to an array of the described wagons 12 are linked. The linkage mechanism is not described in any further detail; however, two actuators 18 are shown which may move the linkage mechanism for the translation of the wagons 12 op and down with respect to the chassis.

Also seen in Fig. 2, a pair of driving wheels 20 (only one is shown) and a front castor wheel 21 is provided, such that the driving wheels impart motion to the vehicle 1 with respect to the ground when they are rotated. The castor wheel 21 is at the front of the vehicle 1, and it turns around a vertical suspension axis according to a speed difference between the driving speeds of the two driving wheels 20, which are at the back end of the vehicle. Above the chassis there is mounted a solar panel 22, which may provide electrical power for the driving motion. Also, the vehicle 1 may comprise a number of batteries or other power releasing devices (not shown) in order to ensure propulsion power to the driving wheels 20. Electrical power is also needed for actuators and for electronic calculation and control units and a sensor pack, which are responsible for manoeuvring the vehicle. To the sensor pack belongs

antenna means capable of picking up GPS or local positioning signals, such that the vehicle shall know its exact location and orientation at any given time in the field.

The vehicle 1 is guided along predefined rows of crops (not shown) such as turnips or similar vegetables used for human consumption or animal feed and the dirt surface between the rows shall be tilled with the horizontally extending weeding rods 2, which shall be pushed along parallel to the surface, but between 1 and 3 preferably 1,50 cm below surface.

The weeding rods 2 are made from round iron rods, which has a diameter between 1 and 7, and preferably at between 1 and 5 mm and most preferred at 3 mm. The preferred material for the rods is steel, and preferably a 3 mm DIN 17224, AISI 302 grade round steel rod is used. When the rods 2 lack a sharp edge, they will wear down without essentially loosing their rounded shape. This rounded shape is responsible for the efficient weeding action, as roots of newly sprouted weeds are especially easy to pull out of the ground, which is what the weeding rods 2 do. It has been established, that pulling the weed roots out of the ground is a superior weeding tactics over cutting weed roots, which would have been the result of the weeding action of an implement with a sharpened edge.

Fig. 3 and Fig. 4 discloses the suspension of the weeding rod 2. This suspension is arranged from a downwardly extending iron bar 10, which at its top comprises an angled portion 25 which has bolt holes for the fastening thereof to the corresponding wagon 12.

Two weeding rods 2 are provided at each suspension and the two rods 2 extend horizontally away from each their proximal part 4 at two opposed, but axially aligned directions of the suspension, transversely

of a dominant movement direction, such that a proximal part 4 of each weeding rod is fixated and clutched at the lower end of the suspension iron bar 10, and a distal part 6 of the weeding rod 2 is un-supported.

As can be seen in Fig. 5, the two proximal parts 4 of the weeding rods 2 are connected at the suspension, and preferably the two weeding rods 2 are made from one length of iron rod, which has been bent to shape the two axially aligned weeding rods 2, which extends in each their direction away from the proximal part 4, which part 4 is connected to a curved top 7 through two upwardly extending or vertical parts 8. Each such vertical part 8 is connected to its weeding rod 2 through a curved connection part 9, which connects the horizontal weeding rod 2 with the vertical part 8 through a 90-degree curve.

In Fig. 6 the downwardly extending suspension iron bar 10 is visible, and it can be seen that it has a through-going track 26 which leads from an edge part and slopes downward towards the centre of the bar 10, and then change direction to slope upwards from a lowermost position. This shape ensures a downwardly extending locking nose, which, when iron clutches 28 are added prevents the upper curved top 7 of the weeding rod 2 to slide out of the track 26.

The clutches 28 are added at each their side of the suspension iron bar 10, and by way of a bolt and nut (not shown) they shall be fixated towards the sides of the iron bar 10. A hole 24 passes through the iron bar 10 and the two clutches 28 to accommodate the bolt. As seen in Fig. 3 and Fig. 4 each clutch 28 comprises a linear track 30 for the accommodation of the two vertical parts 8 of the weeding irons 2. The tracks 30 extend from a lower edge and upwards to an apex part of each clutch 28. The tracks 30 themselves will allow the curved top 7 of the weeding rods to slide vertically therein, but as the through going track 26 in the suspension iron bar 10 is sloping with respect to the

vertical direction at its upper end, the iron clutches 28 shall prevent vertical movement of the curved top 7 once the clutches 28 are clamped to the sides of the iron bar 10.

This arrangement shall allow the weeding rods 2 a little slack when mounted to the iron bar 10, and especially the linear tracks 30 in the clutches 20 shall not prevent the vertically extending parts 8 at the proximal part 4 of each weeding rod 2 to turn or twist around its vertical axis, and such a twist allows the horizontally extending weeding rod 2 to become angled backwardly with respect to its movement direction in the soil. Such an angulation may take place if solid objects in the ground such as stones or dropped farming implements are encountered, or if roots from weeds and dirt have accumulated on the weeding iron and impedes its movement beneath the surface. This movement along with the possible spring action of each weeding rod allows any accumulated matter on each rod to slide outwardly towards the distal part 6 and thus the accumulation of dirt or roots will not hamper the function of the weeding rod.

It shall also be noticed that two weeding rods are suspended with one and the same bolt-and-nut connection, and thus it is both easy and fast to perform exchange of weeding rods when they have been worn down. In this connection it shall be mentioned that the relative low speed of the weeding rods in the ground minimizes wear on them.

Fig. 7 discloses an alternative suspension of the weeding rods at a suspension thereof. Here the two weeding rods 2 shown are not interconnected directly, but each comprises a vertical part 8, which is attached to the suspension iron bar 10 by way of a locking clamp 32, which tightens the vertical parts of each rod 2 by a nut and bolt connection 34 schematically indicated. Each vertical part 8 has at its upper end an angled portion 35, which is secured to the iron bar 10 by

being allowed to protrude through a hole in the bar 10.

Fig. 8 shows a further alternative embodiment of a weeding rod 2 at a suspension thereof. Here the vertical parts 8 are made as a loop such that the horizontal rod 2 at the bend 9 loops upwards at an opposed side of the iron suspension bar 10 and goes through a slit in the suspension bar 10 at a curved top 7 and loops downward to join with a further horizontal rod 2. Clutches 28 are provided as explained with respect to Figs. 3 and 4.

Fig. 9 shows a further embodiment of a weeding rod 2, where the vertical part of each of two rods are connected at an apex thereof and follow each other upward in a plane perpendicular to the axis direction of the horizontal parts.

Fig. 10 shows the vertical parts in plane view, seen from an endpart of the horizontal element. The vertical elements are clamped by screw or similar onto a suspension iron (not disclosed) and above the apex there is a clamp or bolt 32 to prevent the weeding rods from moving upwards.

In the Figs. 3 - 10 the pair of weeding rods mounted to the suspension bar 10 each extend transversely to the principal direction of movement, however it is possible by twisting the vertical part 8 of the weeding rod, or by provision of a further bend in a horizontal plane to let each rod run more or less angled with respect to a movement direction. This is indicated schematically in Figs. 11A - 11D. In these figures the weeding rods are seen from above, and the arrow marked D indicates the principal direction of motion of the weeding rods in the ground. In Fig. 11A the pair of rods are disclosed which move perpendicular to their common length axis in the ground commensurate with the indications in Figs. 3- 10. In Fig. 11B the weeding rods are angled backwordly with

respect to the direction D with an angle of 45°. Thus, each rod 2 is suspended at its foremost part in the direction of movement and unsuspended at a rearmost part. This aids in keeping the rod clean during its action in the ground.

In Fig. 11C the angel is 65 degrees and in Fig. 11D the angle is 85 degrees.

The angulation of the weeding rod with respect to the direction of motion will, when in use, also impart a small sideways force on the surface dirt being tilled by the rod, and if the rod is moved many times over in the same trace, this may cause some longitudinal furrows to evolve in the field, which is not desired. For this reason also, it is preferred to keep the weeding rods perpendicular to the direction of motion.

Fig. 12 shows a singled-out wagon 12 next to a crop row in a 3d view mode. The crop plants 38 are disclosed in a row 39 as is the usual way of sowing or planting different types of crops used in agriculture. In between rows it has long been customary to drive weeding implement along using tractors but between the individual plants in a row, it is to this day still customary to weed by hand power or rely on chemical agent to supress weed growth. When the seeds for the crop has been placed precisely according to GPS coordinates as it is known with newly developed sowing robots, a weeding robot may perform weeding between the individual plants while at the same time the robot weeds between the crop rows. To do this, the wagon 12 disclosed in Fig. 12 comprises a weeding rod pair 2, which are provided on a pivotal arm 40. The pivotal arm is seated at a hinge 42 or rotational axel, on the wagon 12 in order to pivot back and forth between two positions guided by an electrical engine 41. In a first position, the arm 40 is retracted and pivoted such that the weeding rods 2 does not interfere with the

crop plants 38 in the row 39, and in the second position the arm 40 is rotated or pivoted around the rotation axel 42, such that the weeding rods 2 are place between two consecutive plants in the row 39. As the position of each plant 38 is known in advance, it is possible to calculate the timing of the pivotal movement of the arm to avoid damage to the crop plants and at the same time obtain a tilling and weeding action of the earth between the plants 38.

Fig. 13 shows the wagon 12 in Fig. 12 in a plane sideview, and here the electrical engine 41 and hinge 42 are shown.

Fig. 14 shows the wagon 12 from Fig. 12 in a plane view from a rearmost side.

Figs. 12, 13 and 14 an assembly 44 is visible at the wagon 12, and similar assemblies 44 are visible at the array of wagons at the robot displayed in Fig. 1 and 2. This assembly is used when the robot is used in sowing operation and is not used during weeding action. However the assembly may be pivoted into sowing position with the loosening of few bolt and nut connections, and similarly the weeding implements are easily taken out of use and placed in a position above the wagon, such that they do not interfere with a sowing operation.

The back and forth pivotal movement of the arm 40 may be linked to a cam follower element (not shown), such that the arm is lifted to retract the weeding rods out of the soil when the arm is not advanced for weeding between he crop plants, and is lowered down for engagement with the soil when pivoted to weed between the plants.

Weeding rod depths is individually adjustable by simple and as such known measures. In Fig. 12 it can thus be seen that the foremost weeding rod pair on the wagon are connected to a frame member of the

wagon through a vertically shaped slit therein, and similarly the pivotally mounted rod assembly may be moved up and down manually by the suspension iron 10 being connected to the pivotal arm 40 through a similar vertical slit in which is seated a bolt and nut connector pair.

List of reference numerals

1	- Farm robot
2	- Weeding rods
4	- Proximal part
6	- Distal part
7	- Curved top
8	- Vertical part
9	- Curved connection part
10	- Suspension iron bar
12	- Wagon
14	- Front wheel
15	- Back wheel
16	- Upper frame
17	- Transverse bar
18	- Actuators
20	- Driving wheels
21	- Front castor wheel
22	- Solar panel
24	- Hole
25	- Angled portion
26	- Through going track
28	- Iron clutches
30	- Linear track
32	- Locking clamp
35	- Angled portion
34	- Lower clamp
36	- Upper clamp
38	- Crop plant
39	- Crop plant row
40	- Pivotal arm

41 - Electrical engine

42 - Hinge

44 - Assembly

Claims

1. A method for weeding between rows of crops whereby a weeding rod (2) is suspended from a vehicle part at a proximal portion of the weeding rod (4) and left un-suspended at a distal portion (6) thereof whereby the suspension keeps the distal portion (6) and proximal portion (4) in the same horizontal plane, whereby the method comprises the step of ensuring that the weeding rod has a rounded cross section in a transverse plane with respect to a length axis thereof between the proximal portion (4) and the distal portion (6) and the further step of advancing the weeding rod (2) below ground level in a direction along a ground plane **characterised in** that the speed of the weeding rod in the motion direction with respect to the ground is between 0,3 and 5 km/h preferably between 0,4 and 1,0 km/h and most preferred between 0,5 and 0,8 km/h.

2. A method according to claim 1, **characterised in** that to a sensor pack of the vehicle belongs antenna means capable of picking up GPS or local positioning signals, such that the vehicle shall know its exact location and orientation at any given time in the field.

3. A method according to claim 1 or claim 2, **characterised in** that the weeding rod (2) is intermittently moved in a direction transverse to the direction of motion in order to also perform a weeding action between individual plants in an adjacent row of crop plants.

4. A method as claimed in claim 1, **characterised in** that the weeding rod is advanced in a direction having an angle V with respect to a length axis between the proximal part and the distal part which angel is between 90 and 45 degrees, and more preferred between 90 and 65 degrees and even more preferred between 90 and 85 degrees and most preferred at 90 degrees.

5. A method according to any of the above claims, **characterised in** that the method comprises the following steps: advancing the weeding rod (2) along with several arrays of similar rods (2) below ground level from a first end of a row of crops to a second end of the row, and at the second end of the row elevating the weeding rods (2) out of the ground and rotating the arrays of weeding rods (2) about a vertical centre axis which is arranged within the arrays of rods (2).

6. A weeding rod (2) adapted to be used in a method as claimed in claim 1, where the weeding rod is (2) made from a steel rod, and has a straight part with a length axis between a proximal part (4) where it is suspended and a distal part (6) where it is un-suspended and where the rod (2) is arranged parallel to a ground surface plane when in use between the proximal and distal parts, whereby the weeding rod (2) at the proximal part (4) comprises a portion (8) which extends upwards with respect to a length axis of the rod (2) and a ground surface plane **characterised in that** the weeding rod (2) is made from a round steel rod, which has a diameter between 1 and 5 mm and most preferred at 3 mm.

7. A weeding rod (2) as claimed in claim 6, **characterised in** that the weeding rod (2) is arranged to be moved underneath a ground level in a direction angled with respect to the length axis between its proximal and distal ends whereby the angle is between 90 and 45 degrees, and preferably between 90 and 65 degrees and more preferred between 90 and 85 degrees and most preferred at 90 degrees.

8. A weeding rod (2) as claimed in claim 6 or 7, **characterised in** that the weeding rod (2) at the proximal part (4) has a curved top (7) and at the curved top (7) is connected to a further weeding rod (2) which extends to a distal and unsuspended end thereof.

9. A weeding rod (2) as claimed in any of claims 6 - 8, **characterised in** that the weeding rod (2) at its proximal part (4) is fixated to a wagon (12) above ground, whereby the wagon (12) has a ground supporting wheel (14,15) at each end thereof and is arranged to extend in a direction between the wheels parallel to the direction of motion of the weeding rod (2).

10. A weeding rod (2) as claimed in any of claims 6 -9, **characterised in** that the weeding rod (2) at its proximal part (4) is fixated to an arm (4), which arm (4) is movably connected to the wagon (12) and adapted to move in a transverse direction relative to the forward motion of the wagon.

11. A weeding rod (2) as claimed in claim 9 or 10, **characterised in** that an array of weeding rods (2) is attached to each wagon (12), and that an array of wagons (12) are provided side by side and has a set of ground engaging drive wheels (20) at one end, and a ground support castor wheel (21) at an opposed end whereby the array of wagons (12) is arranged and adapted to be moved relative to the drive wheels (20) towards or away from the ground.

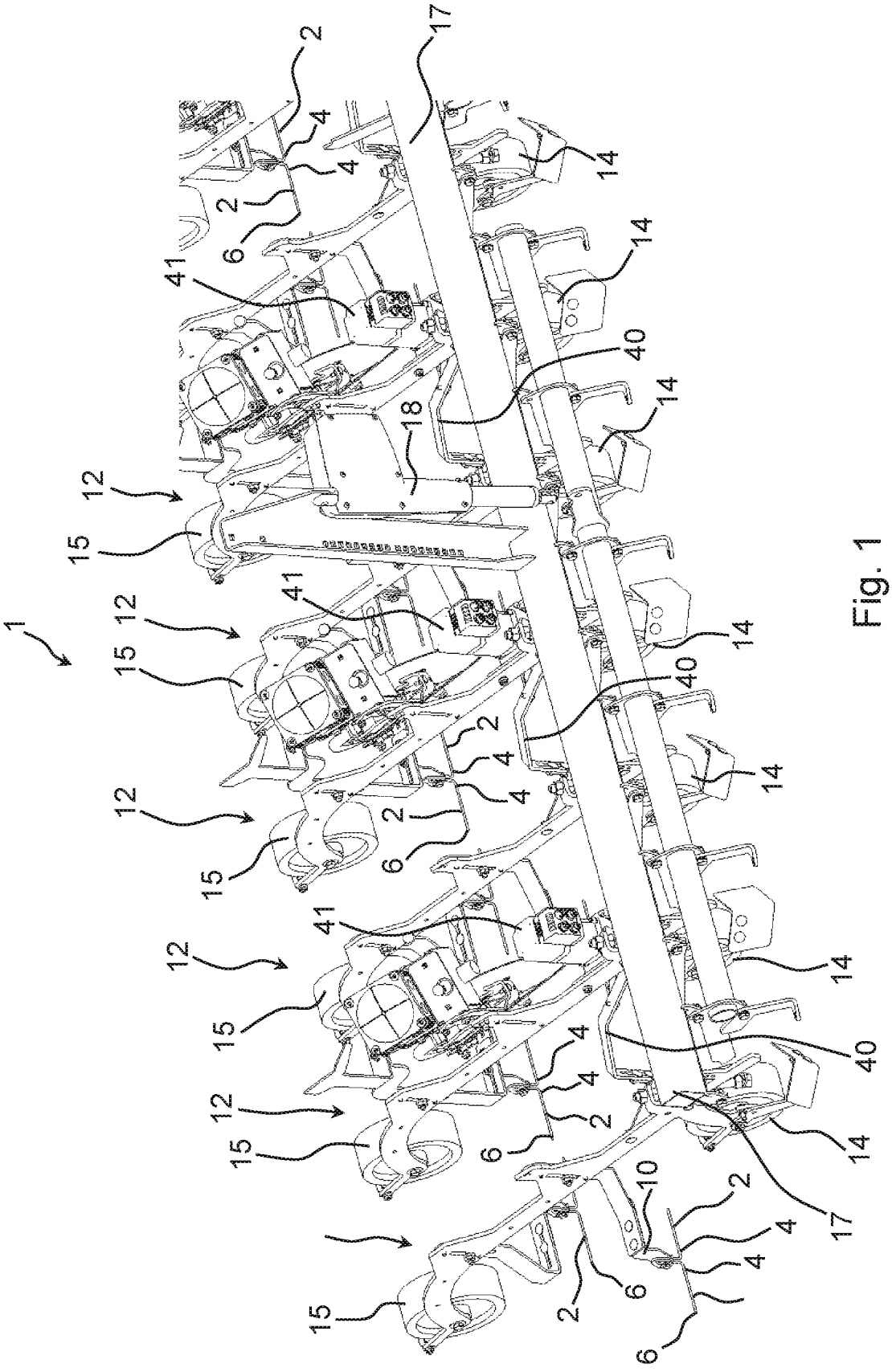


Fig. 1

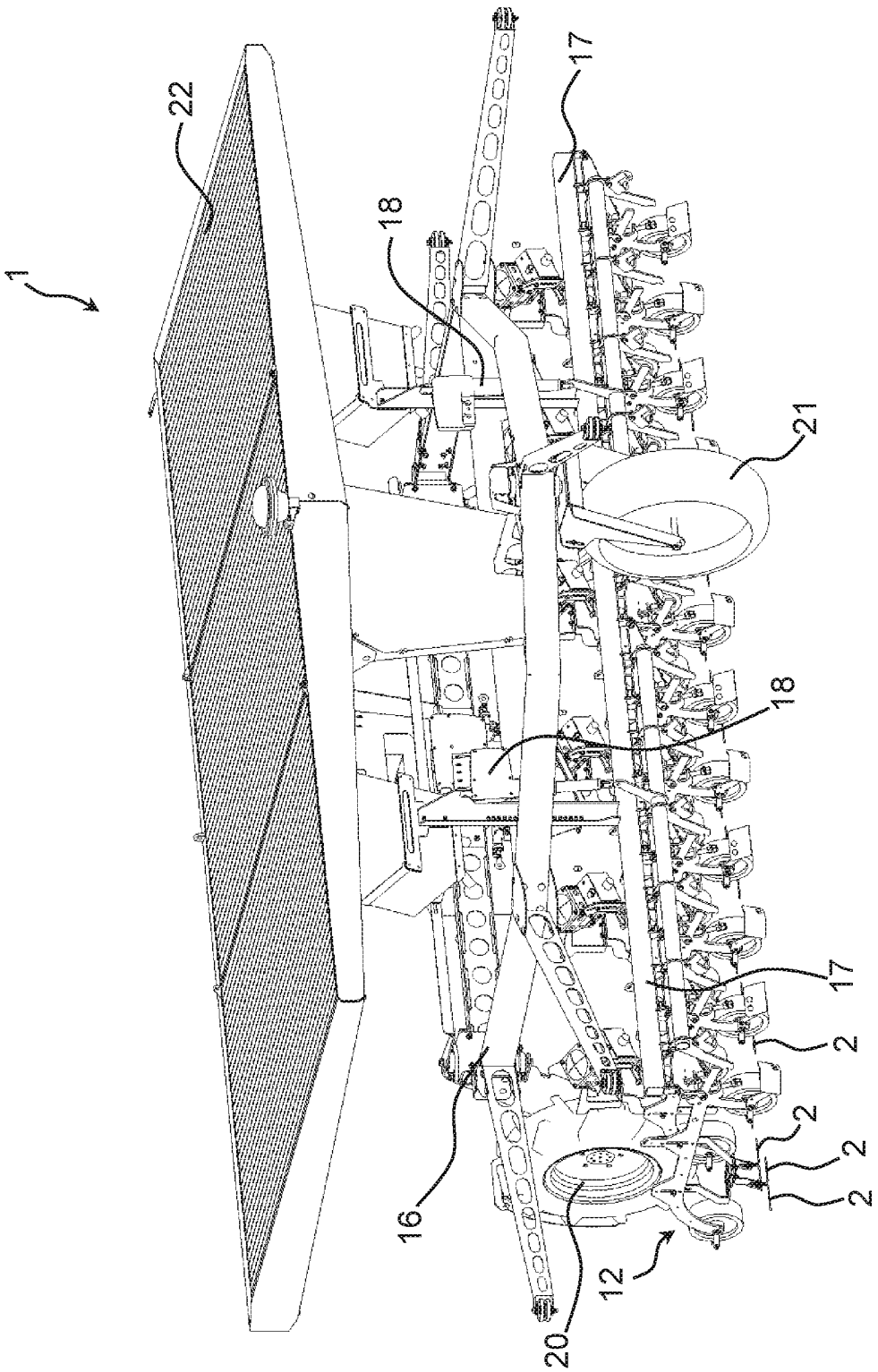


Fig. 2

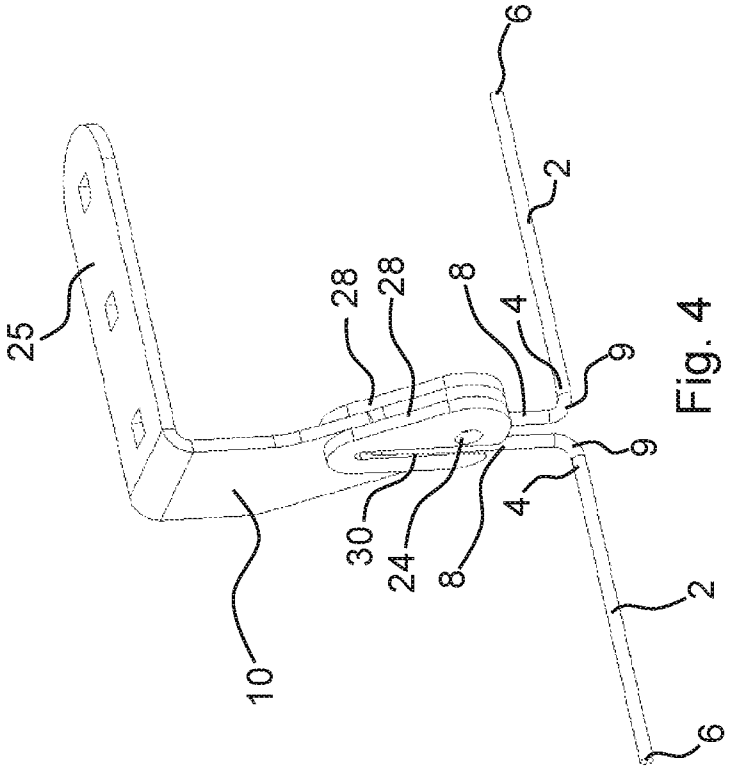


Fig. 4

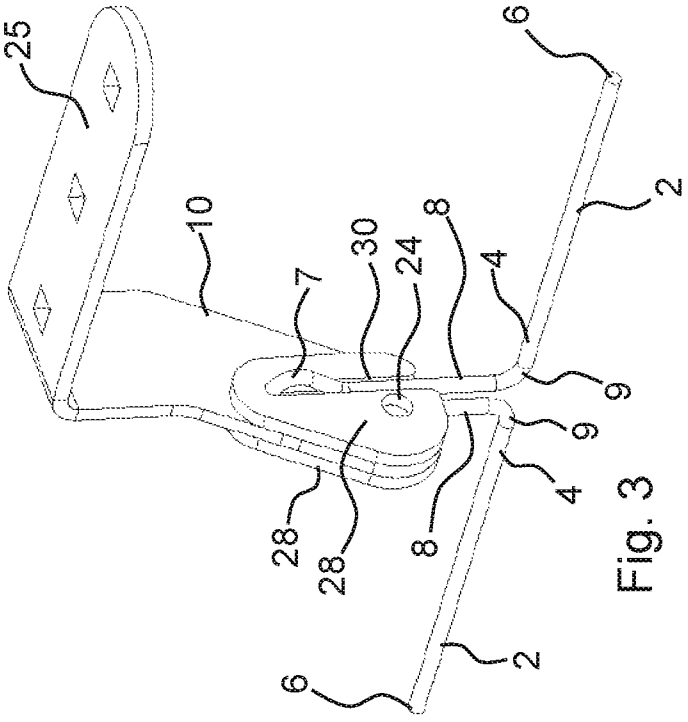


Fig. 3

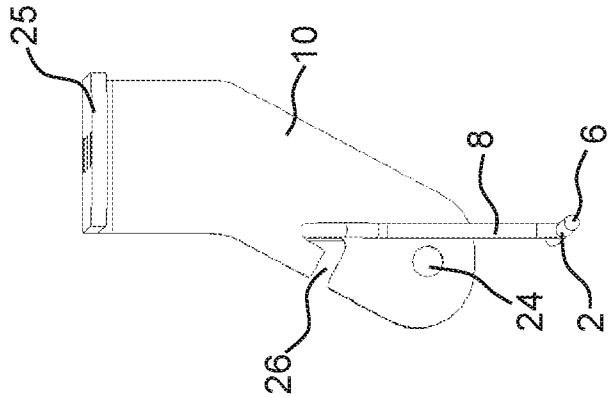


Fig. 6

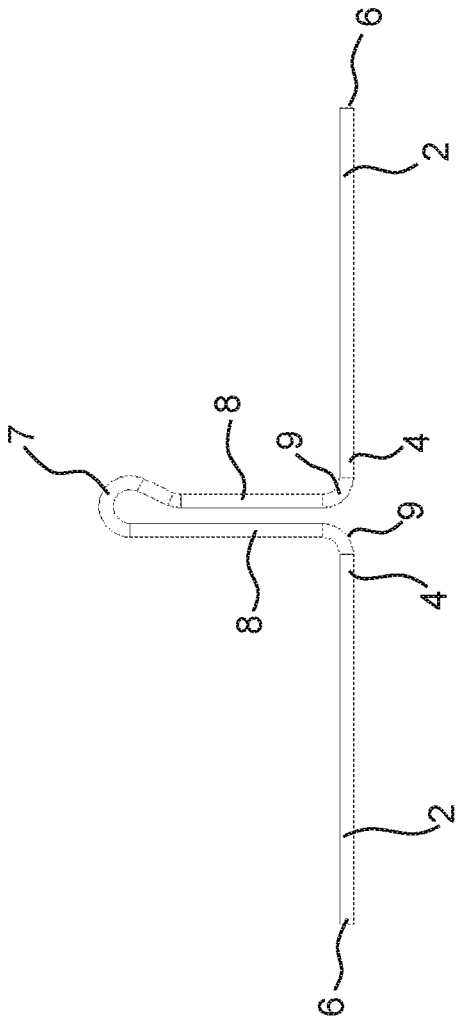


Fig. 5

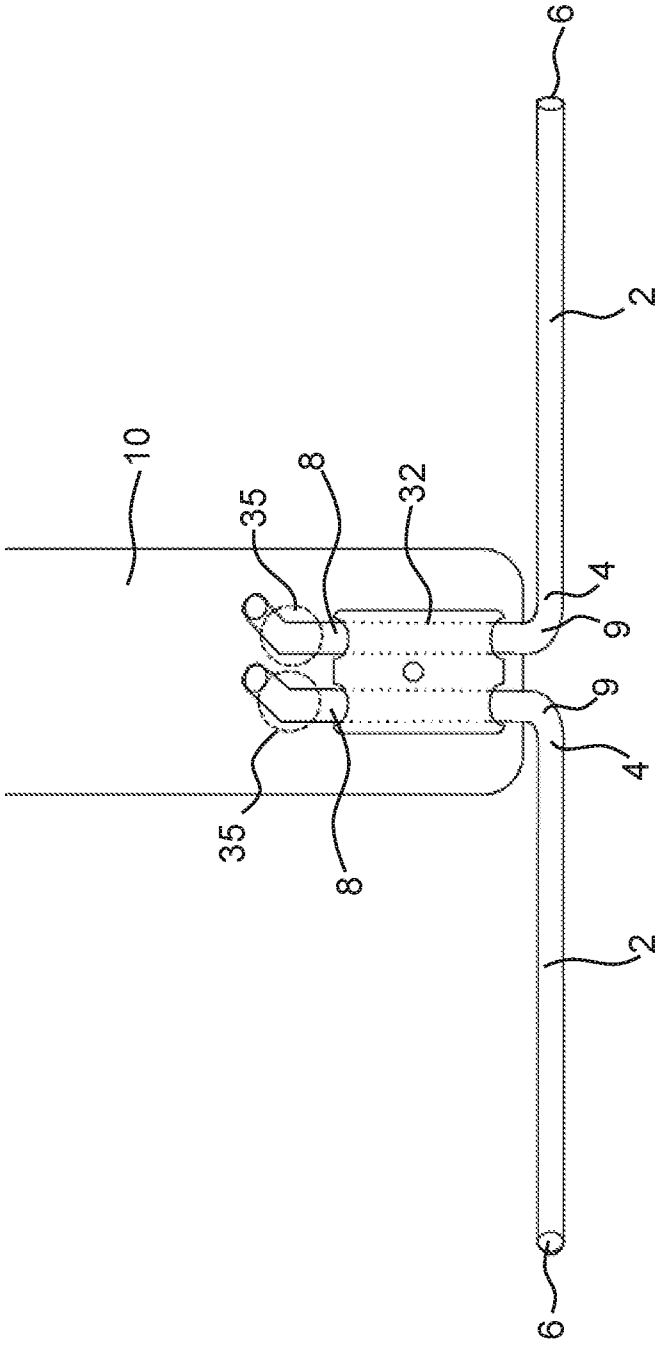


Fig. 7

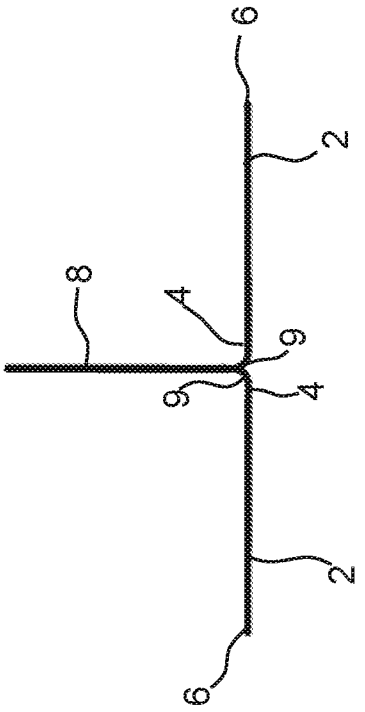


Fig. 9

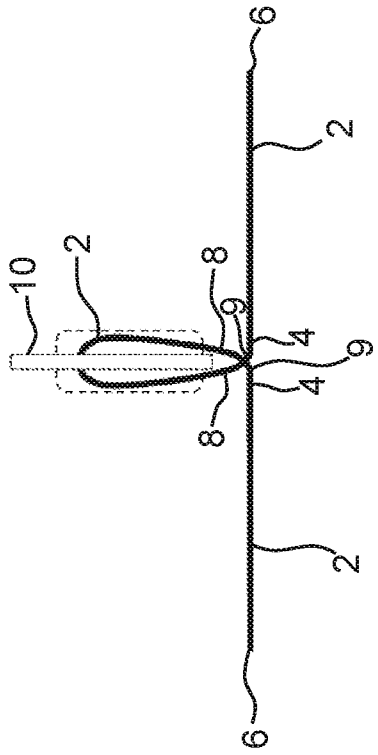


Fig. 8

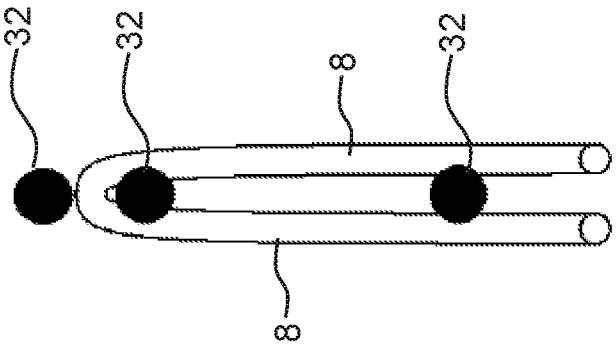
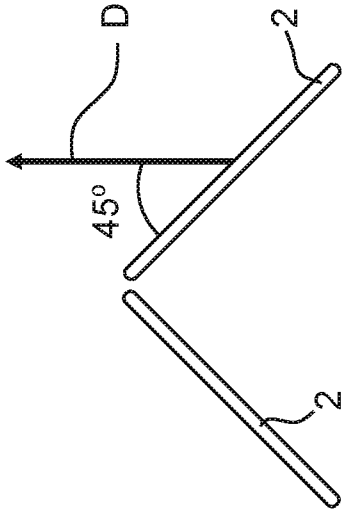


Fig. 10



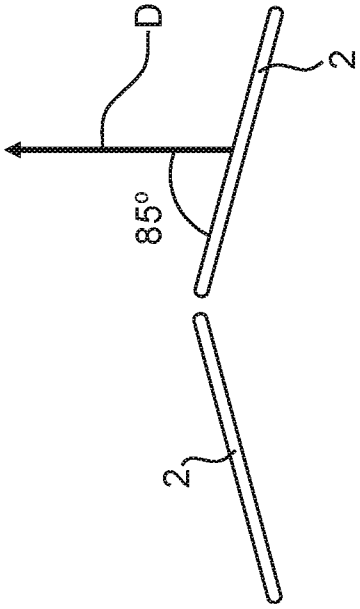


Fig. 11D

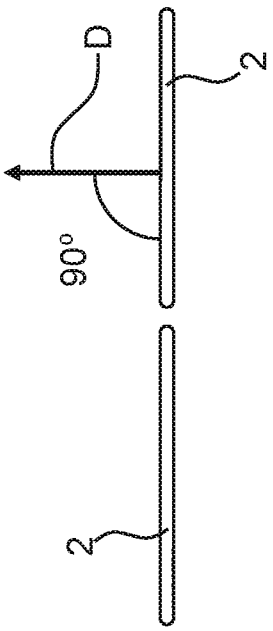


Fig. 11A

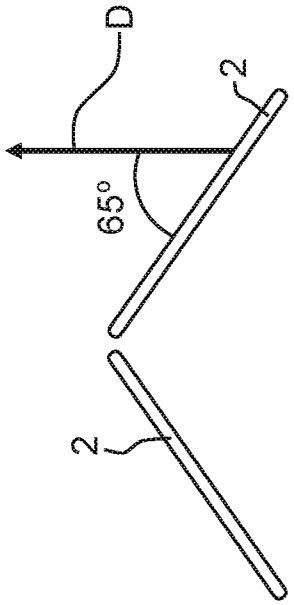


Fig. 11C

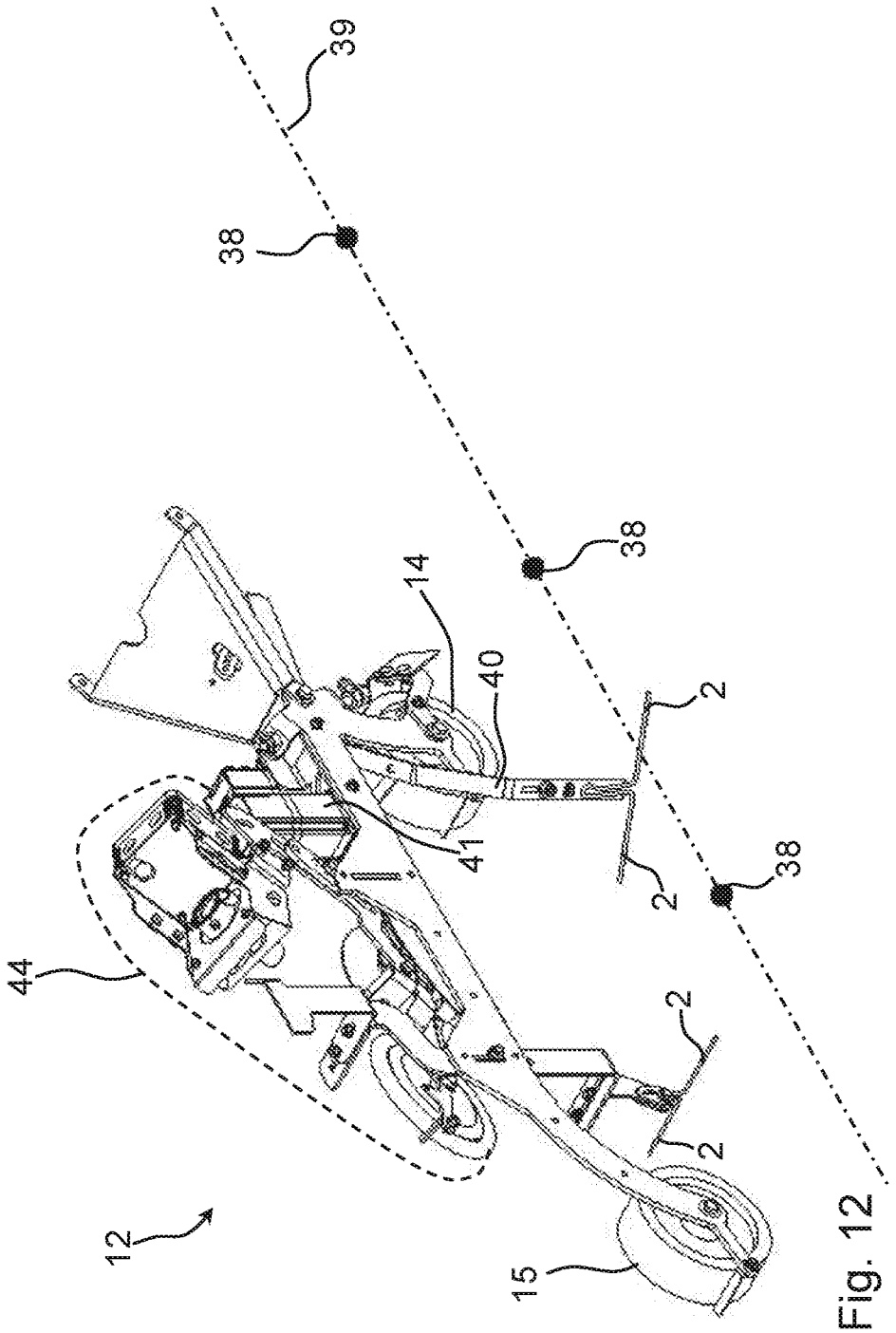


Fig. 12

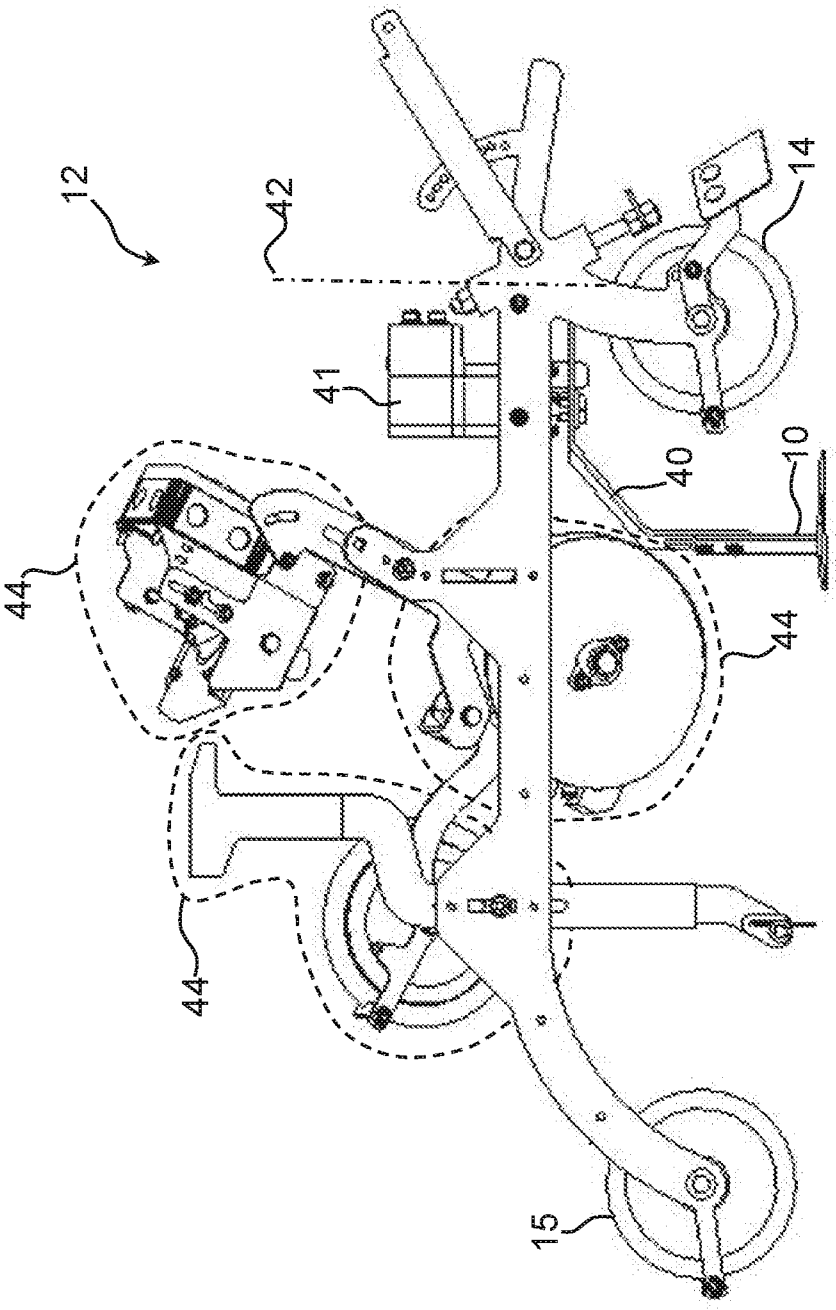


Fig. 13

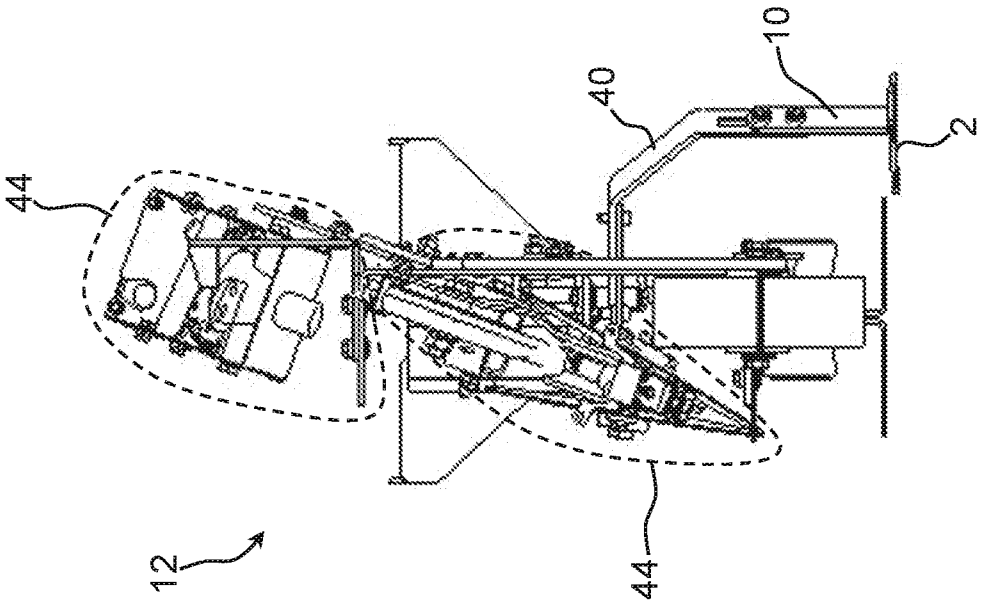


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2020/050078

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01B39/18 A01B63/00 A01B79/00 A01M21/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01B A01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	AU 39427 85 A (LINKLATER I J) 3 October 1985 (1985-10-03) pages 4-8; figures -----	1-11
Y	WO 2016/191825 A1 (UNIV SYDNEY [AU]) 8 December 2016 (2016-12-08) paragraphs [0009] - [0033]; figures ----- -/--	1-11

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 June 2020	07/07/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Vedoato, Luca

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INTERNATIONAL SEARCH REPORT

International application No
PCT/D K2020/050078

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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