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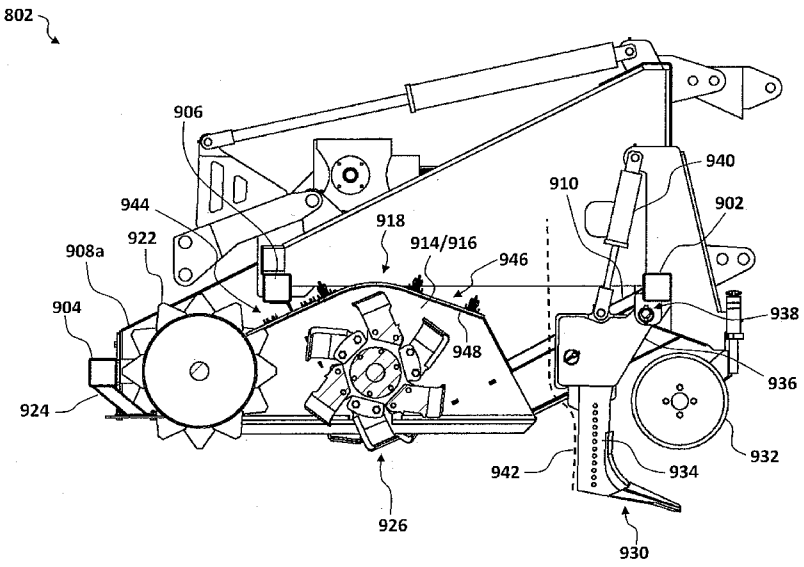
FIG. 10



(57) **Abstract:** A ground working machine includes a chassis, and a plurality of row units attached to the chassis. Each row unit includes a frame, and a ground working rotor rotatably attached relative to the frame. Each row unit includes a ripping tine positioned in front of the rotor relative to the intended direction of travel in use. Each row unit includes a coulter positioned in front of the ripping tine relative to the intended direction of travel in use.

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AN AGRICULTURAL IMPLEMENT

STATEMENT OF CORRESPONDING APPLICATIONS

This application is based on the specification filed in relation to New Zealand Patent Application No. 743074, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

Embodiments of the disclosure relate to an agricultural implement – more particularly a ground working machine.

BACKGROUND

There are a wide variety of techniques used to prepare agricultural land for the planting of crops. Generally, tilling is used to break up the soil for ease of planting, and to create a soil structure which encourages seed germination and plant growth. Tilling also allows for fertilisers and other treatments to be readily added to the soil during or after the tilling process.

Recently, strip tilling has become popular for farming row crops – producing a series of strips in which the soil is loosened and planting is done, with the residue on the surface of the soil between the strips left intact. Strip tillage is considered to reduce the extent of erosion, reduce fertiliser requirements, and conserve soil moisture in comparison with intensive tillage techniques – while still providing the benefits of worked soil to encourage crop growth in comparison with no-tilling techniques.

Strip tillage machines usually comprise a chassis having a rigid frame to which is attached a plurality of tilling units for tilling the soil in rows. Each tilling unit comprises a frame supporting a rotor. As the tilling unit moves along the ground, the rotor is caused to rotate and penetrate the ground to break up the soil.

It is generally desirable to minimise the number of passes required by a strip tillage machine to achieve a desirable soil structure. Known strip tillage machines typically require multiple passes to break up hard soils. As well as fuel and labour costs, this can compact the soil and reduce growth potential.

It is an object of the present invention to address at least one of the foregoing problems, or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

SUMMARY

According to one aspect of the present disclosure there is provided a row unit for a ground working machine, the row unit including:

a frame; and

at least one ground working rotor rotatably attached relative to the frame.

Reference to a row unit for a ground working machine should be understood to mean a device configured to be brought in contact with the ground for the purpose of tilling a row of soil with the passage of the ground working machine.

According to one aspect of the present disclosure there is provided a ground working machine, including:

a chassis; and

at least one row unit substantially as herein described, attached to the chassis.

In an exemplary embodiment the ground working machine may be a trailer, with the chassis configured to be secured to a prime mover such as a tractor. In another embodiment the ground working machine may be self-propelled.

In an exemplary embodiment the ground working machine may include a plurality of row units. In various embodiments the plurality of row units may be permanently attached to the chassis, or releasably attached to the chassis. In exemplary embodiments the row units may be independently secured to the chassis, or may be secured to the chassis in modules including at least two row units each.

The at least one rotor may be any rotating part known for breaking up soil while moving through it.

In exemplary embodiments, the at least one rotor may be driven by a power source. It is envisaged that this may allow for greater working of the soil with the rotor in comparison with a ground driven power train, thereby reducing the number of passes required to sufficiently cultivate the ground. A power driven rotor is believed to be capable of a much greater rate of rotation in comparison with ground driven rotor, producing a finer seed bed due to the higher number of impacts of the rotor blades over the distance travelled. In an exemplary embodiment, the power source may be provided via a power takeoff (PTO) connection to a prime mover. However, it should be appreciated that this is not intended to be limiting

to all embodiments, as other power sources are contemplated – for example, hydraulic motors.

In an exemplary embodiment, the at least one rotor may be a churning rotor. Reference to a churning rotor should be understood to mean a rotor configured to lift and turn soil, using blades having lateral portions – for example so-called "L", "J" or "C" type blades, as known in the art.

In an exemplary embodiment, the at least one rotor may be a cutting rotor. Reference to a cutting rotor should be understood to mean a rotor configured to cut into the soil and any vegetation, having linear projections (for example, blades or spikes) extending radially from a rotor hub.

In an exemplary embodiment, the cutting rotor may include a plurality of blades extending radially from the hub, wherein the longitudinal axis of each blade is angled backwards relative to the direction of rotation. It is envisaged that this embodiment may be particularly suited to rocky ground, with the angle of the blade assisting with driving a stone deeper into the ground, rather than becoming hung up.

In an exemplary embodiment the cutting rotor may include two sets of projections, the sets spaced apart along the longitudinal axis of the hub – in use creating two parallel cuts in the soil.

In an exemplary embodiment, at least one rotor may be driven to forward-rotate relative to the intended driving direction of the row unit. It is envisaged that this may result in a smoother flow of soil through the row unit with a lower likelihood of blockages, as well as reducing demands on the power train driving the rotor(s). It should be appreciated that this is not intended to be limiting, as in an exemplary embodiment, at least one rotor may be driven to counter-rotate relative to the intended driving direction of the row unit.

In an exemplary embodiment, the row unit may include a ripping tine. The ripping tine may be configured to break up the plough pan (the compacted layer of soil near the surface of the ground) and to rip up roots and dead plant material. By breaking up the plough pan, the roots of new plants that are planted in the cultivating strip produced by the row unit can easily branch out and establish themselves in the soil. In an exemplary embodiment the depth of the ripping tine may be adjustable.

In an exemplary embodiment, the ripping tine may be configured as a breakaway ripping tine. The breakaway configuration allows for movement of the tine in the event it strikes a hard object – rather than damaging components of the row unit or ground working machine. This breakaway functionality may be achieved, for example, using a shear bolt system, a hydraulic system, a spring system, or any other mechanism known in the art. For completeness, it should be appreciated that reference to the tine breaking away includes embodiments in which the tine remains connected to the machine, but pivots or otherwise moves out of its working position.

In an exemplary embodiment, the ripping tine may be provided in front of the rotor relative to the intended direction of travel in use. Positioning the ripping tine in front of the rotor is envisaged as increasing efficiency though helping to shatter the soil by reducing the resistance to the rotor working in the soil – assisting with reducing power demands, but also lessening wear on the blades of the rotors to extend their service life. Further, in exemplary embodiments in which the ripping tine is a breakaway tine, this position may provide room for movement of the tine in response to becoming hung up in the soil.

In an exemplary embodiment, a fertiliser delivery conduit may be provided with the ripping tine, for delivery of fertiliser into the soil. It is envisaged that the fertiliser delivery conduit may be located on the trailing side of the ripping time. In an exemplary embodiment, the fertiliser delivery conduit may be provided behind the rotor.

In an exemplary embodiment, the ripping tine may include a vertical shank, and a wing portion including wings extending laterally from the tip of the shank. In an exemplary embodiment the wing portion may be angled downwardly toward the front of the row unit. In an exemplary embodiment the angle relative to ground may be about 1, 5, 10, 15, 20, 25, 20, 40, or 50°, and useful ranges may be selected between any of these values. For example, the angle may be between 10° to 20° relative to ground level, for example 14°. It is envisaged that such an arrangement may assist in lifting the soil between adjacent tines to produce a lateral shattering effect to encourage outward root growth as well as downwardly.

In exemplary embodiments the ripping tine may be configured with a removable tip. This may allow replacement of worn tips, or configuration of the tine for a particular application.

In an exemplary embodiment, the row unit may include a coulter. In an exemplary embodiment the coulter may be a disc coulter.

In an exemplary embodiment, the coulter may be provided in front of the ripping tine relative to the intended direction of travel in use. It is believed that positioning the coulter in front of the ripping tine may reduce the incidence rate of vegetation or other organic material becoming wrapped around the tine, by cutting that material prior to it reaching the tine.

According to one aspect of the present disclosure there is provided a row unit for a ground working machine, the row unit including:

a frame;

a ground working rotor rotatably attached relative to the frame;

a ripping tine positioned in front of the rotor relative to the intended direction of travel in use;

and

a coulter positioned in front of the ripping tine relative to the intended direction of travel in use.

In an exemplary embodiment, each row unit may include a first side wall and a second side wall on either side of the rotor, and a cover above at least the rotor. This provides a tunnel within which loosened soil is contained, producing a band of cultivated soil for planting.

In an exemplary embodiment, the side walls may extend between support members of a chassis of the ground working machine. In an exemplary embodiment the support members may include a front support beam and a rear support beam.

In an exemplary embodiment, the row unit may include a removeable cover above at least the rotor. In an exemplary embodiment, the removeable cover may be supported by the side walls. Known soil working machines utilise a contiguous deck from which side walls are suspended (i.e. the side walls are supported by the deck). Such arrangements do not allow access to components through the deck, which is required to provide structural strength.

In an exemplary embodiment, at least the surface facing the rotor may be made of a material having non-stick properties to discourage soil from building up on it. For example, the cover may include a base structure having a layer of non-stick plastic facing the rotor.

In an exemplary embodiment the cover may be shaped to curve over the rotor. It is envisaged that shaping the cover in this way may reduce the distance between the rotor and the cover along its length, thereby increasing the likelihood of soil being knocked loose from the cover by the rotor, rather than building up on the interior of the tunnel. In an exemplary embodiment, the cover may extend towards the ground behind at least a portion of the rotor.

In an exemplary embodiment, the ground working machine may include a packer roller positioned behind the at least one rotor. It is envisaged that the roller may act press the soil down, to produce a firm seed bed. In an exemplary embodiment, the packer roller may be a tooth packer roller, including a plurality of teeth extending from a roller drum.

In an exemplary embodiment in which the cover extends behind the rotor, the cover may include at least one slot configured to allow one or more teeth of the tooth packer roller to pass through. It is envisaged that this may assist with breaking up soil stuck to the interior of the tunnel behind the rotor by pulling soil through with the teeth.

In an exemplary embodiment the machine may include a rear linkage system for connection of a seed

distribution device – commonly referred to as seeders or planters. In an exemplary embodiment, the rear linkage system may be configured to transition the seed distribution device between an operational position (for example, extended behind the row unit), and a transporting position (for example, raised position above the row unit). However, it is also envisaged that in exemplary embodiments the rear linkage system may utilise a three point linkage as known in the art.

In an exemplary embodiment, the machine may include at least one seed distribution device attached to at least one of the row units. In an exemplary embodiment the seed distribution device may be fixed to the row unit, with a height adjustment system (as described further below) accommodating changes in contour. However, it is envisaged that the seed distribution device may be secured to the row unit via a dedicated height adjustment system, allowing for vertical movement relative to the row unit. In exemplary embodiments, the rear linkage system may also function as the dedicated height adjustment system.

In an exemplary embodiment the row unit may include at least two rotors. In an exemplary embodiment the at least two rotors may be positioned such that one is positioned in front of the other relative to the intended direction of travel in use.

In exemplary embodiments having a front rotor and a rear rotor, the front rotor may be a cutting rotor. In exemplary embodiments having a front rotor and a rear rotor, the rear rotor may be a churning rotor. In exemplary embodiments having a front rotor and a rear rotor, the front rotor may be a cutting rotor and the rear rotor may be a churning rotor.

It is envisaged that such an arrangement may assist in achieving a desired soil consistency in a single pass, in a range of soil conditions. The front rotor cuts through the vegetation and hard soil – performing a preliminary breaking of the soil, which is then lifted and turned by the rear rotor.

According to one aspect of the present disclosure there is provided a row unit for a ground working machine, the row unit including:

a frame; and

at least two ground working rotors rotatably attached to the frame, including a front rotor positioned in front of a rear rotor relative to the intended direction of travel in use,

wherein the front rotor may be a cutting rotor and the rear rotor may be a churning rotor.

In exemplary embodiments in which the row unit includes at least two rotors, a ripping tine may be positioned between the rotors.

According to one aspect of the present disclosure there is provided a row unit for a ground working machine, the row unit including:

a frame; and

at least two ground working rotors rotatably attached to the frame, including a front rotor positioned in front of a rear rotor relative to the intended direction of travel in use, and

a ripping tine positioned between the rotors.

Positioning the ripping tine between the rotors is envisaged as increasing efficiency though helping to shatter the soil by reducing the resistance to the rotors working in the soil – assisting with reducing power demands, but also lessening wear on the blades of the rotors to extend their service life.

In an exemplary embodiment, the ripping tine may extend downwardly past the front rotor, within the outer circumference of the front rotor. It is envisaged that this may assist in clearing vegetation or other organic matter from the tine, particularly in embodiments in which the front rotor includes projections positioned on both sides of the tine, with the projections lifting and cutting such material.

In an exemplary embodiment the leading tip of the ripping tine may extend underneath the front rotor. This may help with lifting broken soil into the area of effect of both the front rotor and the rear rotor for ease of processing.

In exemplary embodiments in which the row units are arranged in modules, driven elements (such as the at least one rotor) of the respective units may be interconnected to allow those elements to be driven from a single power source.

In an exemplary embodiment, the ground working machine may include at least one height adjustment system configured to secure the at least one row unit to the chassis, and allow relative height adjustment between the at least one row unit and the chassis. For example, the height adjustment system may be used to move the at least one row unit between a raised position for transportation, and a lowered operational position in which the at least one rotor contacts the ground.

In an exemplary embodiment, when in the lowered position the height adjustment system may be configured to allow travel upwardly and downwardly in response to contours of the ground.

The height adjustment system may use any suitable linkage and actuator assembly known in the art for controlling elevation of a load relative to a base platform. In an exemplary embodiment the height adjustment system may include a parallelogram linkage – more particularly a hydraulically controlled four bar parallelogram linkage. It should be appreciated that this is not intended to be limiting, and that other

lifting arrangements may be used.

However, it is envisaged that a hydraulically actuated height adjustment system may be used to provide a degree of protection against breakage in the event of one of the ground working elements – particularly the ripping tine – becoming hung up on a hard object within the soil. In particular, it is envisaged that in the lowered position, a pressure setting of the hydraulic actuator may be maintained which limits the extent of float of the row unit or row unit module during normal operation – but may be overcome in the event the element strikes a hard object and the unit needs to rise over that object to reduce the likelihood of damage.

It is envisaged that the height adjustment system may act as a support structure for a power train between the row unit and a power source.

In an exemplary embodiment the position of the at least one row unit across the chassis may be adjustable. For example, the chassis may include a lateral support member, and the row unit, or row unit modules, may be releasably secured to the lateral support member at a desired location. Similarly, it is envisaged that the chassis may include a rear lateral support member, with wheel units releasably secured at desired locations along the rear member.

In exemplary embodiments, it is envisaged that row units within modules may be spaced relative to each other to suit row spacing for a target crop. For example, row unit modules configured for 500 mm spacing for crops such as fodderbeet, beetroot, or beans may be secured to the lateral support member, and wheel units positioned accordingly – then when the machine is to be used for crops such as maize or sweetcorn, the row unit modules may be replaced with other modules configured for 750 mm spacing and the wheel units adjusted to suit.

In an exemplary embodiment the row unit may include a backing gate system, presenting a continuously moving barrier surface to the at least one rotor in use. In an exemplary embodiment, at least a portion of the barrier surface is located within a region into which the at least one rotor propels soil – for example behind the at least one rotor. It is envisaged that the barrier surface may prevent displacement of soil outside a desired region, while the movement of the barrier reduces the likelihood of soil build up occurring which could impact on the performance of the row unit.

For example, the continuously moving barrier surface may be a plate or screen vibrated to shake loose soil which comes in contact with it. This vibration may be achieved by mechanical or electromechanical means – for example an electromagnetic vibrator. In another exemplary embodiment, the moving barrier surface could be presented by a series of rollers.

According to one aspect of the present disclosure there is provided a row unit for a ground working machine, the row unit including:

a frame;

at least one ground working rotor rotatably attached to the frame; and

a backing gate system, presenting a continuously moving barrier surface to the at least one rotor in use.

In an exemplary embodiment the row unit may include a continuous belt system, including:

a belt, and

at least one pulley about which the belt rotates.

It should be appreciated that in exemplary embodiments the continuous belt system may comprise the backing gate system. Such a belt may readily provide a barrier spanning the width of the at least one rotor, with rotation of the belt discouraging the soil from adhering to the exposed exterior of the belt – whether though purely through inertial forces and gravity, or in combination with scraping elements as described further below.

It should be appreciated that reference to "a" or "the" belt is not intended to exclude the use of two of more belts to perform the same function.

In an exemplary embodiment the at least one pulley may include a drive pulley, rotation of which causes the belt to rotate.

In an exemplary embodiment the at least one drive pulley may be coupled to a drive gear having fins extending to ground level in use, wherein passage of the row unit relative to the ground causes rotation of the drive gear and therefor the drive pulley. In an exemplary embodiment the drive pulley may be an elongate shaft, on which the drive gear is located. In exemplary embodiments in which a ground working machine includes a plurality of row units, the elongate shaft may be shared between at least two of the row units.

In an exemplary embodiment, the drive pulley itself may bear against the ground in use.

In an exemplary embodiment the at least one drive pulley may be driven by a power source, for example a motor or a drive shaft of a prime mover – whether directly or via an intermediary device such as a gearbox.

In an exemplary embodiment, rotation of the belt may be achieved by bringing a portion of the belt itself

into contact with the ground in use. In another exemplary embodiment, the belt system may be configured to extend below the frame at the rear of the frame, such that the belt may contact the ground in use. It is envisaged that even in embodiments in which the belt is not driven by contact with the ground, the belt and/or shaft on which it is mounted at the rear may serve to press against the soil to produce a firm seed bed behind the row unit for ease of planting.

In an exemplary embodiment, at least a portion of the belt may extend from a level above the at least one rotor to a position behind the at least one rotor. It is envisaged that the belt may extend such that at least a portion of the exterior of the belt is at a non-perpendicular angle relative to the ground. In an exemplary embodiment, this angle may be between 25° and 75° relative to the ground.

In an exemplary embodiment the belt may extend over at least a portion of the at least one rotor. In an exemplary embodiment the belt may extend from a position behind the at least one rotor, over the at least one rotor, to a position in front of the at least one rotor.

In particular, the belt may form an inverted U-shape with splayed arms – forming a partial housing around the at least one rotor to keep soil from being displaced outside the row unit.

In an exemplary embodiment the continuous belt system may include at least one belt guide to achieve the desired shape of the belt.

In an exemplary embodiment, the at least one belt guide may include a fixed guide between the belt and rotors. For example, the belt guide may include a rail on either side of the belt, against which the exterior surface of the belt bears down against while passing over at least a portion of the at least one rotor. If rollers or pulleys were used in this position, they could be more susceptible to a build-up of soil occurring, or bearings becoming jammed. It should be appreciated that this is not intended to be limiting, and that in exemplary embodiments the at least one belt guide between the belt and rotors may be a pulley.

In an exemplary embodiment the row unit may include at least one belt scraper. For example, the at least one belt scraper may include a blade extending across a surface of the belt, the edge of the blade catching soil carried by the belt and dislodging it.

In an exemplary embodiment, the belt scrapper may include an outer belt scraper located externally to the belt. In an exemplary embodiment the outer belt scraper may be located on the upper side of the belt towards the rear of the row unit. It is envisaged that this may encourage the dislodged soil to fall behind the row unit in use.

In an exemplary embodiment, the belt scraper may include an inner belt scraper located in the interior of the belt. In an exemplary embodiment the inner belt scraper may include a soil guide onto which

dislodged soil falls and is guided to a desired location. For example, the soil guide may include at least one downwardly angled surface leading to a side of the belt.

In an exemplary embodiment the row unit may include at least one scraper aperture in at least one side wall of the frame for distribution of soil from the inner belt scraper out of the frame.

According to one aspect of the present disclosure there is provided a method of for a ground working machine

The various steps or acts in a method or process may be performed in the order shown, or may be performed in another order. Additionally, one or more process or method steps may be omitted or one or more process or method steps may be added to the methods and processes. An additional step, block, or action may be added in the beginning, end, or intervening existing elements of the methods and processes.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of an exemplary strip tillage machine in accordance with an embodiment of the present disclosure;

FIG. 2A is a perspective view of an exemplary height adjustment system of the strip tillage machine in accordance with an embodiment of the present disclosure;

FIG. 2B is a side view of the exemplary height adjustment system;

FIG. 3A is a perspective view of an exemplary row unit module of the strip tillage machine in accordance with an embodiment of the present disclosure;

FIG. 3B is a top view of the exemplary row unit module;

FIG. 3C is a bottom view of the exemplary row unit module;

FIG. 4 is a side view of an exemplary row unit of the row unit module;

FIG. 5A is a perspective view of an exemplary rotor and tine arrangement of the row unit module in accordance with an embodiment of the present disclosure;

FIG. 5B is an end view of the exemplary rotor and tine arrangement;

FIG. 5C is a side view of the exemplary rotor and tine arrangement;

FIG. 6A is a side view of an exemplary belt scraper of the row unit module in accordance with an embodiment of the present disclosure;

FIG. 6B is an end view of an exemplary belt scraper;

FIG. 7 is a side view of an exemplary side plate of the row unit in accordance with an embodiment of the present disclosure;

FIG. 8 is a perspective view of another exemplary strip tillage machine having an associated seed distribution device in accordance with an embodiment of the present disclosure;

FIG. 9A is a perspective view of the exemplary strip tillage machine;

FIG. 9B is a side view of the exemplary strip tillage machine;

FIG. 9C is an end view of the exemplary strip tillage machine, and

FIG. 10 is a side view of an exemplary row unit of the exemplary strip tillage machine.

DETAILED DESCRIPTION

FIG. 1 illustrates an exemplary strip tillage machine 100, herein referred to as the machine 100. The machine 100 includes a chassis having a front lateral support member (herein referred to as front crossmember 102), and a rear lateral support member (herein referred to as rear crossmember 104), joined by side support members 106a and 106b, and a central support member 108.

A plurality of wheel units 110a-d are releasably secured to the rear crossmember 104, for example by U-bolts. The wheel units 110a-d angle forwards towards the front crossmember 102 to provide clearance behind the rear crossmember 104 for trailing equipment, such as a seed distribution device (for example, a seeder or planter).

A drawbar 112 extends forward from the front crossmember 102, having a hitch 114 for attachment of the machine 100 to a prime mover such as a tractor (not illustrated). The hitch 114 may be any suitable device for connection of a trailer to a prime mover as known in the art.

The machine 100 includes lift linkages 116a and 116b secured to the front crossmember 102, for lifting and lowering row unit modules 118a and 118b relative to the chassis – as will be described in greater detail below. A gearbox 120 – for example a 20 Spline "T" Series gearbox supplied by BARE-Co (NZ) Ltd at

the time of filing the application – is mounted to the front crossmember 102, configured to connect a powertrain of the row unit modules 118a and 118b to a power takeoff (PTO) shaft of the tractor (not illustrated).

The machine 100 also includes a rear linkage arm 122 for connection of a seed distribution device to the chassis – in this exemplary embodiment having a three point linkage. The rear linkage arm 122 may be hydraulically raised or lowered – both for transfer between a fully raised position for transportation and an operational position, as well as allowing float of the trailing device in operation.

FIG. 2A and FIG. 2B illustrates an exemplary embodiment of the lift linkage 116, being a hydraulically controlled four bar parallelogram linkage. The lift linkage 116 includes a vertical member 200, having a clamp recess 202 at the lower end for fitting over the front crossmember 102 and being bolted in place (see FIG. 2B). Upper lift arms 204a and 204b are pivotally connected to the vertical member 200, with a hydraulic actuator 206 connected between the vertical member 200 and a point on the upper lift arms 204a and 204b for lifting and lowering the arms 204a and 204b. The upper lift arms 204a and 204b are configured for connection to a row unit module 118 by points on the arms 204a and 204b distal from the vertical member 200.

Lower support arms 208a and 208b are also pivotally connected to the vertical member 200 at a point lower than the upper lift arms 204a and 204b. The lower support arms 208a and 208b pivot about a shaft extending from the gearbox 120 (see FIG. 1), and a first sprocket 210 is mounted on the shaft at the end of the lower support arm 208a connected to the vertical member 200. A second sprocket 212 is located at the distal end of the lower support arm 208a, configured to be connected by a chain 214 (see FIG. 2B) to provide power across the lift linkage 116 to the row unit module 118.

FIG. 3A, 3B, and 3C illustrate a row unit module 118 in greater detail. The row unit module 118 includes three row units 300a-c, joined by a lifting bar 302. The upper lift arms 204a and 204b of the lift linkage 116 (not illustrated here, but see FIG. 2A and FIG. 2B) connect to the lifting bar 302.

Bushes on the lifting bar 302 help define the spacing between the row units 300a-c, together with upper spacing braces 304a and 304b, and lower spacing braces 306a and 306b. The spacing between the row units 300a-c is selected based on the preferred spacing for the target crop, for example: 500 mm spacing for crops such as fodderbeet, beetroot, or beans, and 750 mm spacing for crops such as maize or sweetcorn.

FIG. 3B and 3C shows the row unit module 118 from above and below respectively, where it may be seen that front rotor axles 308a and 308b, and rear rotor axles 310a and 310b, are axially connected and extend between the row units 300a-c. While not illustrated, it should be appreciated that the second sprocket

212 of the lift linkage 116 (see FIG. 2B) may be secured to one of the front rotor axles 308a or 308b to drive said axles. Further, the rear rotor axles 310a and 310b may be operatively coupled to front rotor axles 308a and 308b – for example using a belt, chain, or spur gears.

A front roller 312 is shared by all of the row units 300a-c, with drive gears 314 located along the front roller 312 in the gaps between the row units 300a-c.

FIG. 4 shows a single row unit 300. Side plates 400 form a frame of the row unit 300 (only one side plate is depicted). A front rotor 402 is mounted to the frame, leading a rear rotor 404, with a ripping tine located between them. The configuration and operation of these ground engaging elements will be described further below in relation to FIG. 5A-C.

An exemplary backing gate is provided in the form of a belt 408, extending from the front roller 312, above the front rotor 402, ripping tine 406, and rear rotor 404, and down to a rear roller 410. The belt 408 in this exemplary embodiment is a single belt, substantially 200 mm in width – however, it should be appreciated that width of the belt may be selected based on the desired width of a tilled strip, and that multiple belts may be used to achieve this desired width.

Shaping of the belt 408 to arc over the central components is achieved by a combination of fixed and moving guide elements in this exemplary embodiment. The upper portion of the belt 408 is supported by tension pulleys 412a and 412b on the inside of the belt 408 – which are smaller in diameter relative to the front and rear rollers 312 and 410 in part to produce a shaper angle to encourage soil to flick off the belt 408. An upper tension roller 414 guides the belt 408 around the front roller 312 beyond 180° in order to increase the contact area for power transfer purposes.

The lower portion of the belt 408 – i.e. that facing the ground working components – is supported by internal guide plates 416a and 416b, in combination with exterior guide rails 418a and 418b on both sides of the frame. While pulleys could be used in place of the exterior guide rails 418a and 418b, the configuration reduces the number of moving parts within the interior of the row unit 300 which might be susceptible to the buildup of soil and jamming of those parts.

In operation – i.e. when the row unit 300 is lowered to rest on the ground, and pulled forward – the drive gears 314 engage the ground, and drive front roller 312 to rotate the belt 408. This rotation prevents the buildup of loose soil flicked up by the rotors 402 or 404 on the interior of the unit – whether by flicking off due to momentum, or actively scraping the belt. Scraping may occur, for example, where the belt passes under the rear roller 410, or between the blades of the belt scraper 420 (as will be described further with regard to FIG. 6A and FIG. 6B).

The belt 408, on rear roller 410, rests on the ground in use. This smooths the surface of the tilled strip behind the row unit 300, to present a consistent planting or seeding surface for trailing equipment (or another machine as the case may be).

Referring to FIG. 5A-C, the front rotor 402, rear rotor 404, and ripping tine 406 have a specific arrangement 500 relative to each other. The front rotor 402 is configured as a cutting rotor, having a front hub 502 from which flat blades 504 extend radially on either side of the hub 502 at offset angles. The rear rotor 404 is configured as a churning rotor. Reference to a churning rotor should be understood to mean a rotor configured to lift and turn soil, having a rear hub 506 from which "L" shaped blades 508 extend radially and inwardly on either side of the hub 506 at offset angles.

The ripping tine 406 includes a vertical shank 510, and a wing portion 512 including wings extending laterally from the tip of the shank 510. The wing portion 512 angles downwardly at approximately 14°. The ripping tine 406 is positioned so the vertical shank 510 extends between the flat blades 504 of the front rotor 402, with the tip of the wing portion 512 projecting forward of the front hub 502 and below the circumference of the flat blades 504.

In use, the front rotor 402 cuts the soil and plant matter below ground level 514, while also clearing vegetation or other organic matter from the tine. The ripping tine 406 serves to break up the plough pan and shatter the soil outwardly, as well as lifting the soil into the area of effect of both the front rotor 402 and the rear rotor 404 (which churns and further breaks the soil) for ease of processing.

The belt scraper 420, as shown in FIG. 6A and 6B, includes an upper scraper 600 having an upper scraper bracket 602 and an upper scraper blade 604 – the upper scraper blade 604 positioned against, or close to, the outer surface of the belt 408 to scrape loose soil not dislodged after the belt 408 passes around the rear roller 410.

The belt scraper 420 also includes a lower scraper 606, having a lower scraper bracket 606 and a lower scraper blade 608 – the lower scraper blade 608 positioned against, or close to, the inner surface of the belt 408. The lower scraper bracket 606 includes an outwardly angled soil guide portion 612 onto which soil dislodged by the lower scraper blade 610 falls and is directed in the directions 614 illustrated in FIG. 6B.

Referring to FIG. 7, as previously noted, the frame of the row unit 300 is made of side plates 400. The side plates 400 include a soil aperture 700, to which the guide portions 612 of the lower scraper 606 lead in order to dispel dislodged soil from the interior of the belt 408.

The plate 400 includes a front slot 702 for positioning the front roller 312 relative to the frame. The plate 400 illustrated is designed to act as an end plate within a row unit module 118, with the front roller slot 702 sized to accommodate a central shaft of the front roller 312. It should be appreciated that the front roller slot 702 of intermediate plates may be much larger to accommodate the drum portion of the front roller 412 around which the belt 408 is looped.

The plate 400 also includes a rear slot 704 having adjustment apertures 706 for receiving the rear roller 410 and adjusting the height thereof relative to ground.

Upper tension roller apertures 708 allow for adjustment of the upper tension roller 414 position and therefore extent to which the belt 408 wraps around the front roller 312. A rear tension roller slot 710 allows for selective positioning of the tension roller 412b to tension the belt 408.

FIG. 8 illustrates another exemplary strip tillage system 800, including a strip tillage machine 802.A linkage system 804 is provided for connecting a seed distribution device 806 such as a seeder or planter to the trailing end of the strip tillage machine 802 relative to the intended forward direction of movement indicated by arrow 808. It is noted that the seed distribution device 806 is not illustrated in FIG. 8, but the position relative to the strip tillage machine 802 is shown.

The linkage system 804 is configured to transfer the seed distribution device 806 between an operational position behind the machine 802 (as illustrated), and a transport position above the machine 802. In both positions, and during the transition therebetween, the seed distribution device 806 is maintained in a level orientation.

In the exemplary embodiment illustrated, a gearbox 810 is provided to connect powertrains of driven components of the machine 802 to a power takeoff (PTO) shaft of a prime mover, such as a tractor (not illustrated).

FIG. 9A to 9C illustrate the strip tillage machine 802 without the seed distribution device 806. The machine 802 includes a chassis 900, having a front lateral beam 902, rear lateral beam 904, and intermediate lateral beam 906. First chassis side wall 908a and second chassis side wall 908b are provided at distal ends of the lateral beams 902, 904, and 906. Tunnel support beams 910 (for example, first tunnel support beam 910a) extend backwards from the front lateral beam 902.

A plurality of row units 912a to 912f are secured to the chassis 900. In the exemplary embodiment illustrated, each row unit 912 includes a first tunnel side wall 914 (for example, first tunnel side wall 914a), and an opposing second tunnel side wall 916 (for example, second tunnel side wall 916a). A removable rotor cover 918 (for example, first rotor cover 918a) is releasably secured to the tunnel side walls 914,

916. Each cover 918 includes teeth slots 920 in its trailing end (for example teeth slots 920a), described further below.

A tooth packer roller 922 extends across the machine 802 behind the row units 912a to 912f, with the roller helping to press the soil down to produce a firm seed bed. The teeth of the packer roller 922 pass through the teeth slots 920 in the covers 918 to assist with clearing soild buildup on the interior of the covers 920. The teeth of the packer roller 922 also pass through vertical slots in a scraper 924 to clear soil from the teeth.

Referring to FIG. 9B, a rotor 926 (for example, first rotor 926a) is provided for each row unit 912, mounted on a shared rotor axle 928 which is used to drive the rotors 926. Breakaway ripping tines 930 are provided for each row unit 912, forward of the rotors 926 and rotor covers 918. Disc coulters 932 are provided for each row unit 912, forward of the ripping tines 930.

It may be seen in FIG. 9C that ripping tine 930a is substantially centred on the rotor 926a when viewed in the driving direction. Further, while not explicitly illustrated in FIG. 9D the associated disc coulter 932a is also centred on the ripping tine 930a.

In FIG. 10, further detail of the ripping tine 930 may be seen. A vertical shank 934 extends below ground level in use. A lever arm 936 extends from the vertical shank 934, connected to pivot point 938. In this exemplary embodiment, a hydraulic cylinder 940 is provided between the chassis and lever arm 936 to control the position of the vertical shank 934.

In exemplary embodiments, a fertiliser delivery conduit (indicated by dashed line 942) is positioned on the trailing side of the vertical shank 934 of the ripping tine 930, for the delivery of fertilizer into the slot in the soil produced by the ripping tine 930. It is envisaged that in alternative embodiments, the fertiliser delivery conduit 942 may be provided behind the rotor 926 and in front of the packer roller 922.

The removeable cover 918 is releasably secured to tunnel side walls 914/916 above the rotor 926 – for example using one or more fasteners such as bolts, clasps, locks, or any other suitable means known in the art of fastening covers or hatches.

The removeable cover 918 includes a rear portion 944 extending at an angle down behind the rotor 926, which together with the tooth packer roller 922 prevents lifted soil from being scattered from the rear of the tunnel. The angle of the rear portion 944 brings the cover close to the rotor 926 so that soil build up may be broken by the rotor 926, and also so the teeth of the roller 922 can pass through the slots 920 in the trailing edge to scrape soil free from that point. A forward portion 946 of the cover 918 also angles towards the ground, to help deflect scattered soil downwardly, but allows room for movement of the

ripping tine 930.

It is envisaged that the smooth curve of the cover 918 – i.e. without sharp angles – may reduce the likelihood of soil being built up. Further, the ground facing surface 948 of the cover 918 is provided by a layer of plastics material with relatively non-stick properties to discourage soil build up – for example, an ultra-high-molecular-weight polyethylene (UHMWPE) such as Polystone® MATROX® by Röchling Group. In the exemplary embodiment illustrated, reinforcing plates are provided to provide strength and assist with maintaining shape of the cover 918 – but it should be appreciated that this is not intended to be limiting to all embodiments.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to".

The entire disclosures of all applications, patents and publications cited above and below, if any, are herein incorporated by reference. Reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that that prior art forms part of the common general knowledge in the field of endeavour in any country in the world. The discussion of the references states what their authors assert, and the applicant reserves the right to challenge the accuracy and pertinency of the cited documents.

The invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, in any or all combinations of two or more of said parts, elements or features.

Where in the foregoing description reference has been made to integers or components having known equivalents thereof, those integers are herein incorporated as if individually set forth.

It should be noted that various changes and modifications to the presently disclosed embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the disclosure and without diminishing its attendant advantages. It is therefore intended that such changes and modifications be included within the present disclosure.

CLAIMS

1. A ground working machine, including:

a chassis; and

at least one row unit attached to the chassis, wherein each row unit includes:

a frame;

a ground working rotor rotatably attached relative to the frame;

a ripping tine positioned in front of the rotor relative to the intended direction of travel in use; and

a coulter positioned in front of the ripping tine relative to the intended direction of travel in use.

2. The ground working machine of claim 1, including a plurality of the row units.

3. The ground working machine of claim 1 or claim 2, wherein the at least one rotor is a churning rotor.

4. The ground working machine of claim 1 or claim 2, wherein the at least one rotor is a cutting rotor.

5. The ground working machine of any one of claims 1 to 4, wherein the at least one rotor is driven by a power source.

6. The ground working machine of claim 5, wherein the at least one rotor is driven to forward-rotate relative to the intended direction of travel in use.

7. The ground working machine of any one of claims 1 to 6, wherein the ripping tine is configured as a breakaway ripping tine.

8. The ground working machine of any one of claims 1 to 7, wherein the ripping tine includes a vertical shank, and a wing portion including wings extending laterally from a tip of the shank.

9. The ground working machine of claim 8, wherein the wing portion is angled downwardly toward the front of the row unit.

10. The ground working machine of any one of claims 1 to 9, wherein the ripping tine is configured with a removable tip.

11. The ground working machine of any one of claims 1 to 10, including a fertiliser delivery conduit for delivery of fertiliser into the soil.

12. The ground working machine of claim 11, wherein the fertiliser delivery conduit is provided with the ripping tine.

13. The ground working machine of claim 11, wherein the fertiliser delivery conduit is provided behind the rotor.

14. The ground working machine of any one of claims 1 to 13, wherein the coulter is a disc coulter.

15. The ground working machine of any one of claims 1 to 14, wherein each row unit includes a first side wall and a second side wall on either side of the rotor, and a cover above at least the rotor.

16. The ground working machine of claim 15, wherein the cover is removable.

17. The ground working machine of claim 15 or claim 16, wherein at least the surface of the cover facing the rotor is made of a material having non-stick properties to discourage soil build up.

18. The ground working machine of any one of claims 15 to 17, wherein the cover is shaped to curve over the rotor.

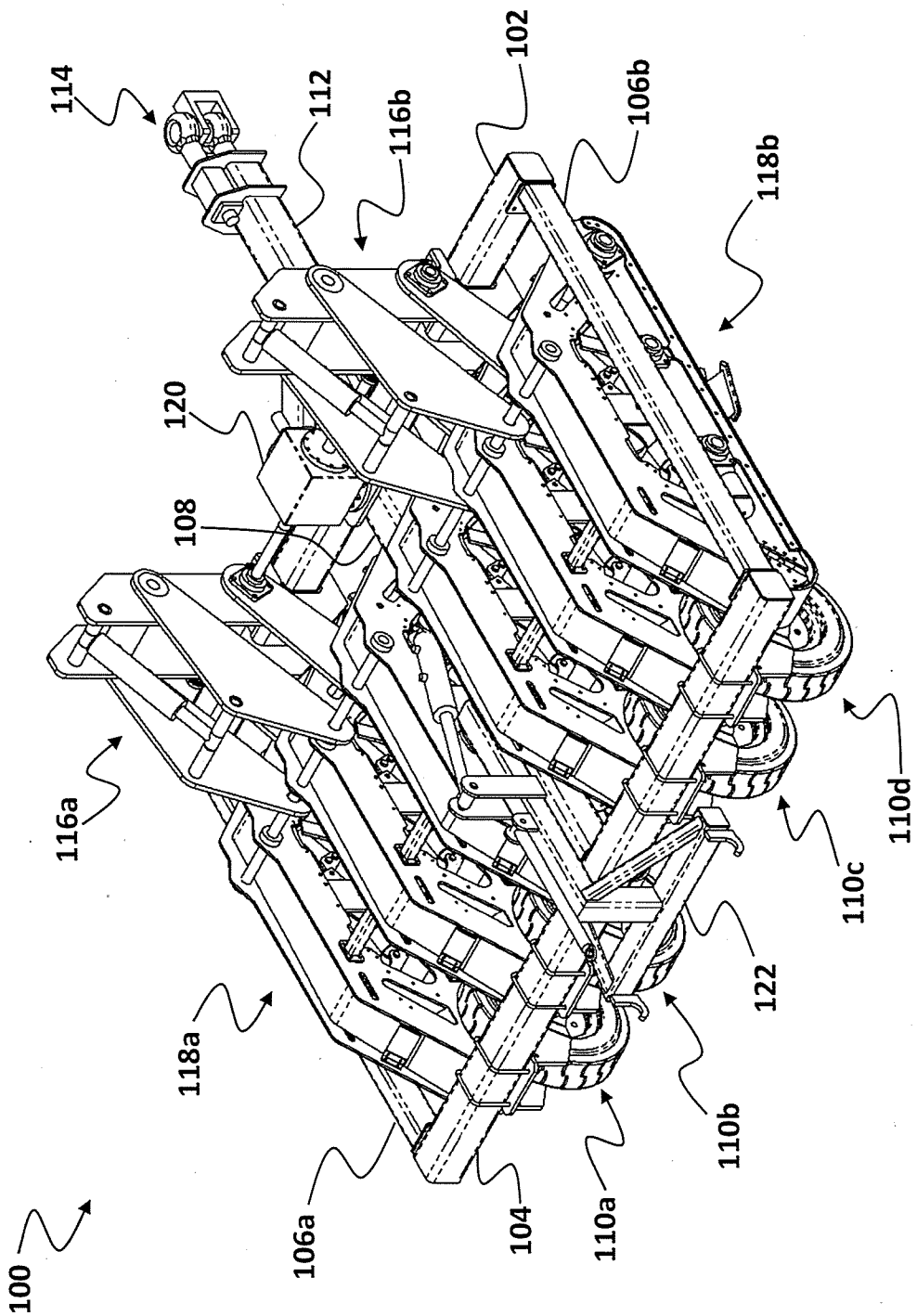
19. The ground working machine of any one of claims 15 to 18, wherein the cover extends towards the ground behind at least a portion of the rotor.

20. The ground working machine of any one of claims 1 to 19, including a packer roller positioned behind the at least one rotor.

21. The ground working machine of claim 20, wherein the packer roller is a tooth packer roller, including a plurality of teeth extending from a roller drum.

22. The ground working machine of claim 21 when dependent on claim 19, wherein the cover includes at least one slot configured to allow one or more teeth of the tooth packer roller to pass through.

FIG. 1


114
112
116b
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106b
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120
108
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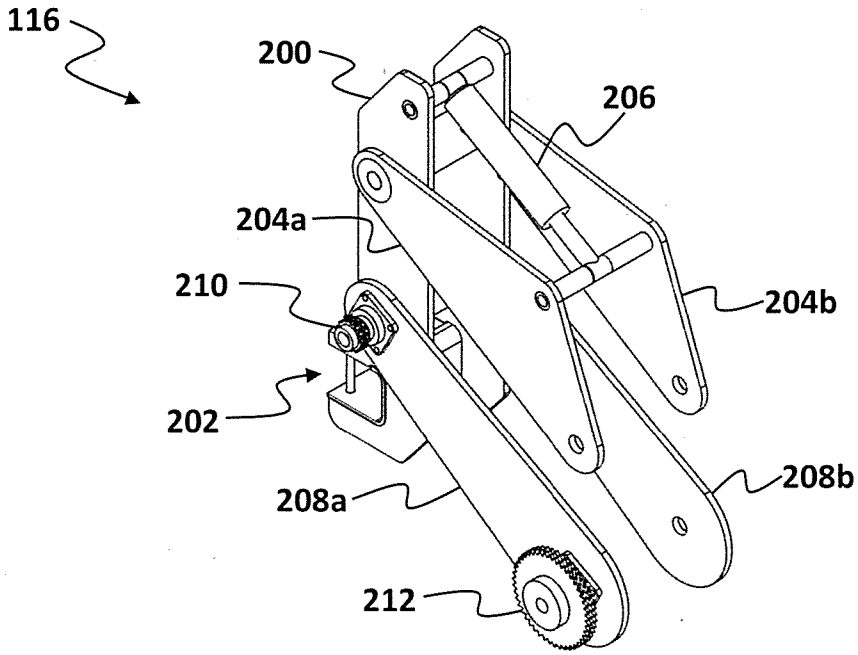
110d
110c
122
118a
110b
106a
104
110a
100

FIG. 2A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204a
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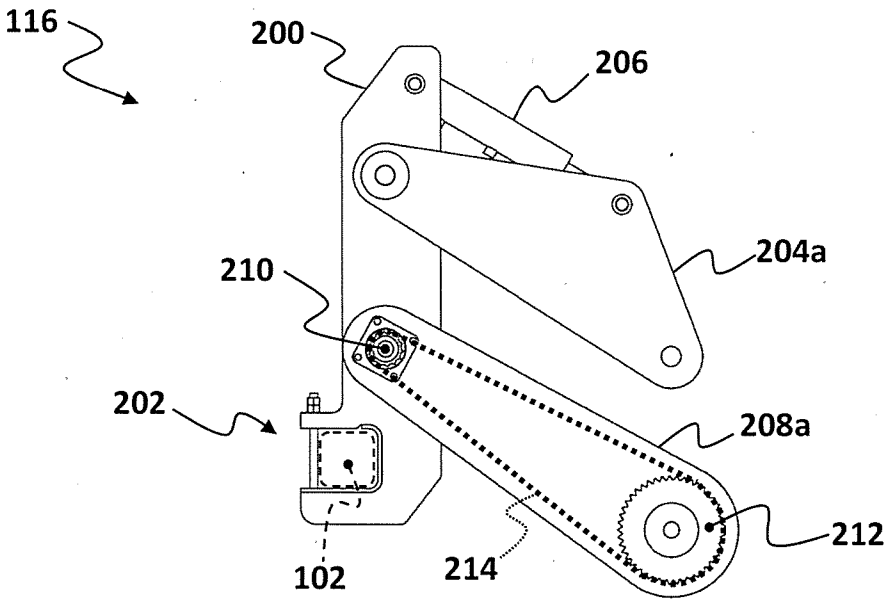
204b
202
208b
208a
212

FIG. 2B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200
206
204a
210
202
208a
212
102
214

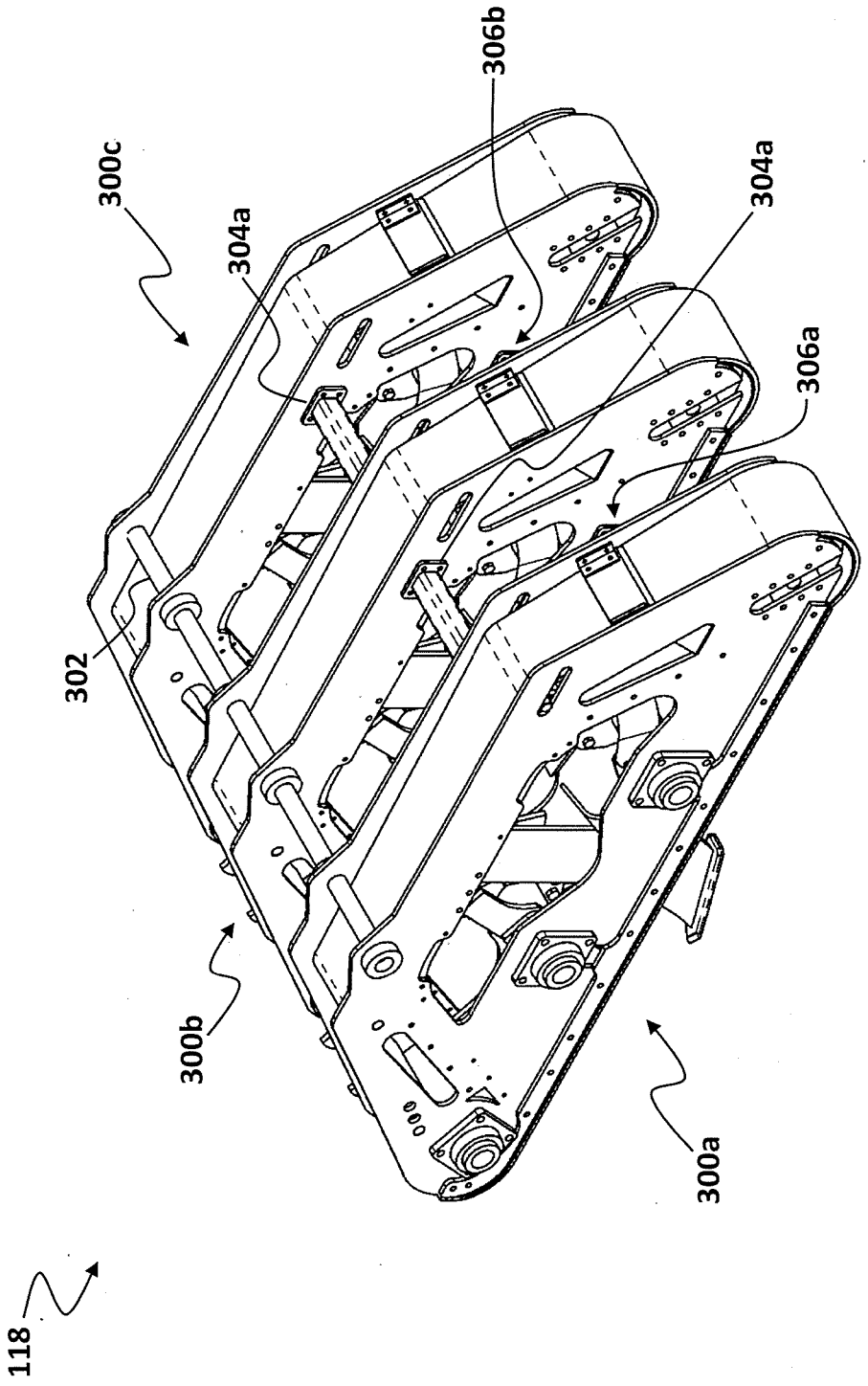
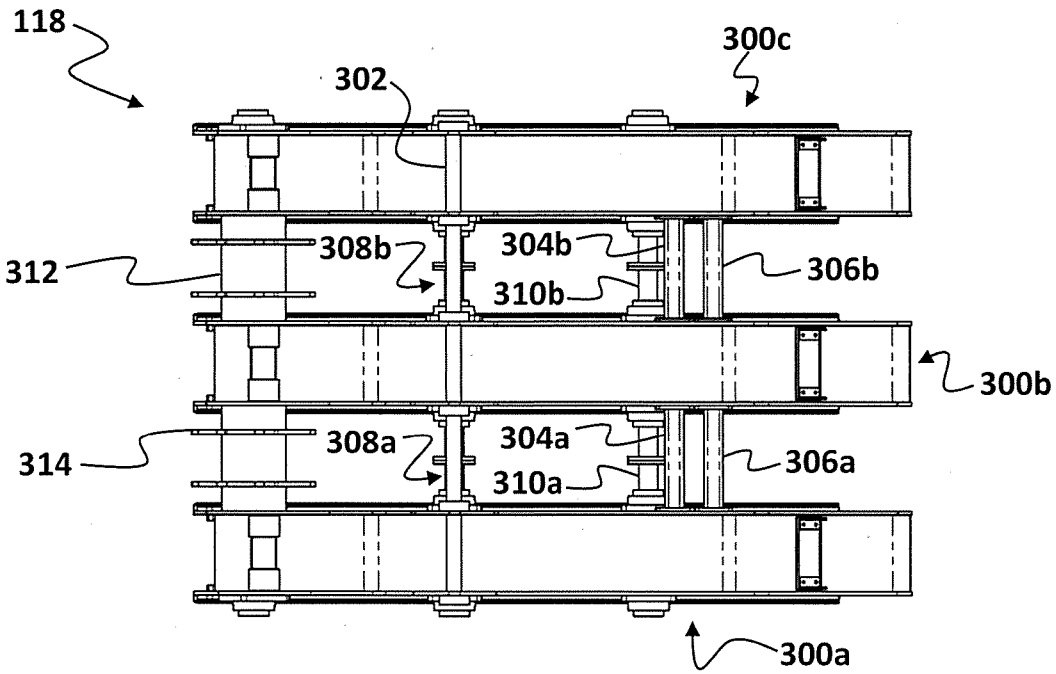


FIG. 3A

FIG. 3B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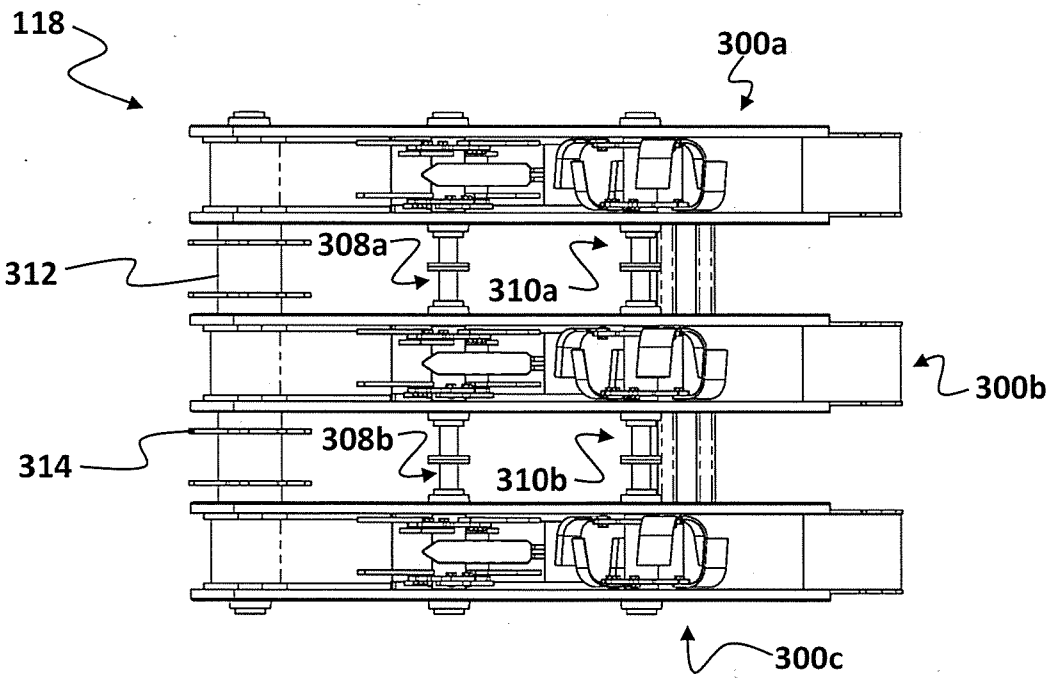
312
308b
304b
306b
310b
300b
314
308a
304a
306a
310a
300a

FIG. 3C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300a
312
308a
310a
300b
314
308b
310b
300c

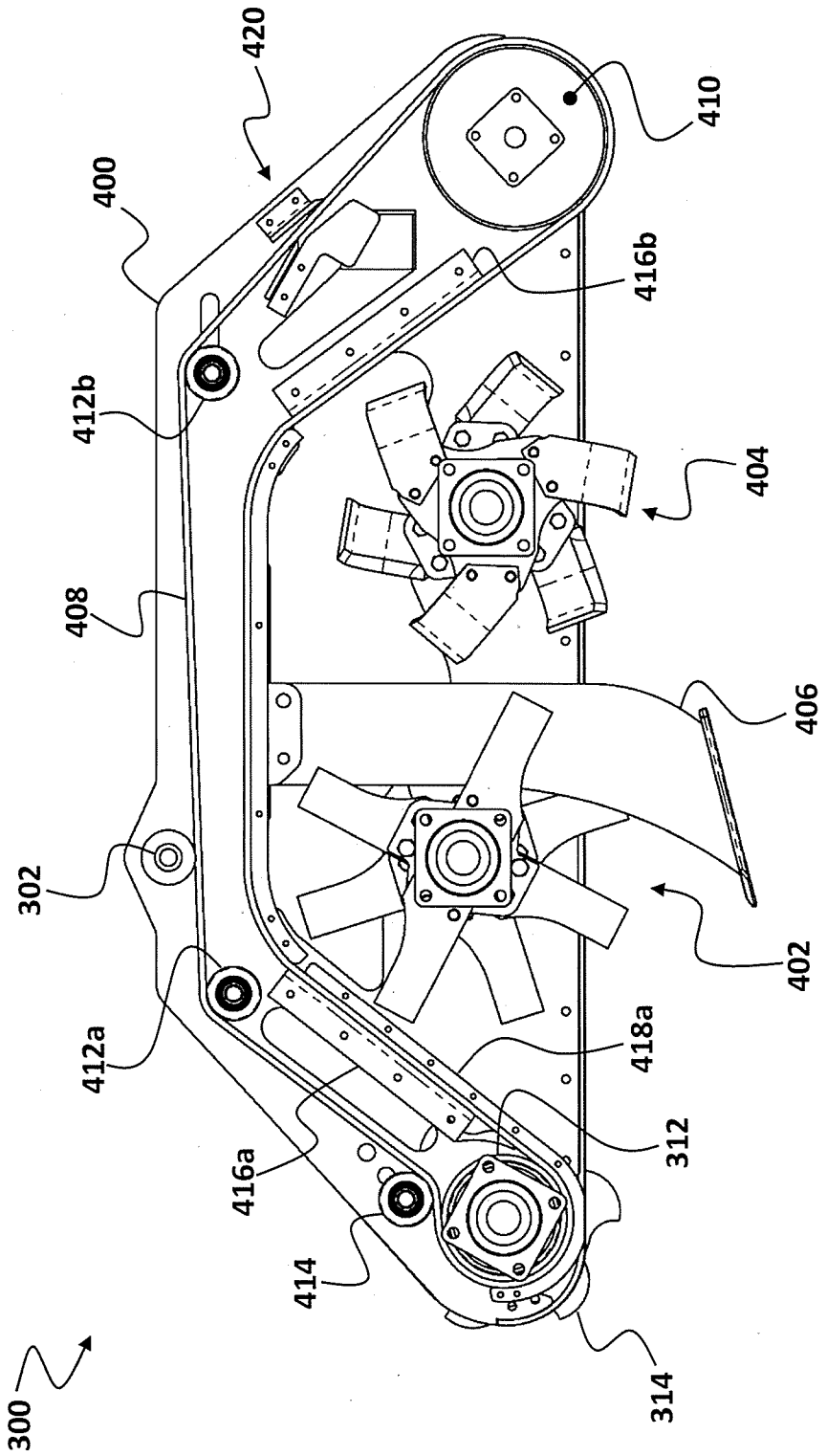

420
410
400
416b
412b
404
408
406
302
402
412a
418a
312
416a
414
314
300

FIG. 4

FIG. 5A

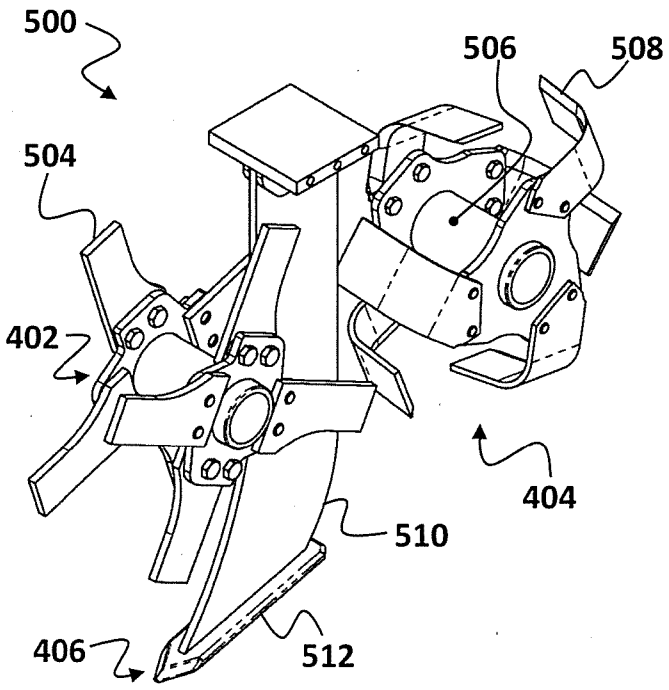


FIG. 5B

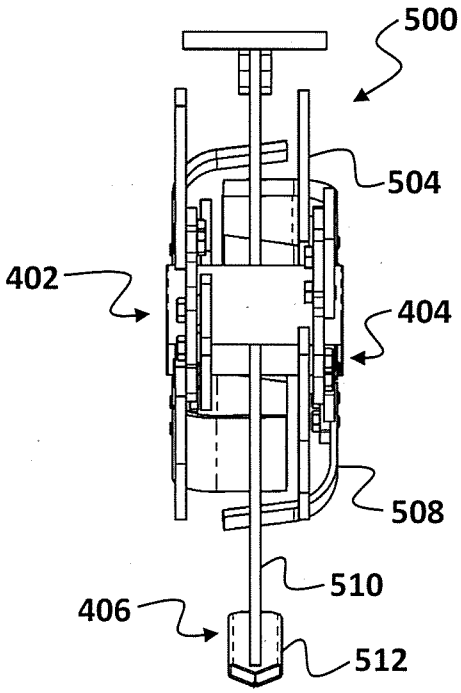


FIG. 5C

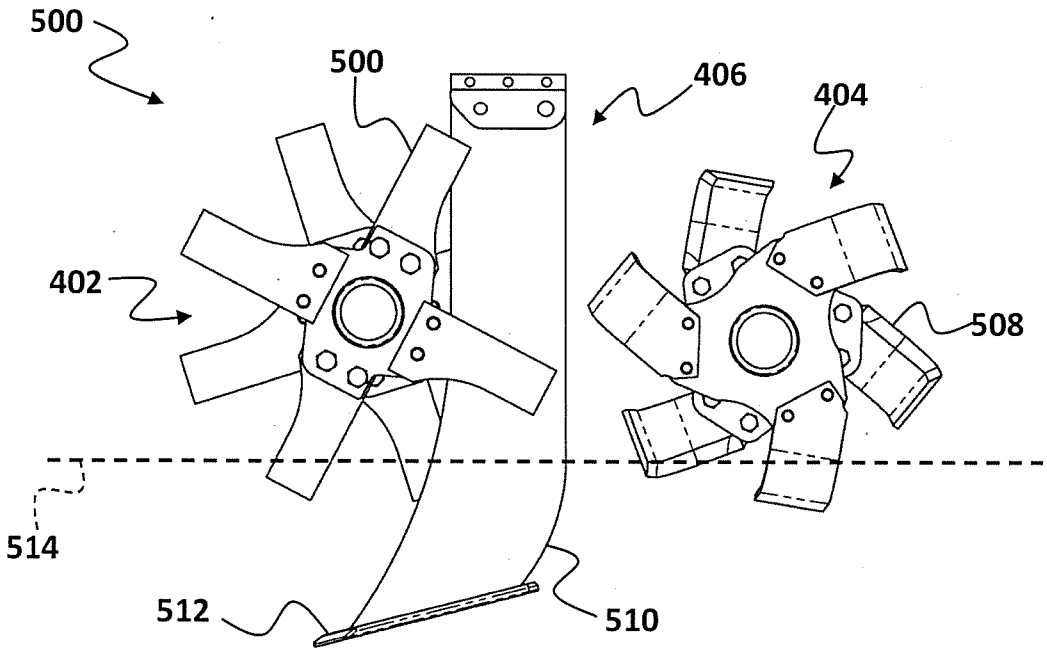


FIG. 6A

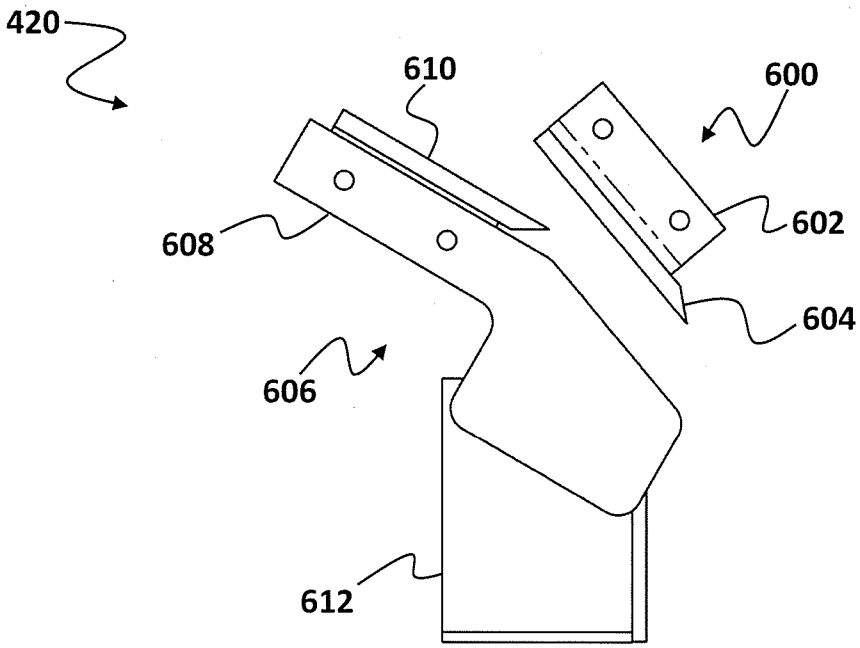


FIG. 6B

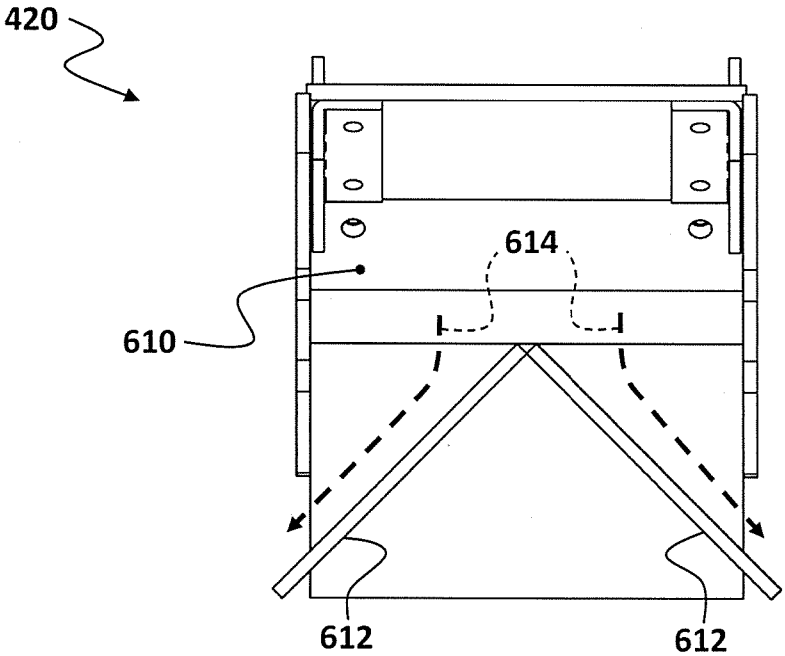
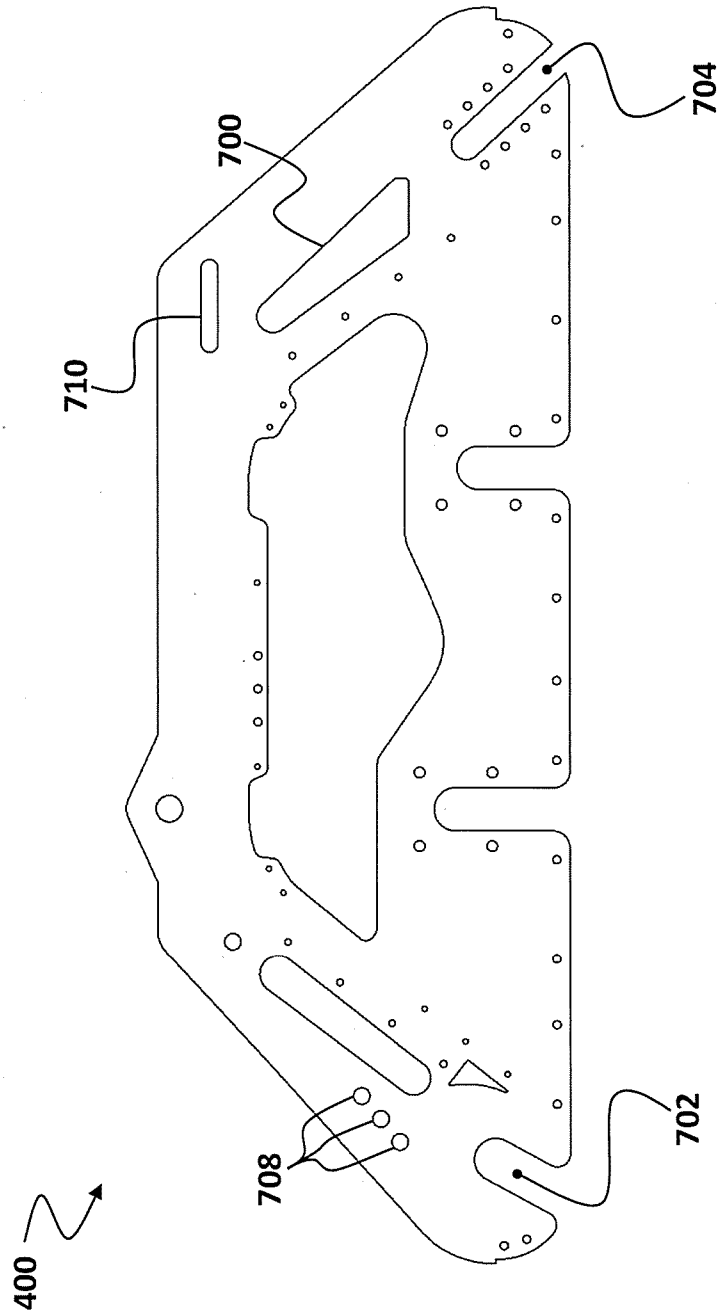


FIG. 7



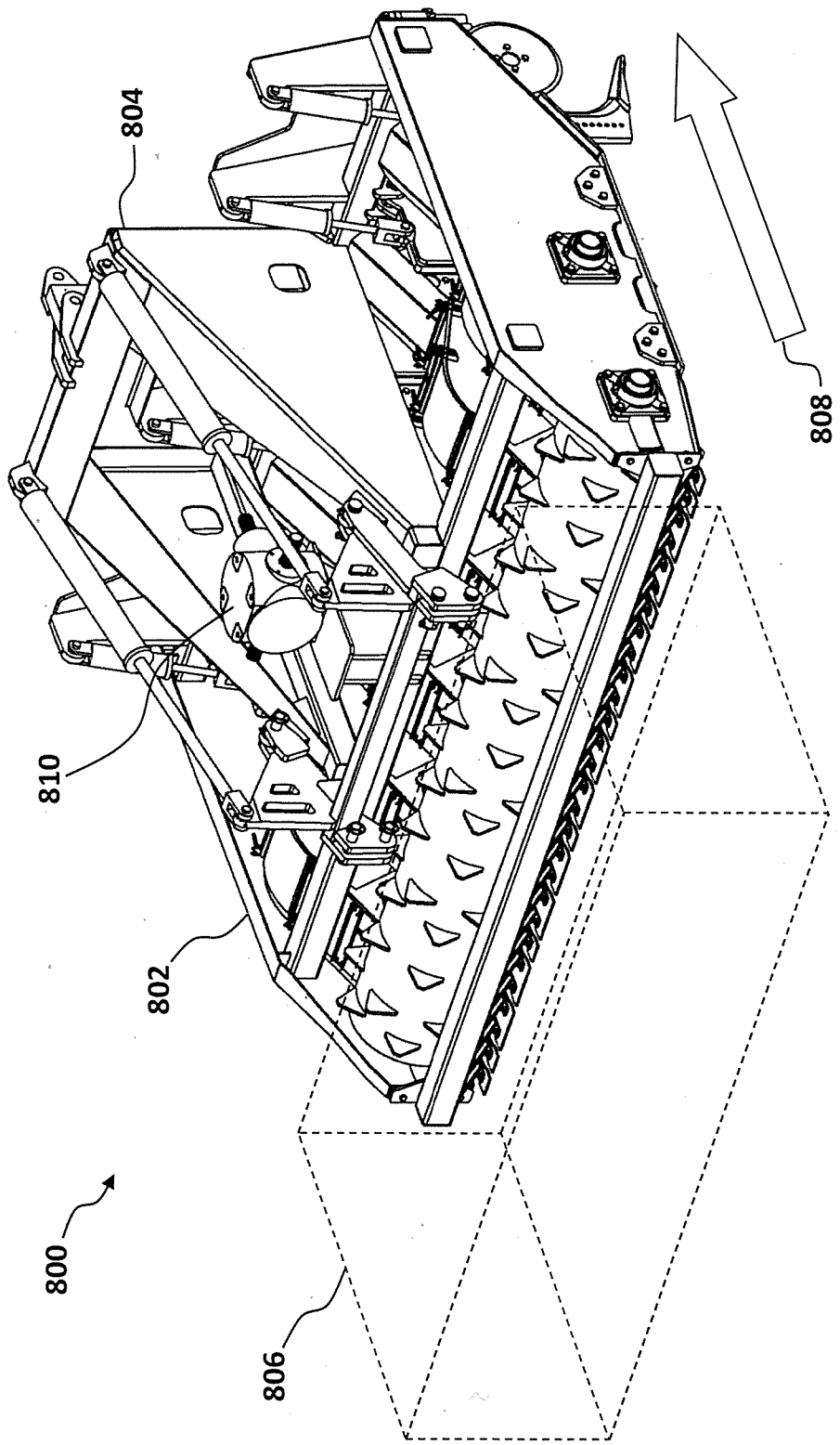


FIG. 8

FIG. 9A

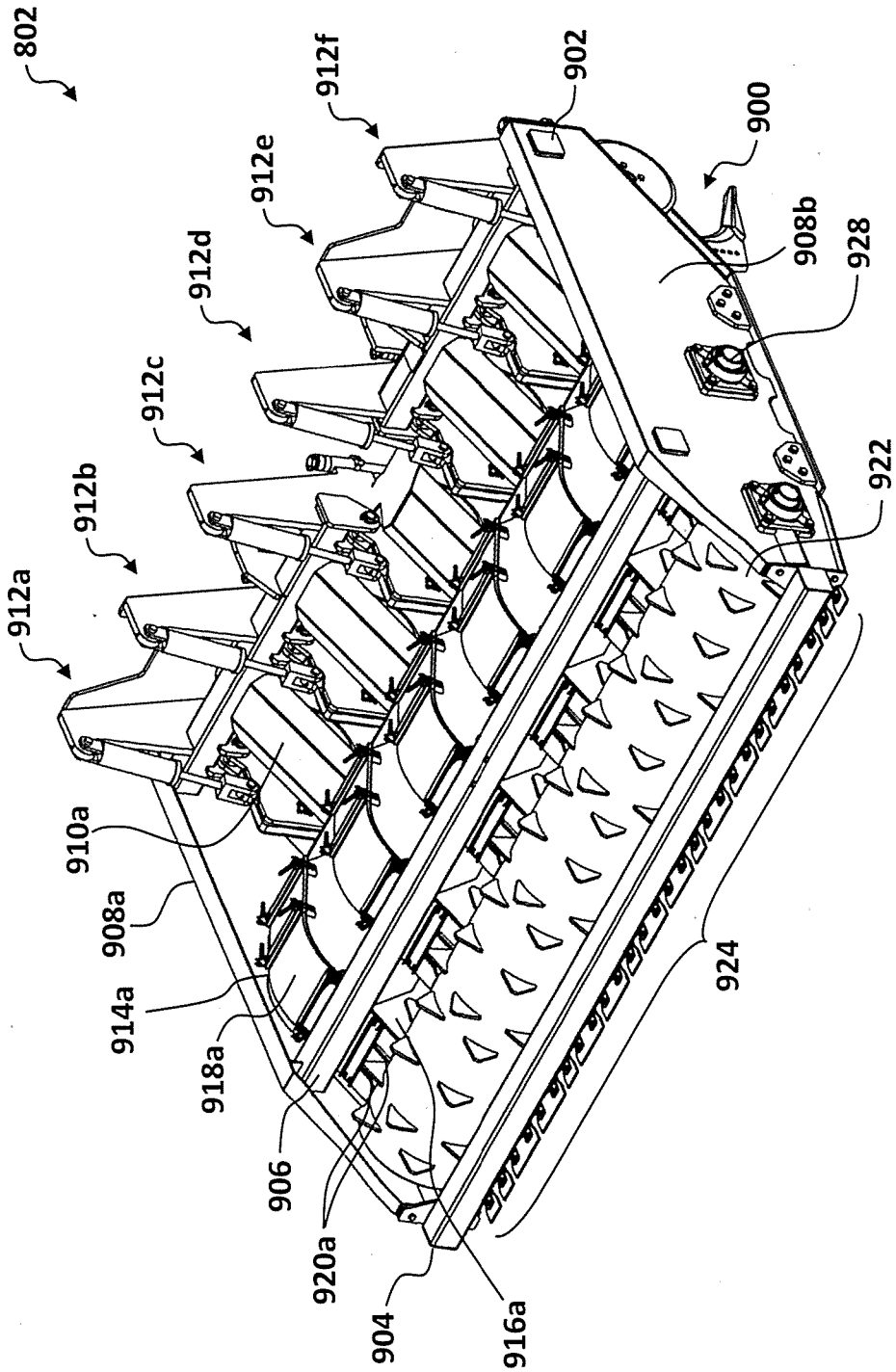

802
912f
902
900
912e
908b
928
912d
912c
922
912b
912a
910a
908a
914a
918a
924
906
920a
904
916a

FIG. 9B

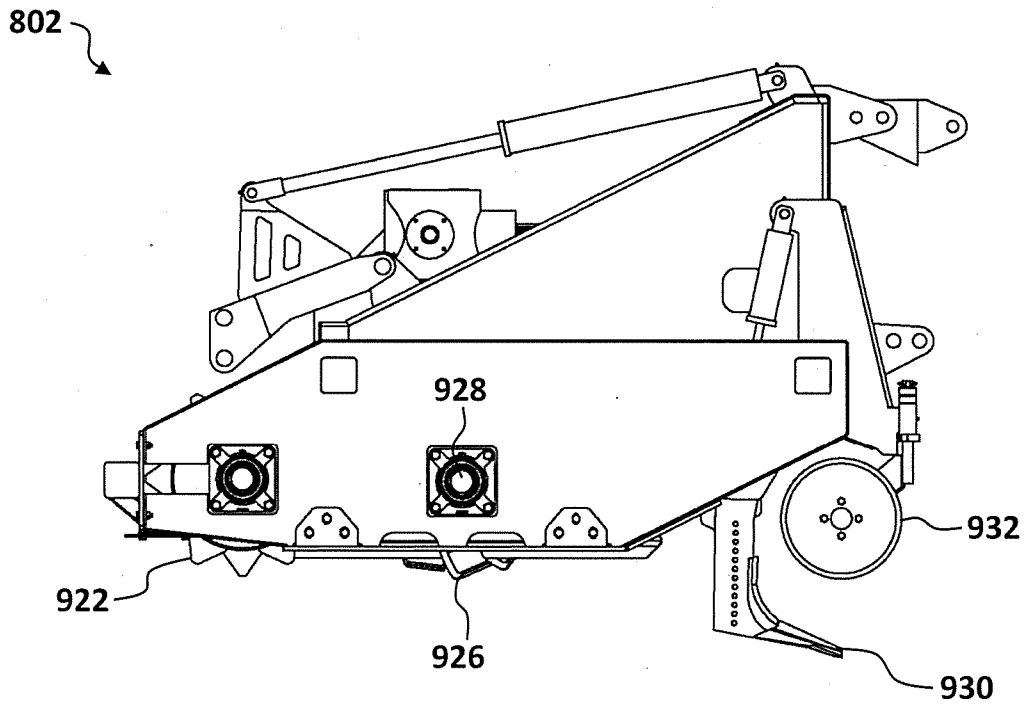
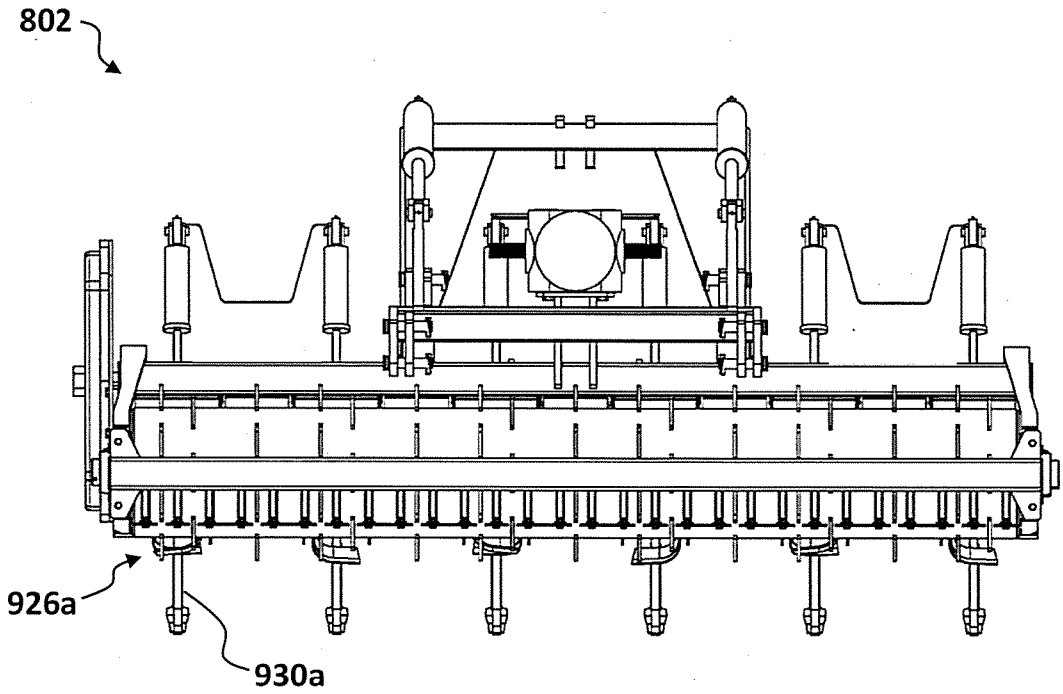


FIG. 9C



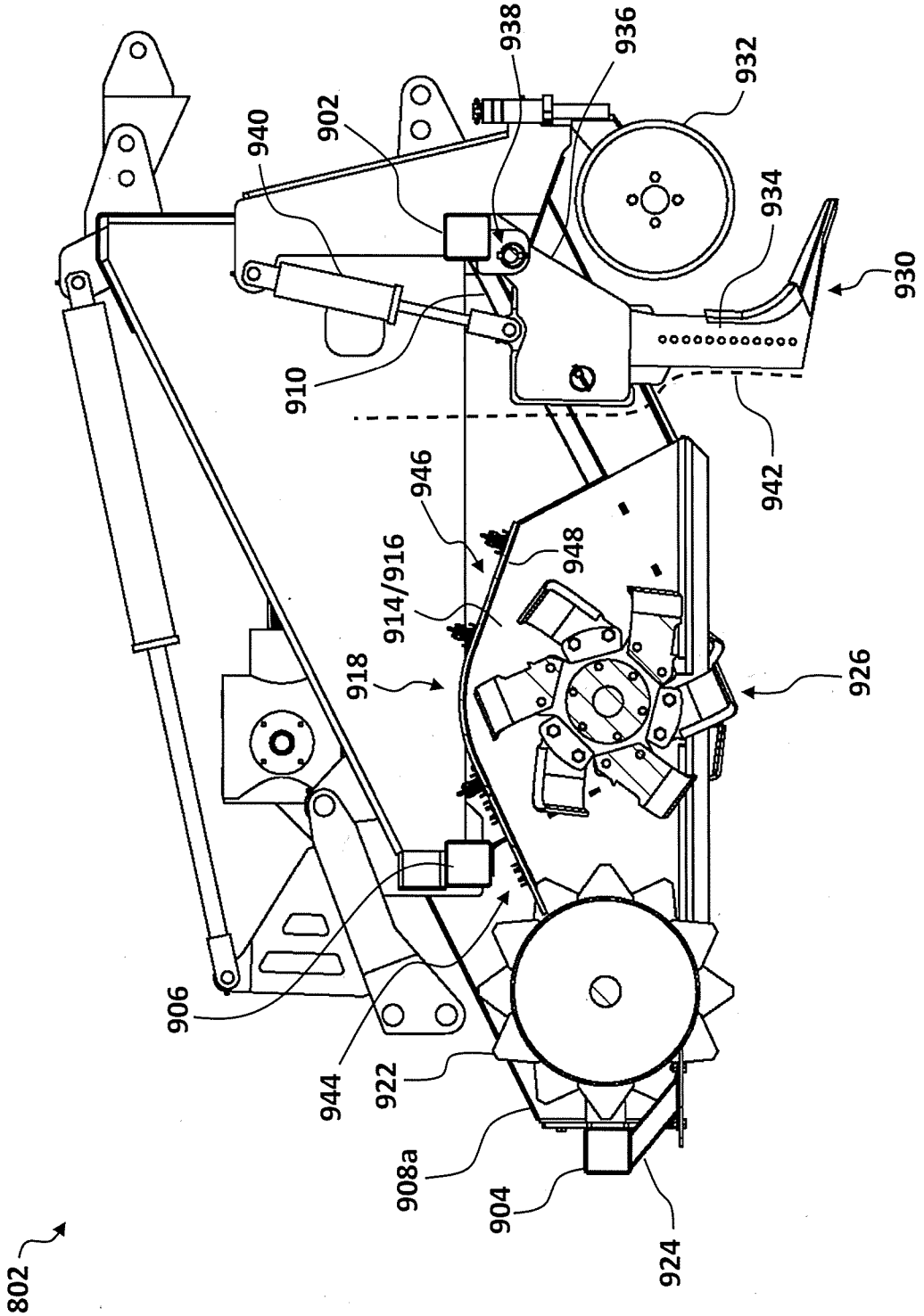

802
906
944
922
908a
904
924
910
940
902
938
936
932
934
930
942
946
948
914/916
918
926

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2019/050062

A. CLASSIFICATION OF SUBJECT MATTER

A01B 33/02(2006.01)i, A01B 59/04(2006.01)i

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 33/02; A01B 27/00; A01B 33/10; A01B 49/02; A01B 49/06; A01B 63/32; A01B 59/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: ground, milling, millage, chassis, row unit, frame, ground working rotor, ripping tine, coulter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017-0034984 A1 (SOIL-KEE PTY. LTD.) 09 February 2017 See paragraphs [0049]-[0060], [0093]-[0095], claim 1, and figures 1-5, 11.	1-4
A	EP 1543710 A1 (BAKER, ANDREW CHARLES) 22 June 2005 See paragraphs [0017]-[0024] and figure 1.	1-4
A	US 2013-0192855 A1 (AGCO CORPORATION) 01 August 2013 See paragraphs [0014]-[0017] and figures 1-3.	1-4
A	JP 2000-139104 A (MITSUBISHI AGRICULT MACH CO., LTD.) 23 May 2000 See paragraphs [0006]-[0019] and figures 1-7.	1-4
A	US 2017-0339818 A1 (SALFORD GROUP INC.) 30 November 2017 See paragraphs [0045]-[0047], [0050] and figures 2A-2F, 4A-4B.	1-4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 September 2019 (26.09.2019)	**26 September 2019 (26.09.2019)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea
Facsimile No. +82-42-481-8578

Authorized officer
LEE, Hun Gil
Telephone No. +82-42-481-8525

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2019/050062

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 6, 9, 12, 13, 16, 21, 22
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 6, 9, 12, 13, 16, 21, 22 are regarded to be unclear because they refer to a multiple dependent claim which does not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 5, 7, 8, 10, 11, 14, 15, 17-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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