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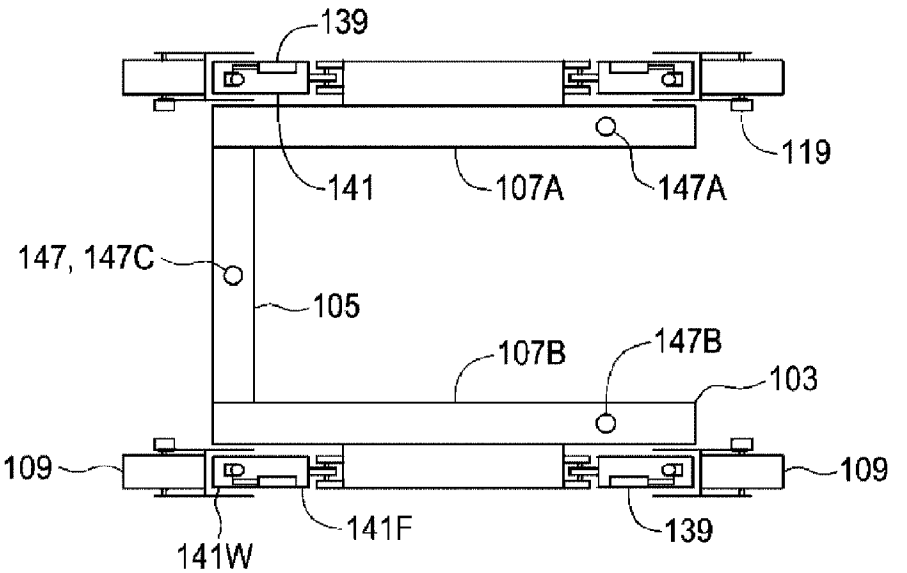

(57) Abrégé/Abstract:
An implement operating system includes a U-shaped drive frame with a base beam and parallel side beams supported on wheels including steering wheels, mounted about a vertical pivot axis, and drive wheels. A motor is connected through a drive control to drive the drive wheels. A steering control pivots the steering wheels and the steering and drive controls move and steer the drive frame along a travel path. Implements are configured to rest on the ground and when the drive frame is maneuvered to an implement loading position with respect to a selected implement, the implement is connectable to the drive frame and movable to an operating position supported by the drive frame where the selected implement is connectable to an implement control system operative to control implement functions. The steering and drive controls are operative to move and steer the drive frame and selected implement along the travel path.

ABSTRACT

An implement operating system includes a U-shaped drive frame with a base beam and parallel side beams supported on wheels including steering wheels, mounted about a vertical pivot axis, and drive wheels. A motor is connected through a drive control to drive the drive wheels. A steering control pivots the steering wheels and the steering and drive controls move and steer the drive frame along a travel path. Implements are configured to rest on the ground and when the drive frame is maneuvered to an implement loading position with respect to a selected implement, the implement is connectable to the drive frame and movable to an operating position supported by the drive frame where the selected implement is connectable to an implement control system operative to control implement functions. The steering and drive controls are operative to move and steer the drive frame and selected implement along the travel path.

IMPLEMENT OPERATING APPARATUS WITH OPEN END LOADING

This disclosure relates to the field of implements for use in agriculture and industry, in particular to a drive apparatus for attachment to a variety of implements and for operating the implement.

BACKGROUND

Implements such as are used in agriculture and various industries such as road construction and maintenance include a wide variety of sizes and configurations. Implements such as combines, swathers, sprayers, road graders, earth movers, and the like are commonly self-propelled, with the engine, drive system, and operators station incorporated into the implement itself. Implements such as air seeders, cultivators, discs, grain carts, mowers, and the like are more commonly towed behind a tractor. Some implements are configured to be mounted directly on a tractor instead of being towed behind, such as snowplows mounted on the front end of a tractor, mowers mounted under a middle portion of the tractor, and a wide variety of implements mounted to the arms of a three point hitch system commonly incorporated on the rear end of tractors.

Some self-propelled implements have comprised a drive unit, which includes the engine, drive train, and operator's station, and different implements which can be mounted to the drive unit. For example Versatile Manufacturing Company of Winnipeg, Manitoba, Canada manufactured the Versatile™ 103 which included a drive unit with a swather header and a spraying assembly which were mountable to the drive unit.

Also with the advent of very accurate external positioning systems using global positioning satellites (GPS) and the like have more recently led to the development of robotic agricultural vehicles with no operators station. For example recently Amazonen-

Werke of Hasbergen, Germany, has developed a robot vehicle for carrying various application modules along a field surface for identifying plants, testing soil compaction, nutrient deficiencies and the like. The robot is controlled by an external guidance system such as using GPS, or by a remote control device. Remote or GPS controlled driverless tractors are also known, such as manufactured by Autonomous Tractor Corporation of Fargo, North Dakota, USA.

See also for example United States Published Patent Application Number 2014/0216314 of Bourgault et al. which discloses a driverless self-propelled air seeder that is guided by a GPS or like external guidance system, and/or by a remote operator.

SUMMARY OF THE INVENTION

The present disclosure provides an implement operating apparatus that overcomes problems in the prior art.

In a first embodiment the present disclosure provides an implement operating system comprising a U-shaped drive frame including a base beam and first and second substantially parallel side beams extending from corresponding first and second ends of the base beam. A plurality of wheels support the drive frame for travel on a ground surface, the wheels including steering wheels, each steering wheel pivotally mounted about a substantially vertical wheel pivot axis to the drive frame, and drive wheels. A motor mounted on the drive frame is connected through a drive control to drive the drive wheels, and the drive control is operative to selectively rotate the drive wheels in first and second directions. A steering control is operative to selectively pivot the steering wheels about the corresponding wheel pivot axes. The steering and drive controls are operative to move and steer the drive frame along a travel path substantially aligned with the first and second side beams. First and second implements are configured to rest on the ground

surface when in an idle position, and the implements and drive frame are configured such that when the drive frame is maneuvered to an implement loading position with respect to a selected one of the first or second implements in the idle position, at least a portion of the selected implement is between the first and second side beams and the selected implement is connectable to the drive frame and movable to an operating position supported by the drive frame where the selected implement is connectable to an implement control system operative to control implement functions. The steering and drive controls are operative to move and steer the drive frame and selected implement along the travel path.

In a second embodiment the present disclosure provides a method of supporting a first implement on a drive frame and operating the first implement, and supporting a second implement on the drive frame and operating the second implement. The method comprises providing a U-shaped drive frame including a base beam and first and second substantially parallel side beams extending from corresponding first and second ends of the base beam; supporting the drive frame on a plurality of wheels for travel on a ground surface, the wheels including steering wheels, each steering wheel pivotally mounted about a substantially vertical wheel pivot axis to the drive frame, and drive wheels; connecting a motor mounted on the drive frame through a drive control to drive the drive wheels, the drive control operative to selectively rotate the drive wheels in first and second directions; providing a steering control operative to selectively pivot the steering wheels about the corresponding wheel pivot axes; operating the steering and drive controls to move and steer the drive frame along a travel path substantially aligned with the first and second side beams; resting the first and second implements on the ground surface in an idle position; moving and steering the drive frame to a first implement loading position with respect to the first implement where at least a portion of the first implement is between the first and second side beams and a portion of the first implement is in close proximity to, above, or below the base beam; connecting the first implement to

the drive frame and moving the first implement to an operating position supported by the drive frame; connecting the first implement to an implement control system operative to control implement functions of the first implement; operating the steering and drive controls to move and steer the drive frame and first implement along the travel path and operating the implement control system to control the implement functions of the first implement; operating the steering and drive controls to move and steer the drive frame and first implement along the travel path to a storage location and moving the first implement to the idle position resting on the ground surface and disconnecting the first implement from the drive frame and from the implement control system; moving and steering the drive frame to a second implement loading position with respect to the second implement where at least a portion of the second implement is between the first and second side beams; connecting the second implement to the drive frame and moving the second implement to an operating position supported by the drive frame; connecting the second implement to the implement control system; operating the steering and drive controls to move and steer the drive frame and second implement along the travel path and operating the implement control system to control the implement functions of the second implement.

The implements that can be used with the present apparatus include a wide range including conveyors, seeding implements, chemical application implements, grain carts, land packers, earth moving equipment, and cutters. Efficiency is improved as at least some of the weight of the implement is supported by the drive wheels providing ballast such that the drive frame can be lighter and there will still be sufficient weight on the drive wheels to provide the necessary traction. Thus the total amount of weight moved by the motor is reduced. Travel is provided along a path parallel to the side beams, or the system can also be configured to travel both a path parallel to the side beams, or a path perpendicular to the side beams.

With a motor of 70 – 100 horsepower and drive frame dimensions of 10 - 12 feet or more square, or a rectangular drive frame of 10 - 12 feet by 15-20 feet, implements suitable for large farming operations can be used, such as seeding implements with a width of 25-30 feet, grain carts with a capacity of 500 bushels, spraying equipment with a width of 60-80 feet. Other larger implements such as 100 foot long grain conveyors are also well suited for use. Tillage and like land working implements are similarly well suited.

With the robotic controls presently available a single operator can supply necessary fertilizer and seed to a fleet of three, four, or more seeding implements for example and monitor the operations of all implements. Similarly the robotic controls can be used to move a plurality of grain carts between a plurality of combines and transport vehicles during harvest.

DESCRIPTION OF THE DRAWINGS

While the invention is claimed in the concluding portions hereof, preferred embodiments are provided in the accompanying detailed description which may be best understood in conjunction with the accompanying diagrams where like parts in each of the several diagrams are labeled with like numbers, and where:

Fig. 1 is a schematic top view of an embodiment of an implement operating system of the present disclosure;

Fig. 2 is a schematic side view of the drive frame of the embodiment of Fig. 1;

Fig. 3 is a schematic end view of the drive frame in an implement loading position with respect to a first implement;

Fig. 4 is a schematic top view of the drive frame in the implement loading position of Fig. 3;

Fig. 5 is a schematic end view of the drive frame and first implement of Fig. 3 with the implement in the operating position supported on the drive frame;

Fig. 6 is a schematic top view of the drive frame with the first implement in the operating position shown in Fig. 5;

Fig. 7 is a schematic end view of the drive frame with a different implement supported thereon in the operating position;

Fig. 8 is a schematic side view of the hydraulic cylinder of the steering control;

Fig. 9 is a schematic top view of an alternate drive frame where the drive frame moves down to a loading mode then up to an operating mode to raise an implement to the operating position;

Fig. 10 is a schematic side view of the drive frame of Fig. 9 shown in the loading mode;

Fig. 11 is a schematic side view of the drive frame of Fig. 9 shown in the operating mode;

Fig. 12 is a schematic end view of the drive frame of Fig. 9 moving from the loading mode to the operating mode raising an implement to the operating position shown in phantom lines;

Fig. 13 is a schematic top view of the drive frame and implement of Fig. 12;

Fig. 14 is a schematic cut away side view of a conical centering arrangement and latching mechanism for connecting an implement to the drive frame;

Fig. 15 is a schematic side view of the drive frame of Fig. 9 in the loading mode and implement loading position with respect to an implement that extends under the base beam when the drive frame is in the implement loading position;

Fig. 16 is a schematic side view of the drive frame of Fig. 2 in the implement loading position with respect to an implement where the wheels of the drive frame roll over the implement to achieve the loading position;

Fig. 17 is a schematic top view of the drive frame and im shown in Fig. 16;

Fig. 18 is a schematic top view of the drive frame of Fig. 2 and an implement in the idle position with a ramp raising system installed thereon;

Fig. 19 is a schematic side view of the drive frame and implement in the idle position with ramp raising system of Fig. 18;

Fig. 20 is a schematic side view of the drive frame and implement of Fig. 18 with the implement in the operating position supported on the drive frame;

Fig. 21 is a schematic side view of a support member mounted on the implement of Fig. 18 moving up a ramp member of the ramp raising system;

Fig. 22 is a schematic side view of the support member of Fig. 21 with the implement in the operating position;

Fig. 23 is a schematic side view of the extendable connection actuator of the ramp raising system of Fig. 18 extending to engage a hook on the implement;

Fig. 24 is a schematic side view of the extendable connection actuator of Fig. 23 engaged with the hook on the implement;

Fig. 25 is a schematic side view of a support member mounted on a drive frame as schematically illustrated in Fig. 27 and moving up a ramp member mounted on an implement;

Fig. 26 is a schematic side view of the support member and ramp member of Fig. 25 when the implement is in the operating position;

Fig. 27 is a schematic side view of a ramp raising system where a support member is mounted on the drive frame and a corresponding ramp member is mounted on the implement;

Fig. 28 is a schematic end view of a support wheel rolling along a trough shaped bearing surface of a ramp member;

Fig. 29 is a schematic sectional side view of a guide member entering a guide aperture to align an implement and drive frame;

Fig. 30 is a schematic sectional side view of the guide member of Fig. 29 fully engaged in the guide aperture and substantially filling the guide aperture;

Fig. 31 is a schematic top view of the drive frame showing the orientation of the wheels with respect to their pivot axes when travelling a path parallel to the side beams;

Fig. 32 is a schematic top view of the drive frame showing the orientation of the wheels with respect to their pivot axes when travelling a path perpendicular to the side beams;

Fig. 33 is a schematic top view showing the configuration of a wheel and corresponding steering hydraulic cylinder with the wheel oriented at the end of the steering angle range for travel along path P';

Fig. 34 is a schematic top view showing the configuration of the drive wheel and corresponding steering hydraulic cylinder of Fig. 33 with the wheel pivoted about the vertical wheel axis through about 130 degrees to the end of the steering angle range for travel along path P;

Fig. 35 is a schematic end view showing the drive frame of Fig. 2 supporting the grain cart of Fig. 1 in the operating position;

Fig. 36 is a schematic top view of an implement mounted on the drive frame of Fig. 2 configured to move along path P' in a wide operating orientation, and to move along path P in a narrow transport orientation;

Fig. 37 is a schematic side view of a conveyor implement mounted on the drive frame with homing devices mounted on the conveyor intake and discharge and corresponding homing devices mounted on the fill and discharge openings of bins;

Fig. 38 is a schematic side view showing the implement in the idle position with the drive frame in the implement loading position and using an alternate loading system where the implement is moved to the operating position supported on the drive frame by a combination of a raising arm and ramp member;

Fig. 39 is a schematic side view of the alternate loading system of Fig. 38 with the implement in the operating position supported on the drive frame.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Fig. 1 schematically illustrates an embodiment of an implement operating system 1 of the present disclosure. The system 1 comprises a U-shaped drive frame 3, further illustrated in Fig. 2, including a base beam 5 and first and second substantially parallel side beams 7A, 7B extending from corresponding first and second ends of the base beam 5. Typically as illustrated the side beams 7 are somewhat longer than the base beam 5. A plurality of wheels 9 support the drive frame 3 for travel on a ground surface 11. The wheels 9 include steering wheels and drive wheels which may be arranged in various locations depending on the particular application. In the illustrated system 1, each wheel 9 is both a drive wheel and a steering wheel thus providing maximum maneuverability and traction for the system 1. Also in the illustrated system 1 the base beam 5 is straight and joined to the side beams 7 at right angles however it is contemplated that the base beam could be curved or otherwise configured to provide the desired U-shape for the drive frame 3..

Thus each wheel 9 is pivotally mounted about a substantially vertical wheel pivot axis WPA to the drive frame, and a steering control 13 is operative to selectively pivot the each wheel 9 about the corresponding wheel pivot axis WPA. Each wheel 9 is also

connected through a drive control 15 to a motor 17 mounted on the drive frame 3. The drive control 15 is operative to selectively rotate each wheel 9 in first and second directions. Typically the motor 17 will drive a hydraulic pump or electric generator, and a corresponding hydraulic or electric motor 19 will be mounted directly to the axle of each drive wheel 9 as schematically illustrated in Fig. 3. The steering and drive controls 13, 15 are operative to move and steer the drive frame 3 along a travel path P substantially aligned with the side beams 7. The drive frame 3 can be operated with substantially equally speed and maneuverability in either direction along the travel path.

A plurality of implements 21 are configured to rest on the ground surface 11 when in an idle position. A wide variety of implements 21 can be configured for use with the present system 1. For example the illustrated implements 21 include a conveyor 23, a grain cart 25, and an air seeder 27.

The implements 21 and drive frame 3 are configured such that the drive frame 3 is maneuvered to an implement loading position with respect to a selected one of the implements 21 in the idle position, the selected implement is connectable to the drive frame 3 and movable to an operating position supported by the drive frame 3. The drive frame 3 acts as a prime mover for the implements 21.

The conveyor 23 includes a conveyor frame 29 and support plates 31, and as schematically illustrated in Fig. 3, when the conveyor 23 is in the idle position the support plates 31 rest on jack stands 33. Figs. 3 and 4 schematically illustrate the drive frame 3 in the loading position with respect to the conveyor 23 in the idle position. The conveyor 23 is between the side beams 7, and extends over the base beam 5 in one direction along the path P and beyond the outer ends of the side beams 7 in the opposite direction along the path P.

The conveyor 23 is connected to the drive frame 3 and moved to an operating position supported by the drive frame 3, as schematically illustrated in Figs. 5 and 6, by lowering the jack stands 33 until the the support plates rest on the side beams 7 and are connected to the side beams 7 by bolts, latches, or like fastening mechanisms. The jack stands 33 are removed and the conveyor 23 is then connected to an implement control system 35 operative to control implement functions of the conveyor 23. With an implement such as the conveyor 23, such implement functions include activating actuators 37 to raise and lower the conveyor 23, and the motor 17 is further connected to power the conveyor 23, such that the conveyor 23 does not require its own motor.

In the illustrated system 1 the motor 17 is also movable laterally as shown in Figs. 3 and 4 to allow the support plates 31 to pass above the side beams 7, and then can be moved back between the support plates 31 once the conveyor 23 is in the operating position of Figs. 5 and 6. Also once the conveyor 23 is in the operating position of Fig. 5, the steering and drive controls 13, 15 are operative to move and steer the drive frame 3 and conveyor 23 along the travel path P.

The open ended U-shape of the drive frame 3 allows for convenient installation of various implements 21 by driving to an implement loading position where the side beams 7 straddle the implement. For operation of many implement which exert significant stresses on the drive frame 3 it is desirable to secure outer end portions of the side beams 7 to each other to add rigidity to the structure. Typically this is done by providing an end beam attached at first and second ends thereof to outer end portions of the first and second side beams 7A, 7B remote from the base beam 5. In the illustrated example of Figs. 3 - 6 the end beam is provided by the support plates 31 of the implement, conveyor 23, such that the end beam is attached to the first and second side beams 7A, 7B when the conveyor 23 is in the operating position. Other implements 21 will typically be configured to also provide the end beam when required. With no implement 21 installed

on the drive frame 3, or with some light implements, forces on the side beams 7 will generally be minimal and no end beam required.

Fig. 7 schematically illustrates the drive frame 3 where the selected implement is the air seeder 27 supported on the drive frame in the operating position. When moving along the travel path, the air seeder 27 extends laterally beyond the first and second side beams 7A, 7B in a direction perpendicular to the travel path which is parallel to the side beams 7.

As schematically illustrated in Fig. 8 the steering control 13 includes a hydraulic cylinder 39 adjacent to each steering wheel 9 and connected to selectively pivot the corresponding steering wheel 9 about the corresponding wheel pivot axis WPA.

Figs. 9 – 13 schematically illustrate an alternate drive frame 103 with base beam 105 and first and second side beams 107A, 107B where the wheels 109 are movable vertically with respect to the drive frame 103 to raise and lower the drive frame 103 to conveniently pick a selected implement 121 off the ground and move it up to the operating position. The drive frame 103 comprises a frame mode actuator operative to selectively move the wheels 109 up with respect to the drive frame 103 to lower the drive frame 103 to a loading mode shown in Fig. 10 where the drive frame 103 is a reduced height H1 above the ground surface 11, and move the wheels 109 down with respect to the drive frame 103 to raise the drive frame 103 to an operating mode shown in Fig. 11 where the drive frame 103 is at an increased operating height H2 above the ground surface 11.

Each wheel 109 is mounted to a wheel end 141W of a wheel arm 141, and an opposite frame end 141F of each wheel arm 141 is pivotally attached to the drive frame 103. The frame mode actuator comprises a valve mechanism 143, and an arm hydraulic cylinder 145 operative to pivot each wheel arm 141 with respect to the drive frame 103 to move

each wheel 109 up and down with respect to the drive frame 103. Steering hydraulic cylinders 139 are mounted on each wheel arm 141 to pivot each wheel 109 about its wheel pivot axis WPA, and a drive motor 119 is mounted on each wheel 109 so that all wheels 109 can be steered and driven.

Fig. 12 schematically illustrates an end view of the drive frame 103 in the loading mode and in the implement loading position under the selected implement 121. The selected implement 121 extends over the first and second side beams 107A, 107B, and when the drive frame 103 is raised to the operating mode the selected implement 121 moves upward.

When the drive frame 103 is raised to the operating mode, the selected implement 121 moves upward and engages first and second beam lock mechanisms 147A, 147B, further illustrated in Fig. 14, on corresponding outer end portions of the first and second side beams 107A, 107B to connect the implement 121 to the drive frame 103 and to secure the first side beam to the second side beam. The illustrated implement 121, as seen in Fig. 13, extends over the base beam 105 and engages a base beam lock mechanism 147C on the base beam when the drive frame 103 is moved upward to the operating mode.

As schematically illustrated in Fig. 14, the beam lock mechanisms 147 correct slight misalignments of the implement 121 with the drive frame 103. The beam lock mechanisms 147 are provided by conical projections 149 extending down from the implement 121 and corresponding conical recesses 151 on the drive frame 103 such that as the drive frame 103 is raised and the conical projection 149 enter an edge of the conical recess 151, further upward movement will force the conical projection 149 and recess 151 into full engagement in the correct alignment. Further to more quickly connect the implement 121 to the drive frame 103, a lock recess 153 can be provided in the conical projection 149 configured to receive a lock member 155 that is biased by a spring 157 or the like when the conical projection 149 and recess 151 are fully engaged.

The beam lock mechanism 147 provided by the recess 151, lock member 155, and spring 157 is convenient and other lock mechanisms and fasteners as known in the art can also be used to connect the implement 121 to the drive frame 103.

A wide variety of implement will typically be used with the drive frame 103, and will vary significantly in their configuration. Fig. 15 schematically the drive frame 103 in the loading mode and in the implement loading position with respect to an implement 121' resting on the ground surface 11 in the idle mode. A portion 121A' of implement 121' extends under the base beam 105, and a base beam raising arm 159 is operative to connect the base beam 105 to the implement portion 121A' such that when the drive frame 103 is moved upward to the operating mode, the portion 121A' of implement 121' moves upward with the opposite portion of the implement 121B' which extends over the side beams.

Figs. 16 and 17 schematically illustrate the drive frame 3 in the implement loading position with respect to a mowing implement 61 which is much wider than the distance between the wheels 9 under the side beams 7 so the mowing implement is configured such that the wheels 9 of the drive frame simply roll over the mowing implement 61 when moving to the implement loading position. The mowing implement 61 is connected to the drive frame 3 by movable raising arms 63 attachable to the selected implement and the drive frame, and an actuator 65 operative to move the raising arms 63 to move the mowing implement 61 to the operating position. This arrangement allows a wide implement such as a mower to be loaded and operated by the described drive frame 3.

Figs. 18 – 22 schematically illustrate a ramp raising system installed on the drive frame 3 and implement 67 for raising the implement 67 off the ground surface 11 and up to the operating position supported on the drive frame 3. The raising system comprises a

plurality of ramp members 69 attached to one the drive frame 3 and the implement 67, each ramp member 69 including a sloping bearing surface 69S, and a corresponding plurality of support members 79 attached to the other of the drive frame 3 and the implement 67. The ramp members 69 and the support members 79 are configured such that as the implement 67 moves toward the operating position, each support member 79 bears against the sloping bearing surface 69S of the corresponding ramp member 69 and exerts an upward force on the implement 67.

Figs. 18 – 22 schematically illustrate a system where the ramp members 69 are mounted on the drive frame 3 and the support members 79 are mounted on the implement 67. In this arrangement the sloping bearing surface 69S of the ramp members 69 is the top surface. First and second ramp members 69A, 69B are attached to corresponding first and second side beams 7A, 7B. Each ramp member 69 extends substantially parallel to the corresponding side beam 7 from a base end 71 thereof that is nearest the base beam 5, to a remote end 73 thereof. Each ramp member 69 comprises a substantially horizontal flat portion 75 extending from the base end 71 thereof to a midpoint thereof, and an inclined portion 77 sloping downward from the midpoint to the remote end 73 of the ramp member 69.

The raising system further comprises first and second support members 79A, 79B attached to sides of the implement 67 and are configured to move up the sloping inclined portions 77 of the corresponding first and second ramp members 69A, 69B as the implement 67 moves toward the operating position. When the implement 67 is moved all the way to the operating position of Fig. 20 it is supported on the flat portions 75 of the ramp members when in the operating position as seen in Fig. 22.

The illustrated support members 79 each comprise a support wheel 81 configured to roll along the corresponding ramp member 69, and a support surface 83 adjacent to and above a bottom edge of the support wheel 81 as schematically illustrated in Fig. 21. Thus as the

support wheel 81 rolls up ramp member 69 the support surface 83 is above the ramp member 69 as seen in Fig. 21. When the implement 67 moves into the operating position of Fig. 20, each wheel 81 moves beyond the base end 71 of the corresponding ramp member 69 so that the wheel 81 no longer keeps the support surface 83 above the ramp member 69, and instead each support surface 83 rests on the corresponding flat portion 75 of each ramp member 69 supporting the implement 67 when the implement 67 is in the operating position.

An extendable connection actuator 85 is attached to the drive frame 3 and is releasably attachable to the implement 67 by a pin 87 engaging a hook 89 on the implement 67. As the actuator 85 extends the pin 87 rides over the top of the hook 89 and then falls down behind the hook 89. Retracting the actuator 85, typically a hydraulic cylinder, then pulls the implement 67 toward the drive frame 3 such that the support members 79 move up the ramp members 69 and the implement 67 moves to the operating position. Extending the actuator 85 will push the support members 79 away from the drive frame 3 such that the support wheels 81 again roll up onto the ramp members 69 and down to move the implement 67 to the idle position. The actuator 85 can also be configured as a constantly pressurized hydraulic cylinder so that same exerts a substantially constant force on the hook 89 in the retracting direction R to keep the implement 67 in the operating position.

The implement 67 is supported in the idle position by legs 91. In the operating position the legs 91 are sufficiently far above the ground 11 that they will not interfere with implement operations. Further ramp members 69 can be attached to the drive frame 3 at convenient locations, each with a corresponding support member 79 mounted on the implement 67. In the illustrated drive frame 3, third and fourth ramp members 69C, 69D are attached to the base beam 5, and wherein the implement 67 comprises a corresponding third and fourth support members 79C, 79D configured to move up the inclined portion of the ramp members 69C, 69D as the implement 67 moves toward the operating position.

Figs. 25 - 27 schematically illustrate an alternate system where the support members 79' are mounted on the drive frame 3' and the ramp members 69' are mounted on the implement 67'. In this arrangement the sloping bearing surface 69S' of the ramp members 69' is the bottom surface. Each ramp member 69' extends substantially parallel to the path P of the drive frame 3' from a base end 71' thereof that is nearest the base beam 5' of the approaching drive frame 3', to a remote end 73' thereof. Each ramp member 69' again comprises a substantially horizontal flat portion 75' extending from the remote end 73' thereof to a midpoint thereof, and an inclined portion 77' sloping upward from the midpoint to the base end 71' of the ramp member 69'.

Thus it can be seen that a plurality of ramp members 69, 69' and a corresponding number of support members 79, 79' can be mounted on either or both of the drive frame 3, 3' and implement 67, 67' as required by the configuration of various implements. To facilitate proper alignment of the implement and drive frame, Fig. 28 schematically illustrates the sloping bearing surface 69S" of the ramp member 69" formed as a trough with a flat bottom generally the same width as the width of the support wheel 81". If slightly misaligned when contacting the bearing surface 69S", the wheel 81" will slide to the bottom of the trough in the desired aligned position.

Figs. 38 and 39 illustrate a system 201 using a ramp member 269 in combination with a raising arm 259 to move an implement 221 from the idle position of Fig. 38 to the operating position of Fig. 39 supported on the drive frame 203. The support member 279 is mounted on the implement 221 and configured to engage the ramp member 269 about the same time as the pin 260 on the implement 221 engages the recess 262 in the raising arm 259. The actuator hydraulic cylinder 285 is then retracted moving the raising arm 259 and pin 260 up to move the first end 221A of the implement 221 up and toward the drive frame 203 and also moves the support member 279 upward along the ramp member

269. Constant hydraulic pressure retracting the actuator hydraulic cylinder 285 keeps the implement in the operating position, and when it is desired to move the implement 121 off the drive frame 203 into the idle position resting on legs 291 the actuator hydraulic cylinder 285 is simply extended.

Thus the system 201 utilizes a combination of the ramp members 69 shown in Fig. 18 and the raising arm 159 shown in Fig. 15 with the actuator hydraulic cylinder 285 performing the function of the hydraulic connection actuator of Figs. 18 - 20. Other such combinations of the described arrangements are contemplated as well.

Further to facilitate alignment, Figs. 29 and 30 schematically illustrate a guide system comprising a circular guide aperture 92 defined in the selected implement 21, and a conical guide member 94 extending from the drive frame 3. The opposite arrangement with the circular guide aperture 92 defined in the drive frame 3, and the conical guide member 94 extending from the selected implement 21 will function equally as well. The guide member 94 and the guide aperture 92 are configured such that as the implement moves toward the operating position as seen in Fig. 29, the guide member 94 enters the guide aperture 92, and when the implement 21 is in the operating position the guide member 94 substantially fills the guide aperture 92 as seen in Fig. 30. Thus slight misalignments are corrected when the implement achieves the operating position. The guide member 94 and guide aperture 92 can be oriented vertically or horizontally however with the guide member 94 extending horizontally as illustrated, when the guide member 94 enters the guide aperture 92, the conical edge 96 bears against the top of the guide aperture 92 and forces the implement 21 upward, such that when the implement 21 is in the operating position, the implement 21 bears downward on the guide member 94 and is supported on the drive frame 3.

Fig. 31 schematically illustrates the drive frame where a first pair of wheels 9A supports the first side beam 7A and a second pair of wheels 9B supports the second side beam 7B. The first pair of wheels 9A includes a first base wheel 9AX proximate to the base beam 5, and a first end wheel 9AY remote from the base beam 5. Similarly the second pair of wheels 9B includes a second base wheel 9BX proximate to the base beam 5, and a second end wheel 9BY remote from the base beam 5. In the illustrated drive frame 3 all the wheels 9 are both steering wheels and drive wheels.

The drive frame 3 can travel along path P in either direction with the steering control operative to steer same by pivoting either both base wheels 9AX, 9BX or both end wheels 9AY, 9BY about their wheel pivot axes WPA through a steering angle SN. Sharper turns can be made, or crab steering can be achieved, by steering both the base wheels and the end wheels. Skewing of an implement occurs on side-hills or uneven draft situations where the implement swings out of alignment with the travel path. Crab steering can be used to overcome this skewing by varying the angle of the implement with respect to the travel path.

In addition to moving and steering the drive frame along the path P parallel to the side beams 7, the wheels 9 can be configured so that the steering and drive controls 13, 15 are operative to move and steer the drive frame 3 and a supported implement along a second travel path P' that is oriented generally perpendicular to the travel path P as schematically illustrated in Fig. 32.

Figs. 33 and 34 schematically illustrate a steering control for the drive frame 3 that provides operation along either path P or P'. Thus an implement 21 can be configured to cover a wide path when in an operating position and moving along path P' as schematically illustrated in Fig. 36, and then be oriented in a narrow transport width when moving along path P.

The steering control comprises the hydraulic cylinder 39 as shown in Fig. 8 adjacent to each wheel 9, where each hydraulic cylinder 39 is operative to selectively pivot the corresponding wheel 9 about the corresponding wheel pivot axis WPA through a pivot range greater than about 130 degrees.

In order to travel in a straight line along both paths P and P' the wheels 9 need to pivot only 90 degrees, however in order to actually steer the drive frame 3 along either path the wheels 9 need to pivot through a steering angle range SN of at least about 20 degrees either side of the path.

Since the wheels 9 can be rotated in either direction R1, R2 each wheel 9 is only required to pivot about its wheel pivot axis WPA through an angle of about 130 degrees, or for greater steering range through 135 degrees as shown by the position of the wheel edge 9X at one end of the range in Fig. 33 and the position of the same wheel edge 9X at the opposite end of the range in Fig. 34.

While it is contemplated that an operator's position can be provided on the drive frame 3, in a typical application the steering control 13, drive control 15, and implement control system 35 are responsive to signals received from a microprocessor 95 that receives location signals from an external guidance system 97 using field maps with global positioning systems or the like to guide and drive the drive frame 3 and to operate implement controls in a robotic fashion. Typically as well the microprocessor 95 is responsive to wireless signals sent from a remote control box 99 such that a remote operator can monitor and further control the operation of the drive frame 3 and any supported implement 21.

For example Fig. 37 schematically illustrates the conveyor 23 mounted on the drive frame 3 as shown in Fig. 6, with homing devices 80A mounted on the intake and

discharge of the conveyor 23, and corresponding homing devices 80 B mounted on the fill opening 84 of one bin 82, and on the discharge opening 86 of another bin 82. The steering and drive controls can be programmed to position the homing device 80A on the conveyor discharge above the homing device 80B on the fill opening 84 of the bin 82 such that the conveyor 23 discharges into the fill opening 84. Similarly the steering and drive controls can be programmed to position the homing device 80A on the conveyor intake under the homing device 80B on the discharge opening 86 of the bin 82 such that the conveyor 23 receives granular material from the bin discharge opening 86.

Alternatively with precise GPS location equipment available today it is contemplated that the conveyor 23 and drive frame 3 can be maneuvered to locate the conveyor discharge at the fill opening 84 of each bin on a farm, and to locate the conveyor intake at the discharge opening 86 of each bin on a farm, such that the microprocessor essentially maps all the bins 82 and the conveyor 23 "learns" the bin locations and can then be directed automatically to position the conveyor discharge or intake to deposit material into or receive material out of a selected bin 82.

Similar automatic location and operation can be achieved with other implements for other purposes.

The present disclosure further provides a method of supporting a first implement on a drive frame and operating the first implement, and supporting a second implement on the drive frame and operating the second implement. The method comprises providing a U-shaped drive frame 3 including a base beam 5 and first and second substantially parallel side beams 7A, 7B extending from corresponding first and second ends of the base beam 5; supporting the drive frame 3 on a plurality of wheels 9 for travel on a ground surface, the wheels 9 including steering wheels 9, each steering wheel 9 pivotally mounted about a substantially vertical wheel pivot axis WPA to the drive frame 3, and drive wheels 9;

connecting a motor 17 mounted on the drive frame 3 through a drive control 15 to drive the drive wheels 9, the drive control 15 operative to selectively rotate the drive wheels 9 in first and second directions; providing a steering control 13 operative to selectively pivot the steering wheels 9 about the corresponding wheel pivot axes WPA; operating the steering and drive controls 13, 15 to move and steer the drive frame 3 along a travel path P substantially aligned with the first and second side beams 7; resting the first and second implements 23, 25 on the ground surface in an idle position; moving and steering the drive frame 3 to a first implement loading position with respect to the first implement 23 where at least a portion of the first implement 23 is between the first and second side beams 7 and a portion of the first implement is in close proximity to, above, or below the base beam 5; connecting the first implement 23 to the drive frame 3 and moving the first implement 23 to an operating position supported by the drive frame 3; connecting the first implement 23 to an implement control system 35 operative to control implement functions of the first implement 23; operating the steering and drive controls 13, 15 to move and steer the drive frame 3 and first implement 23 along the travel path P and operating the implement control system 35 to control the implement functions of the first implement 23; operating the steering and drive controls 13, 15 to move and steer the drive frame 3 and first implement 23 along the travel path P to a storage location and moving the first implement 23 to the idle position resting on the ground surface 11 and disconnecting the first implement 23 from the drive frame 3 and from the implement control system 35; moving and steering the drive frame to a second implement loading position with respect to the second implement 25 where at least a portion of the second implement 25 is between the first and second side beams 7 as schematically illustrated in Fig. 30; connecting the second implement 25 to the drive frame 3 and moving the second implement 25 to an operating position supported by the drive frame 3; connecting the second implement to the implement control system 35; operating the steering and drive controls 13, 15 to move and steer the drive frame 3 and second implement 25 along the

travel path P and operating the implement control system 35 to control the implement functions of the second implement 25.

The implements that can be used with the present system 1 include a wide range including conveyors, seeding implements, chemical application implements, grain carts, cutters, and the like Efficiency is improved as at least some of the weight of the implement, and any product carried in seeder or sprayer tanks is supported by the drive wheels 9 providing ballast such that the drive frame 3 can be lighter and there will still be sufficient weight on the drive wheels 9 to provide the necessary traction. Thus the total amount of weight moved by the motor 17 is reduced. Travel along either path P or perpendicular along P' allows an implement 21 to be operated in a wide orientation along path P' to cover significant ground area during operation, and then moved in a narrow orientation along path P for transport. The motor 17 drives the wheels 9 in either direction such that the drive frame 3 can be operated in either direction along the path P, adding flexibility to the possible configurations of the implements 21.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous changes and modifications will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all such suitable changes or modifications in structure or operation which may be resorted to are intended to fall within the scope of the claimed invention.

CLAIMS

What is claimed is:

1. An implement operating apparatus comprising:

a frame configured for coupling with an agricultural implement, the frame includes:

an implement socket including opposed frame members and an open end; and

wherein the implement socket surrounds an open implement area configured to receive the agricultural implement;

a plurality of ground engaging elements;

a power source in communication with the plurality of ground engaging elements;

the agricultural implement configured for reception within the implement socket;

wherein the frame is configured to transition between an empty position and an operating position:

in the empty position the open implement area of the implement socket is empty; and

in the operating position the implement socket is positioned around the agricultural implement within the open implement area, and the agricultural implement is coupled across the opposed frame members; and

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a latch mechanism:

a projection recess associated with one of the agricultural implement or the frame;

a projection associated with the other of the frame or the agricultural implement; and

wherein the latch mechanism is configured to guide coupling of the agricultural implement across the opposed frame members.

2. The implement operating apparatus of claim 1, wherein in the operating position the agricultural implement is coupled across the opposed frame members proximate to the open end of the implement socket.

3. The implement operating apparatus of claim 1, wherein the frame includes a base member and the opposed frame members extend from the base member, and in the operating position the agricultural implement is coupled across the opposed frame members remotely relative to the base member.

4. The implement operating apparatus of claim 1, wherein the agricultural implement includes at least one structural member, and the at least one structural member is coupled between the opposed frame members in the operating position.

5. The implement operating apparatus of claim 4, wherein in the operating position the at least one structural member supports the opposed frame members.

6. The implement operating apparatus of claim 4, wherein in the operating position the at least one structural member constrains movement of the opposed frame members relative to each other.

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7. The implement operating apparatus of claim 1 comprising a beam attachment mechanism coupled with the opposed frame members, and the beam attachment mechanism is configured to couple the opposed frame members with the agricultural implement.

8. The implement operating apparatus of claim 1, wherein the frame encloses a portion of the agricultural implement in the operating position.

9. The implement operating apparatus of claim 1, wherein the opposed frame members include mounting beams.

10. The implement operating apparatus of claim 1, wherein the agricultural implement includes a complementary profile to the implement socket.

11. An implement operating apparatus comprising:

an agricultural implement configured to conduct an agricultural operation, the agricultural implement includes:

at least one structural member;

a frame configured for driving and operating the agricultural implement, the frame includes:

an implement socket having a base member and opposed frame members extending from the base member; and

wherein the implement socket is configured to receive the agricultural implement between the opposed frame members in an operating position;

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wherein the at least one structural member is coupled between the opposed frame members and supports the opposed frame members in the operating position; and

a latch mechanism, the latch mechanism includes:

a projection recess associated with one of the agricultural implement or the frame;

a projection associated with the other of the frame or the agricultural implement; and

wherein the latch mechanism is configured to guide coupling of the agricultural implement with the implement socket as the frame transitions from the empty position to the operating position.

12. The implement operating apparatus of claim 11, wherein the at least one structural member is configured to constrain movement of the opposed frame members in the operating position.

13. The implement operating apparatus of claim 11, wherein the implement socket includes an open end; and

in the operating position the at least one structural member of the agricultural implement is coupled across the opposed frame members proximate the open end.

14. The implement operating apparatus of claim 11, wherein in the operating position the agricultural implement is coupled across the opposed frame members remotely relative to the base member.

15. The implement operating apparatus of claim 11 comprising a beam attachment mechanism coupled with the opposed frame members, and the beam attachment

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mechanism is configured to couple the opposed frame members with the agricultural implement.

16. The implement operating apparatus of claim 11, wherein the frame encloses a portion of the agricultural implement in the operating position.

17. The implement operating apparatus of claim 11, wherein the opposed frame members include mounting beams.

18. The implement operating apparatus of claim 11, wherein the frame is configured to transition between an empty position and the operating position:

in the empty position the implement socket is empty; and

in the operating position the implement socket is positioned around the agricultural implement within the implement socket, and the opposed frame members extend along the agricultural implement.

19. A method for using an implement operating apparatus comprising:

guiding a frame having an implement socket toward an agricultural implement, wherein the implement socket is empty and configured for reception of the agricultural implement therein;

positioning the implement socket around the agricultural implement with the agricultural implement between opposed frame members of the frame; and

coupling the agricultural implement to the implement socket of the drive frame, coupling includes:

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engaging the frame with the agricultural implement;

guiding coupling of the agricultural implement to the implement socket with a latch mechanism, guiding includes receiving a projection associated with one of the frame or the agricultural implement within a projection recess associated with the other of the agricultural implement or the frame;

coupling at least one structural member of the agricultural implement between the opposed frame members; and

supporting the opposed frame members with the at least one structural member.

20. The method of claim 19, wherein supporting the opposed frame members with the at least one structural member includes constraining movement of the opposed frame members.

21. The method of claim 20, wherein constraining movement of the opposed frame members includes constraining movement of the opposed frame members relative to each other.

22. The method of claim 19, wherein coupling the at least one structural member between the opposed frame members includes coupling the at least one structural member between the opposed frame members proximate an open end of the implement socket.

23. The method of claim 19, wherein the frame includes a base member, and the opposed frame members extending from the base member; and

coupling the at least one structural member between the opposed frame members includes coupling the at least one structural member between the opposed frame members remote relative to the base member.

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24. The method of claim 19, wherein the frame includes a beam attachment mechanism coupled with the opposed frame members; and

coupling the agricultural implement to the implement socket includes coupling the beam attachment mechanism with the agricultural implement.

25. The method of claim 24, wherein the frame includes a beam attachment mechanism coupled with the opposed frame members; and

coupling the agricultural implement to the implement socket includes coupling the beam attachment mechanism with the at least one structural member of the agricultural implement.

26. The method of claim 19, wherein positioning the implement socket around the agricultural implement includes enclosing a portion of the agricultural implement between the opposed frame members.

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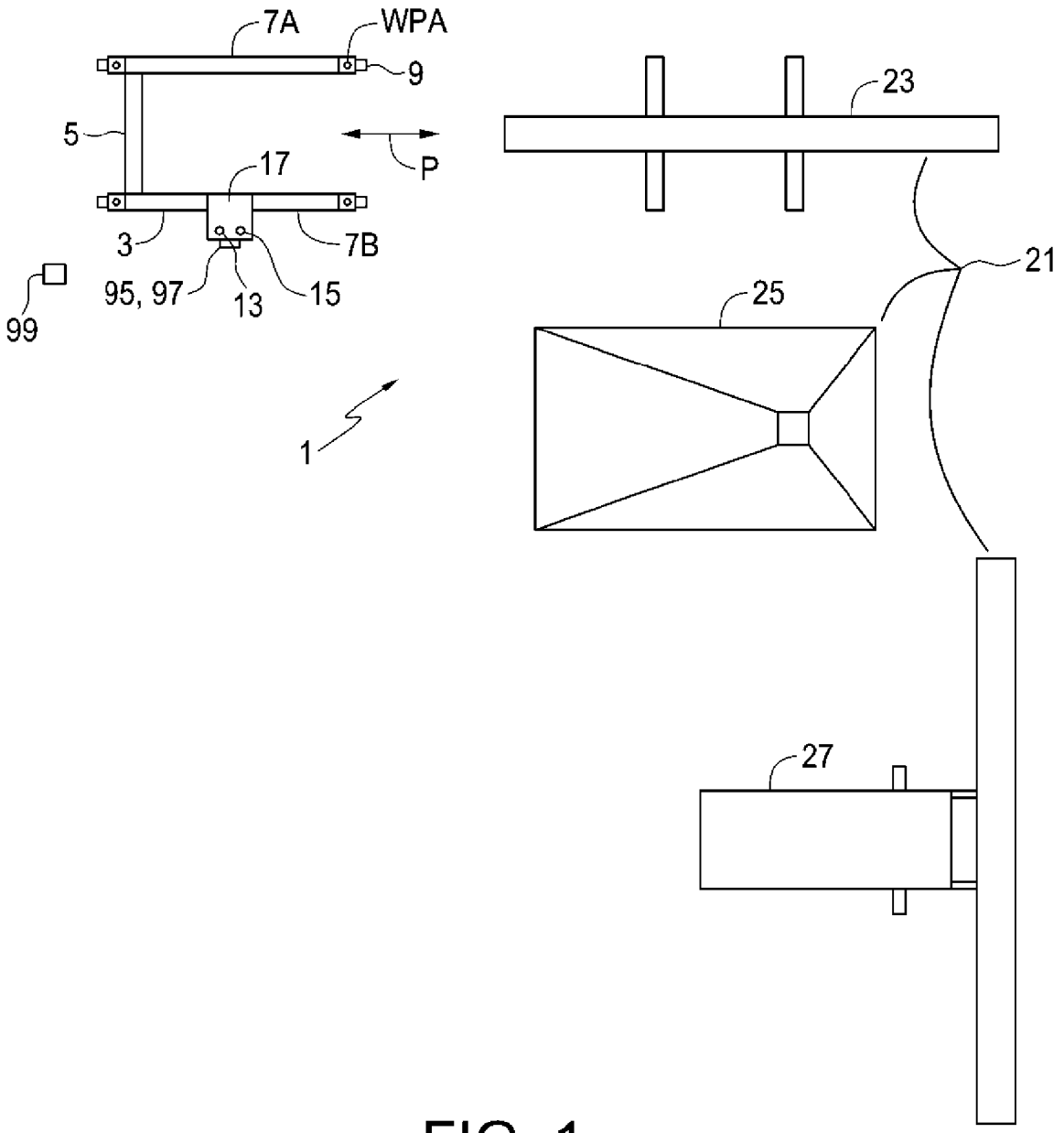

FIG. 1

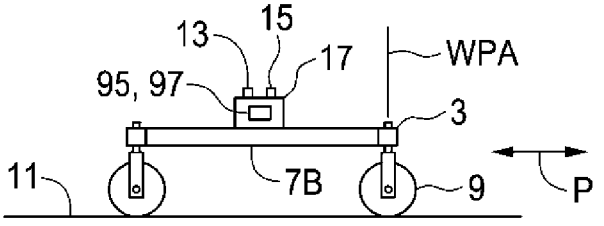

FIG. 2

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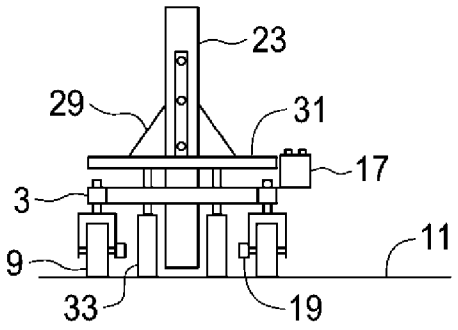

FIG. 3

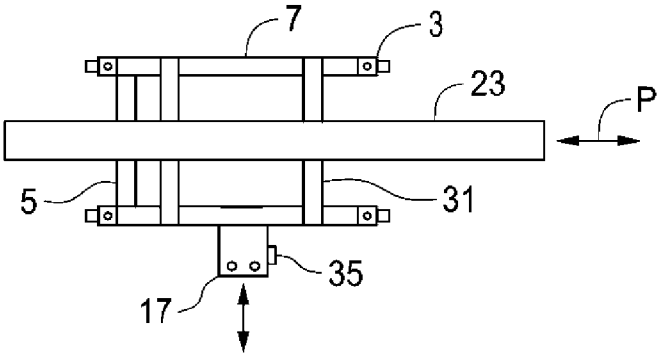

FIG. 4

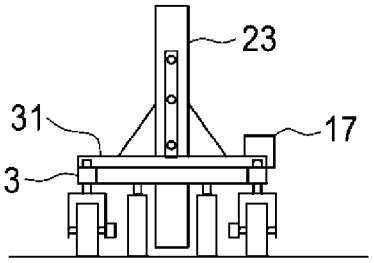

FIG. 5

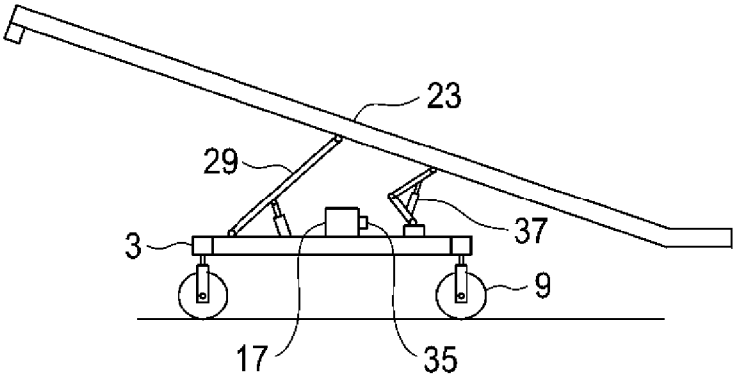

FIG. 6

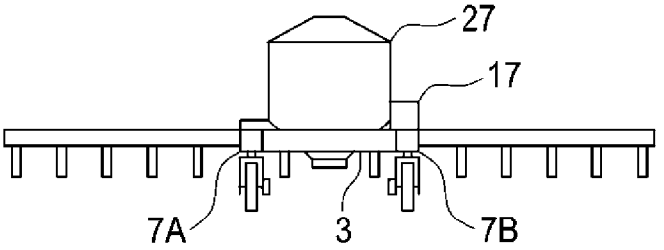

FIG. 7

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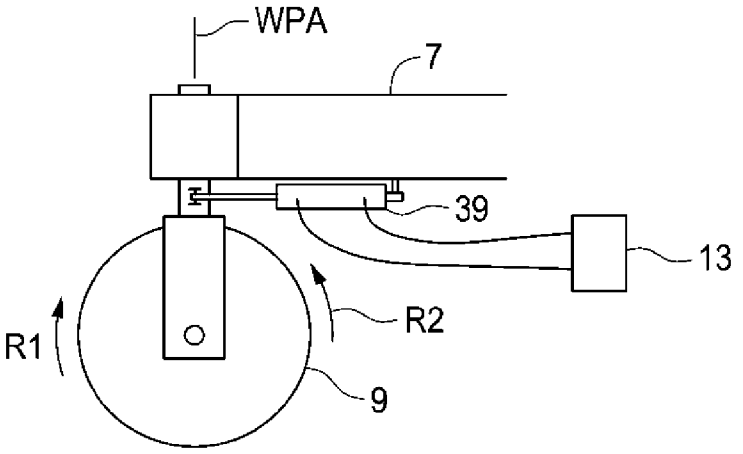

FIG. 8

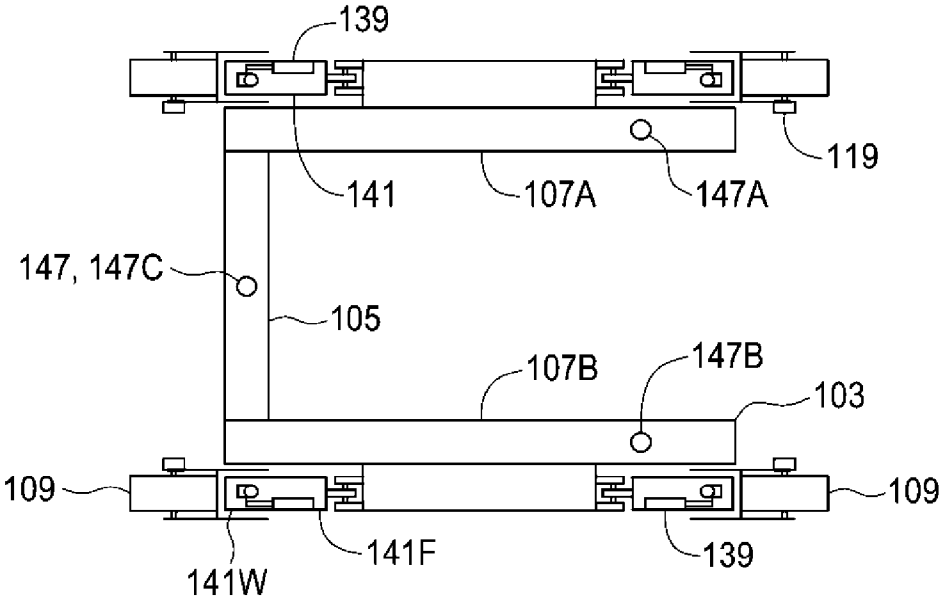

FIG. 9

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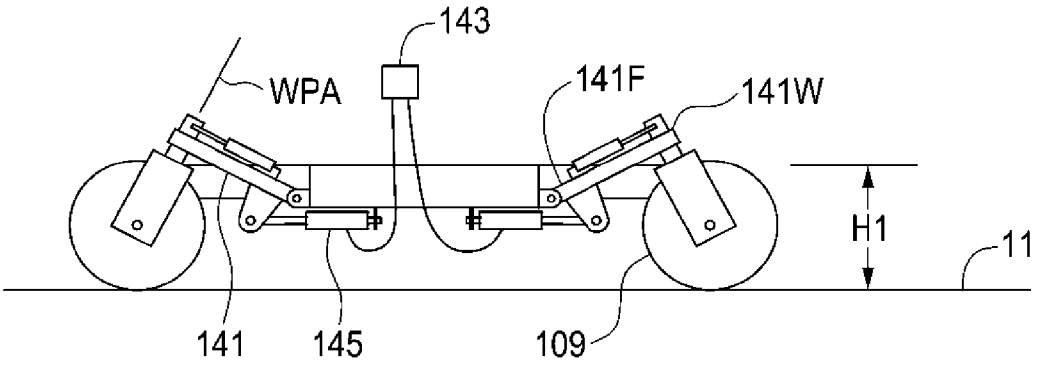

FIG. 10

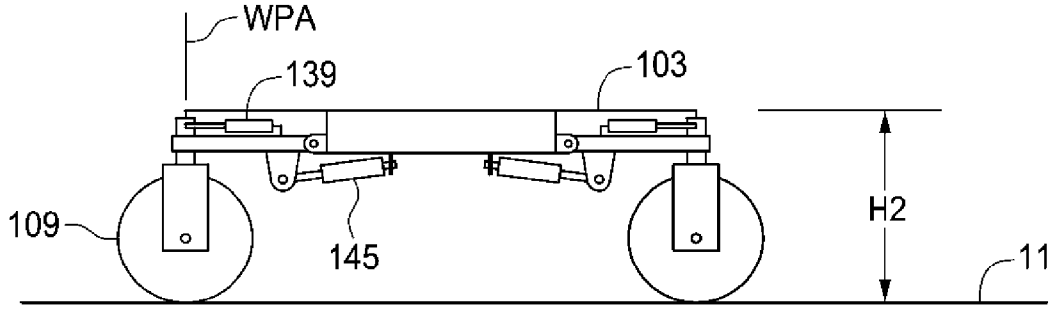

FIG. 11

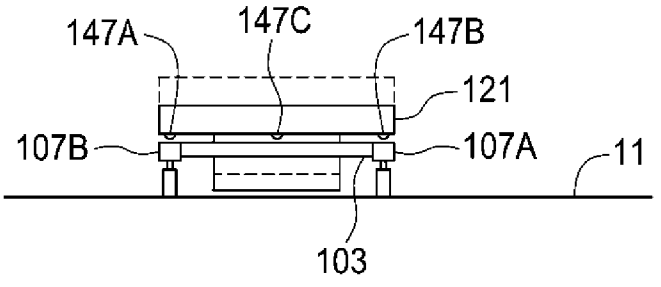

FIG. 12

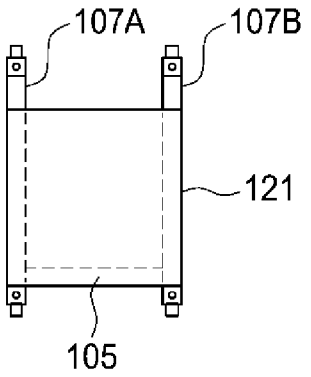

FIG. 13

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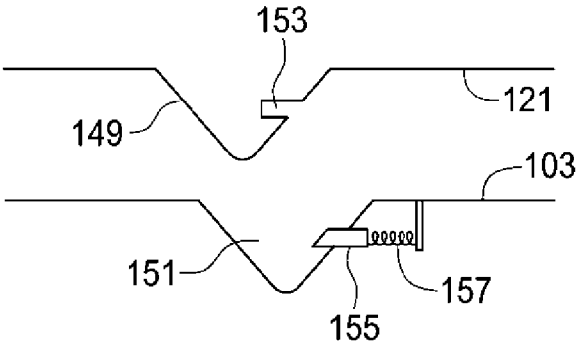

FIG. 14

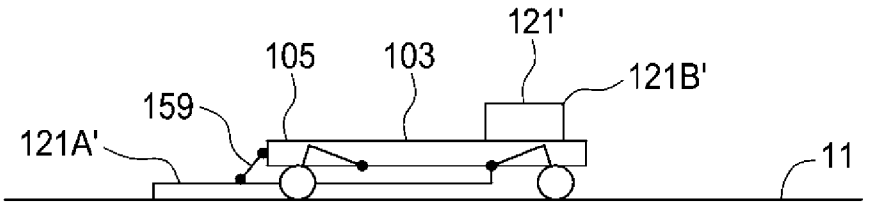

FIG. 15

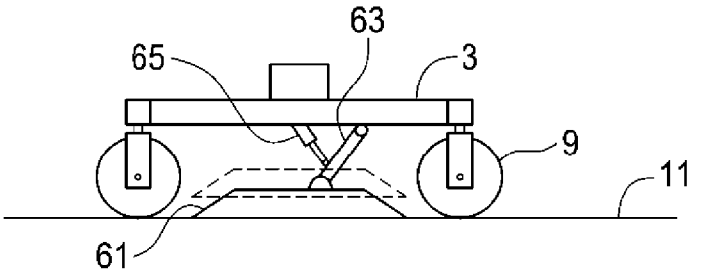

FIG. 16

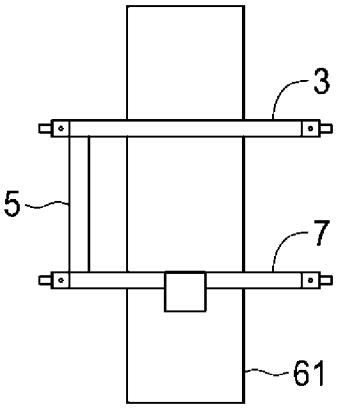

FIG. 17

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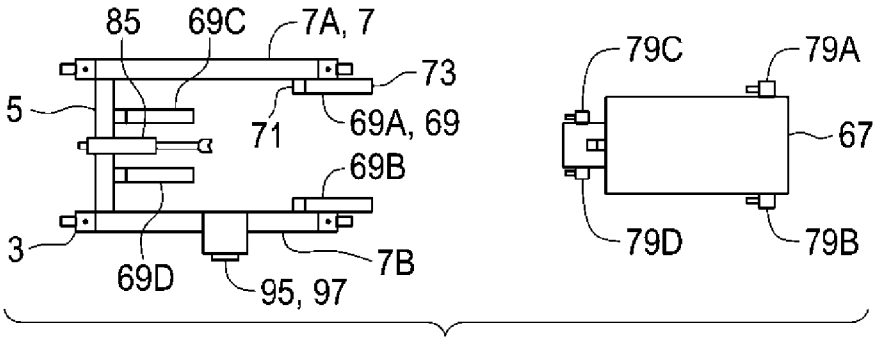

FIG. 18

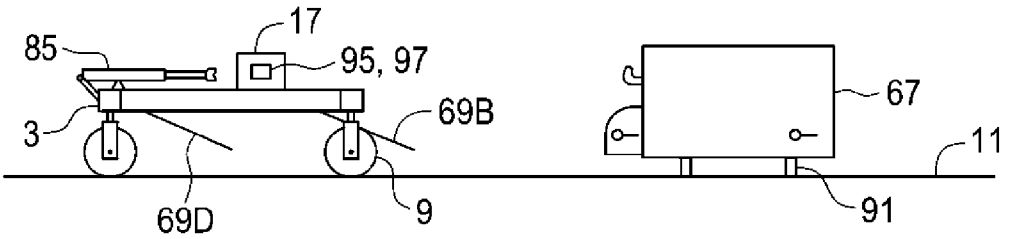

FIG. 19

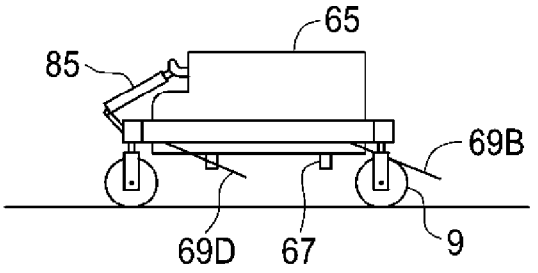

FIG. 20

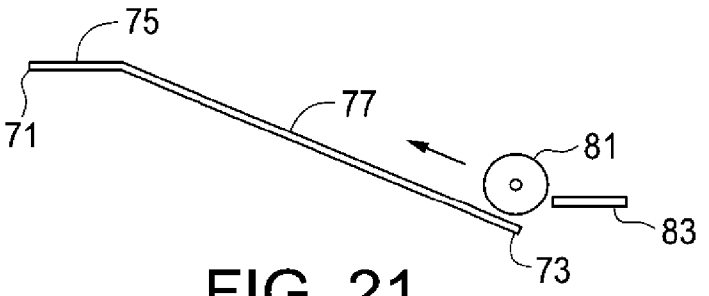

FIG. 21

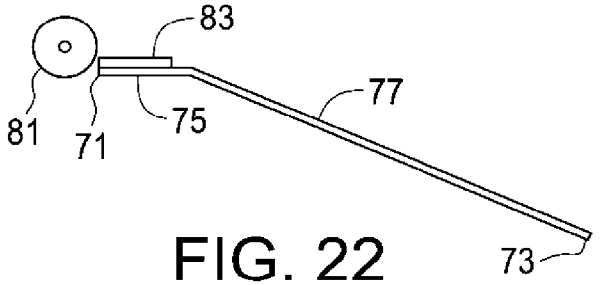

FIG. 22

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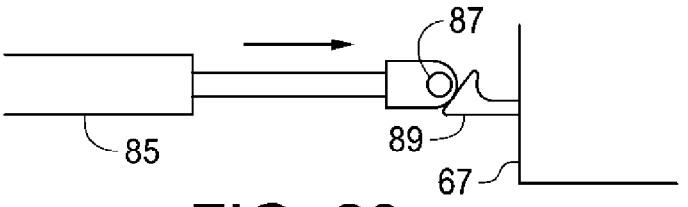

FIG. 23

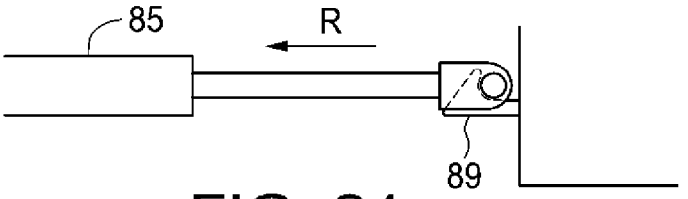

FIG. 24

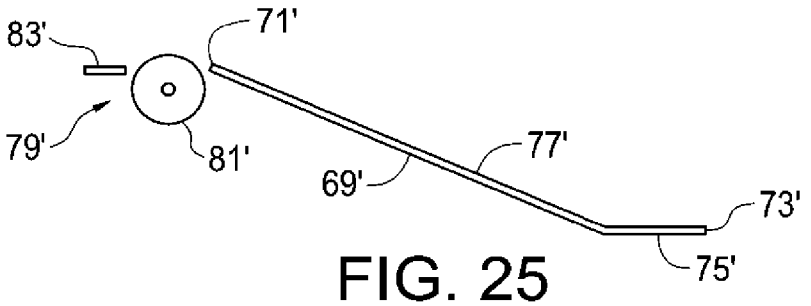

FIG. 25

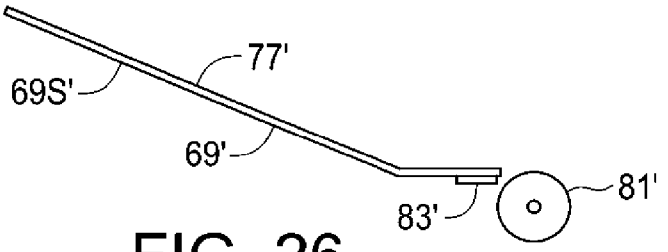

FIG. 26

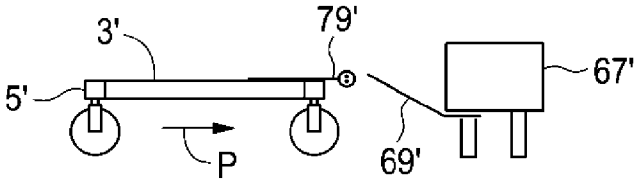

FIG. 27

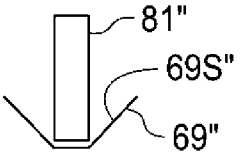

FIG. 28

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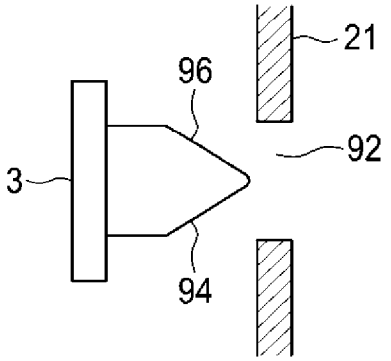

FIG. 29

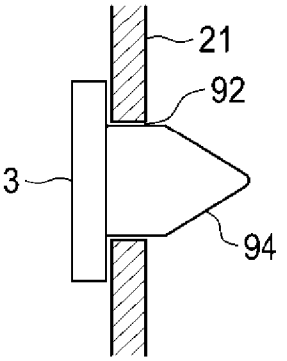

FIG. 30

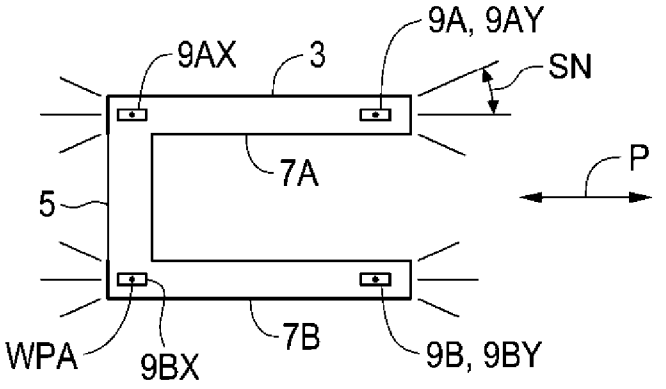

FIG. 31

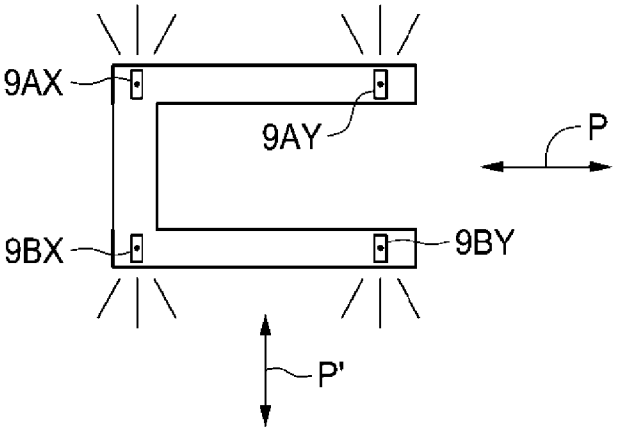

FIG. 32

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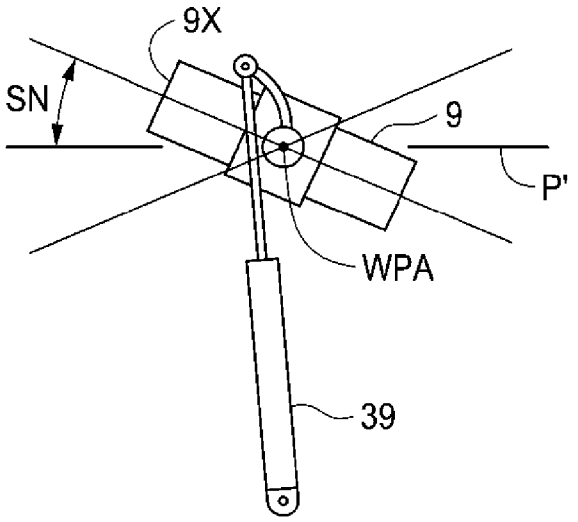


FIG. 33

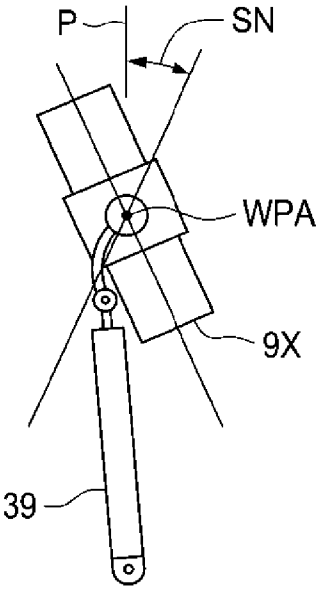


FIG. 34

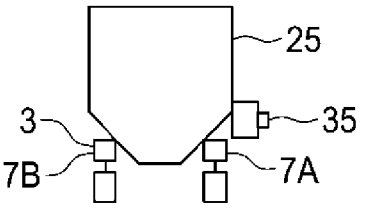


FIG. 35

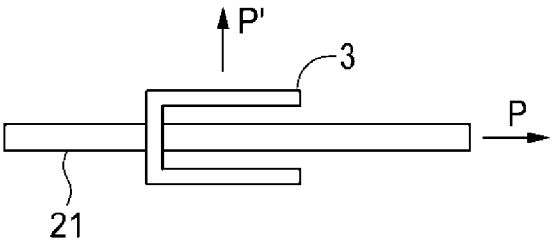


FIG. 36

Date Reçue/Date Received 2021-10-27

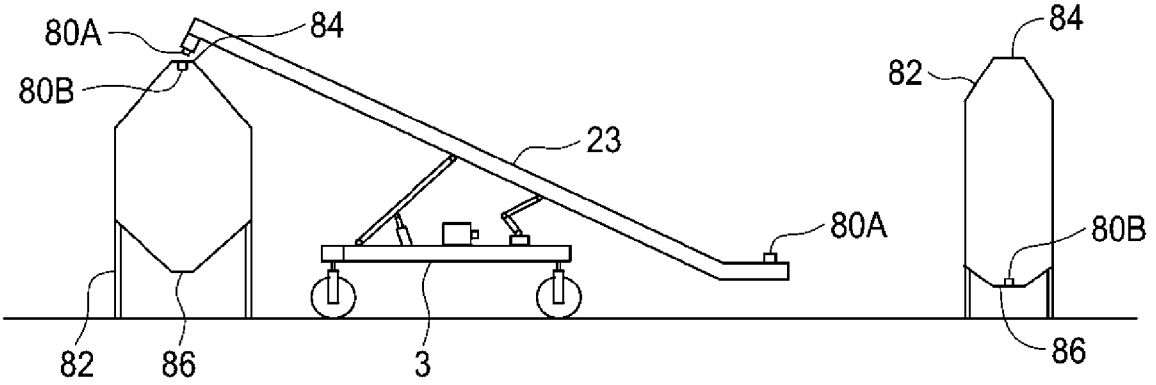


FIG. 37

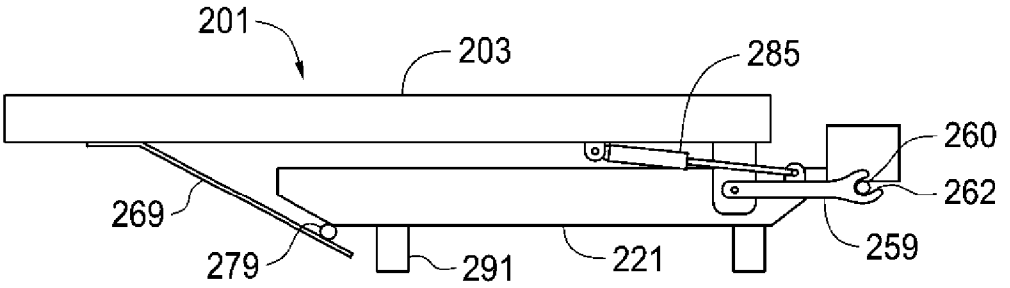


FIG. 38

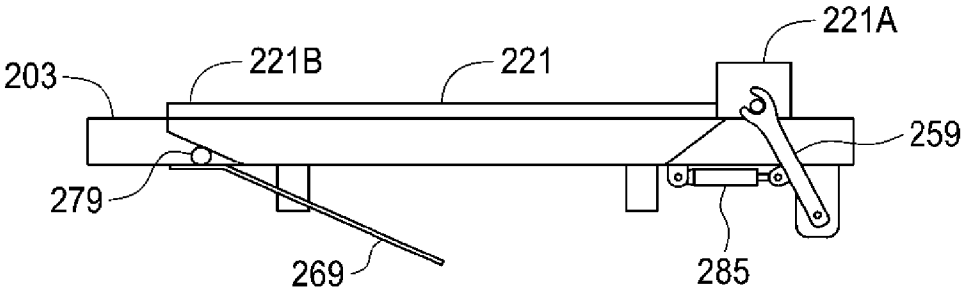
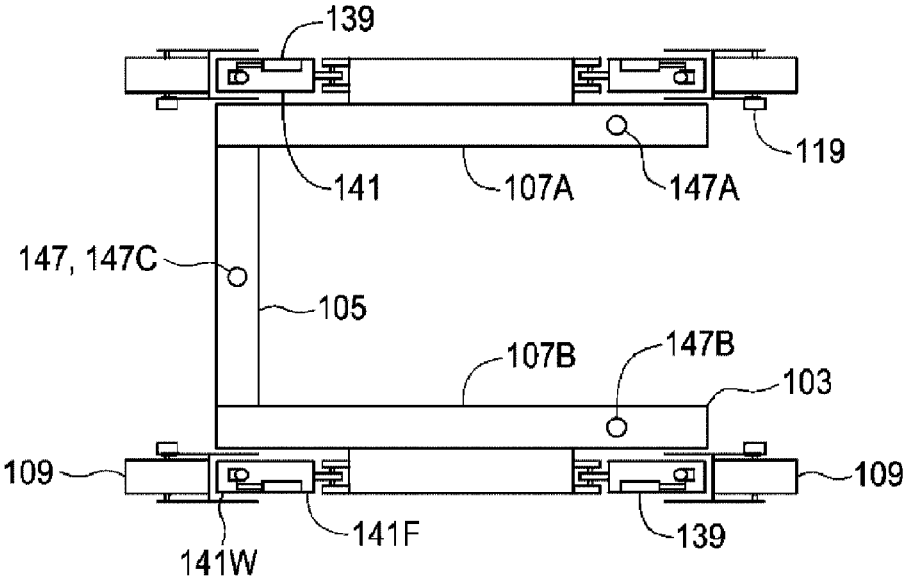


FIG. 39

Date Reçue/Date Received 2021-10-27


139
119
141
107A
147A
147, 147C
105
107B
147B
103
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109
141F
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141W