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(54) **ROUTING HYDROSTATIC GROUND DRIVE HOSES IN A SELF-PROPELLED AGRICULTURAL PRODUCT APPLICATOR**

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A01C 23/04	(2006.01)

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CPC B60K 17/14; B60K 17/10; B62D 49/0678; A01B 76/00; A01C 23/00

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,820,524	A	1/1958	Bear	
3,154,164	A *	10/1964	Shaw	B60B 27/0026 180/209
3,344,879	A *	10/1967	Glomb	B60K 17/10 180/55
3,458,008	A	7/1969	Malm et al.	
3,469,646	A	9/1969	O'Connor	

(Continued)

FOREIGN PATENT DOCUMENTS

EP	2 692 568 B1	2/2014	
WO	2012/035368 A	3/2012	
WO	WO-2012035368 A1 *	3/2012	B60K 17/14

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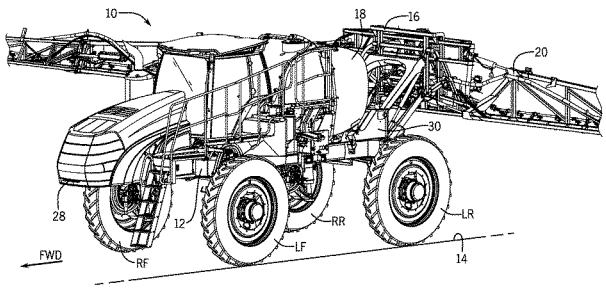
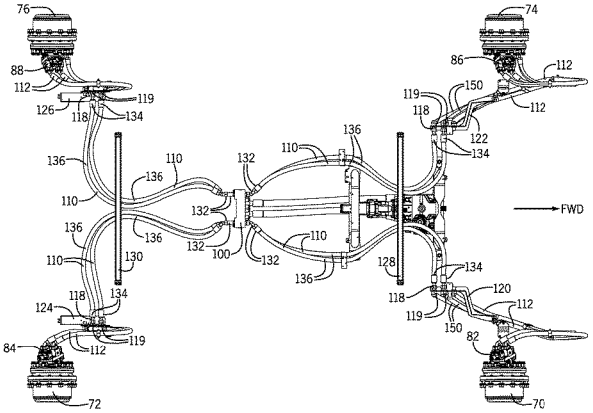
(57) **ABSTRACT**

A ground drive hose routing system and method for a self-propelled agricultural product applicator utilize segments of a hose arrangement that are constrained to lie and move primarily in only one direction, to isolate horizontal hose movement related to track-width adjustment from vertical hose movement resulting from action of suspension members. For steerable wheels, an additional pivotable segment is utilized to accommodate turning motion while maintaining isolation between other primarily horizontally and vertically constrained movable segments of the hose arrangement.

20 Claims, 6 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

4,185,713	A *	1/1980	Williams	B60K 17/10 180/242
5,082,217	A	1/1992	Parker et al.	
5,765,650	A	6/1998	Checkel	
6,378,279	B1	4/2002	Smith et al.	
6,561,535	B1	5/2003	Paluch et al.	
6,752,360	B2	6/2004	Bennett	
7,540,133	B2	6/2009	Zacharias et al.	
7,753,160	B2	7/2010	Velke et al.	
8,205,708	B2	6/2012	Sakakura et al.	
8,668,173	B2	3/2014	Knobloch	
10,266,051	B1 *	4/2019	Trowbridge	A01B 76/00

* cited by examiner

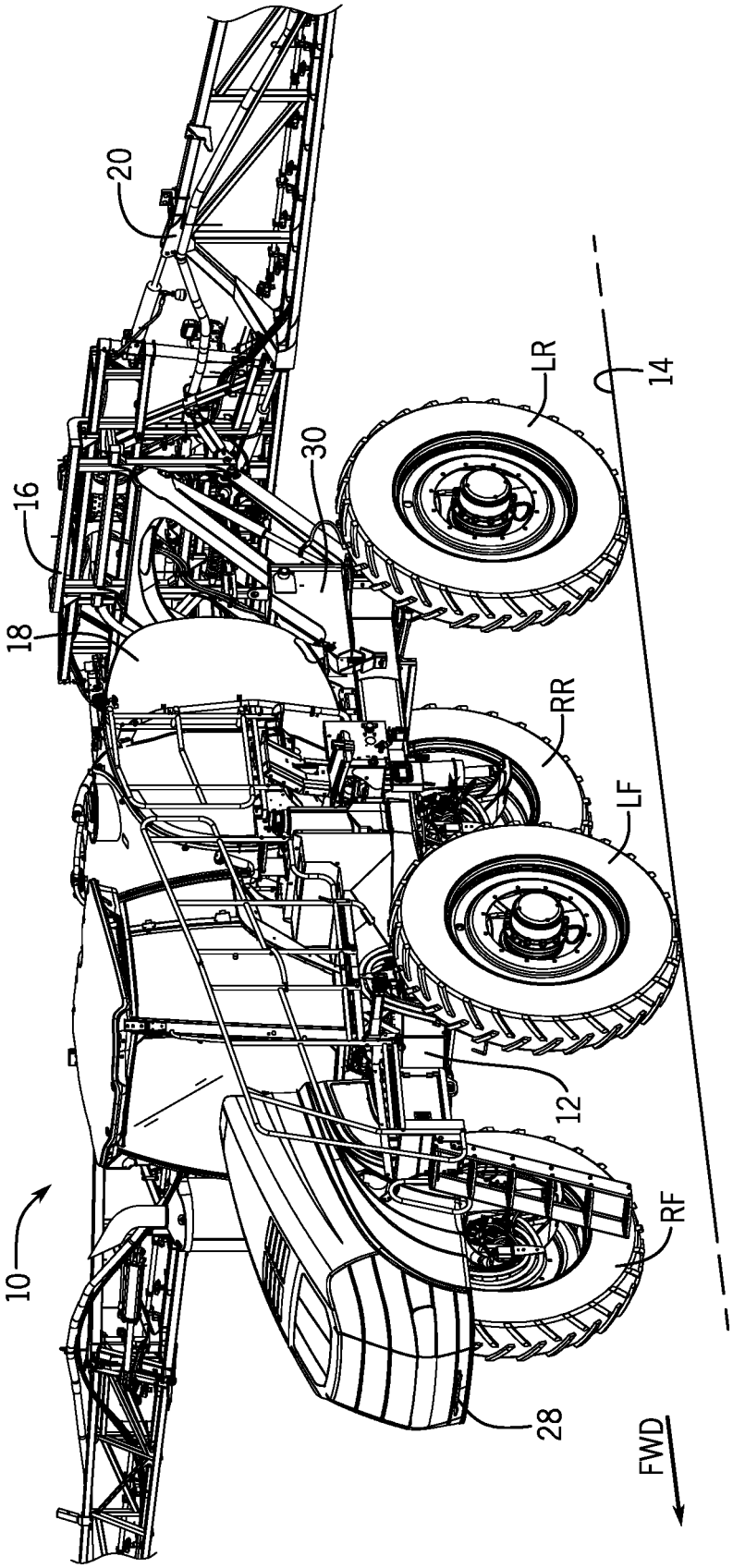
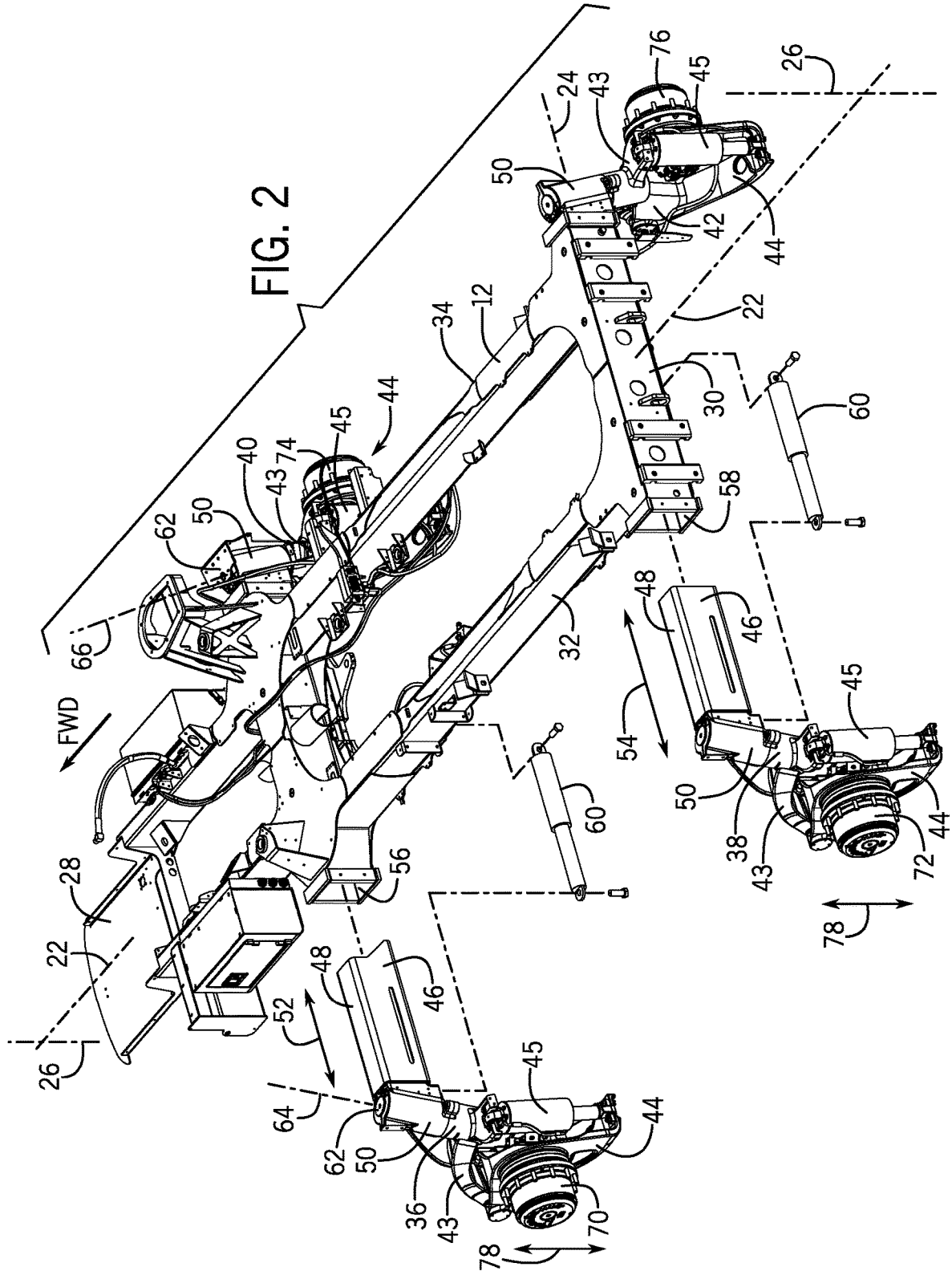


FIG. 1

FIG. 2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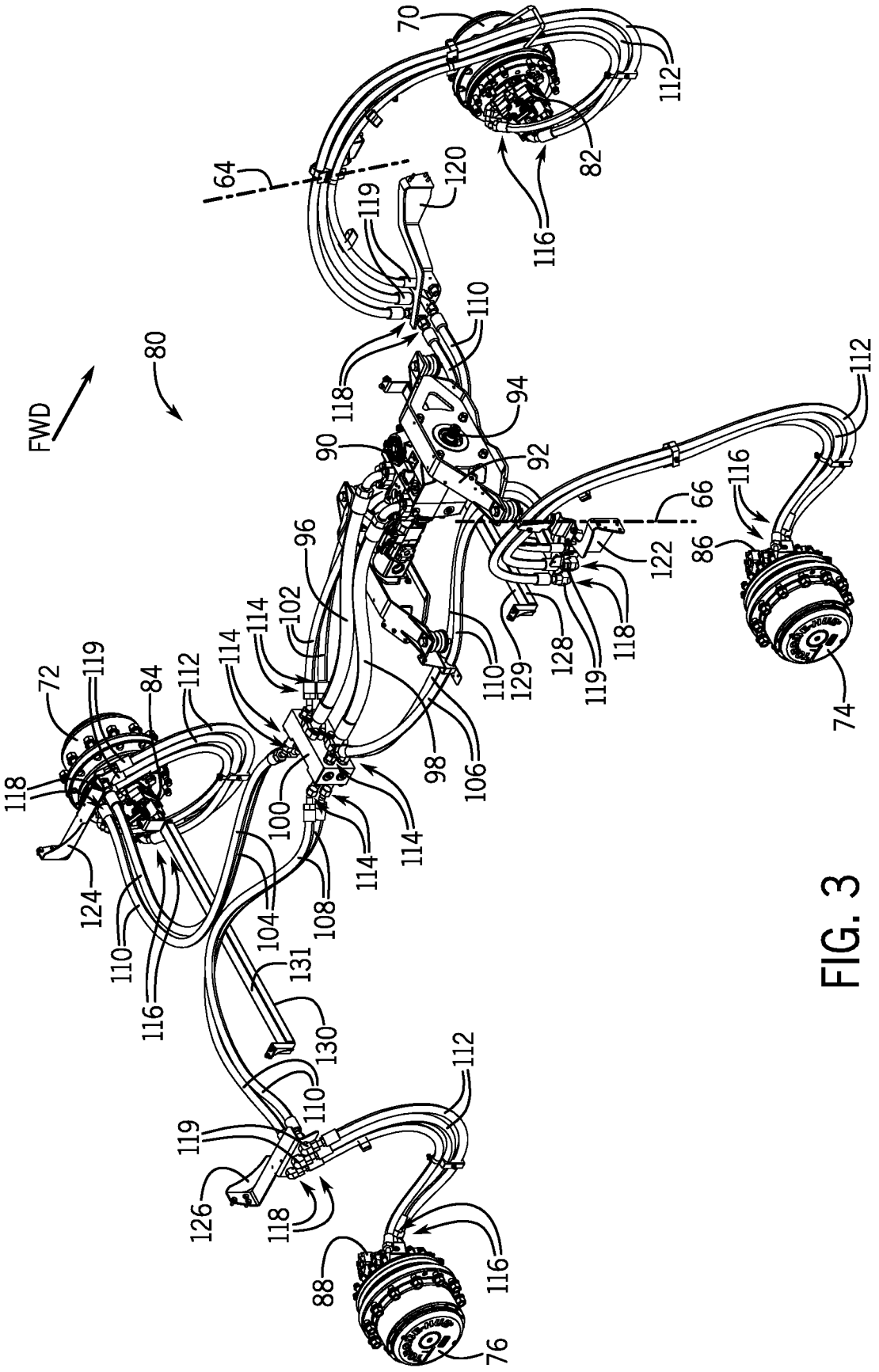
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FIG. 3

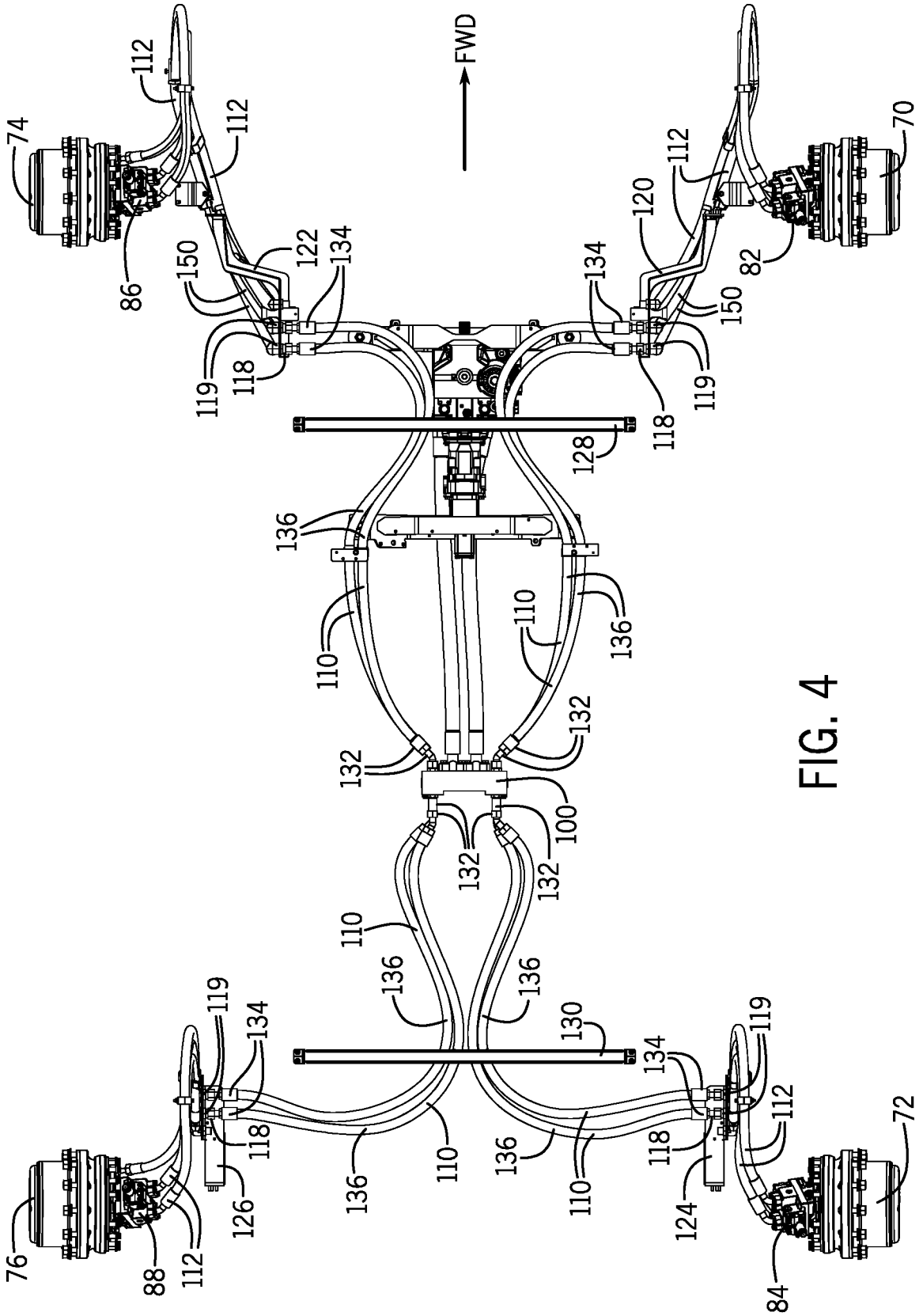
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FIG. 4

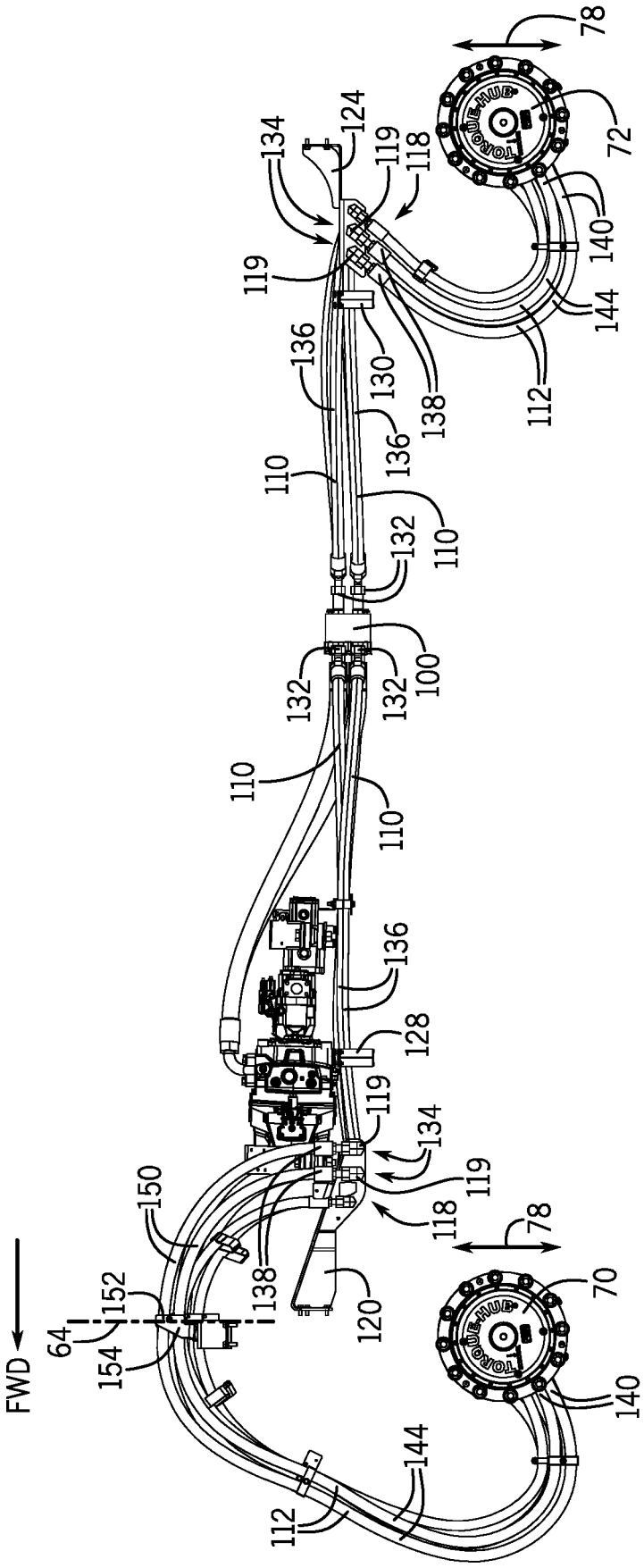
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FIG. 5

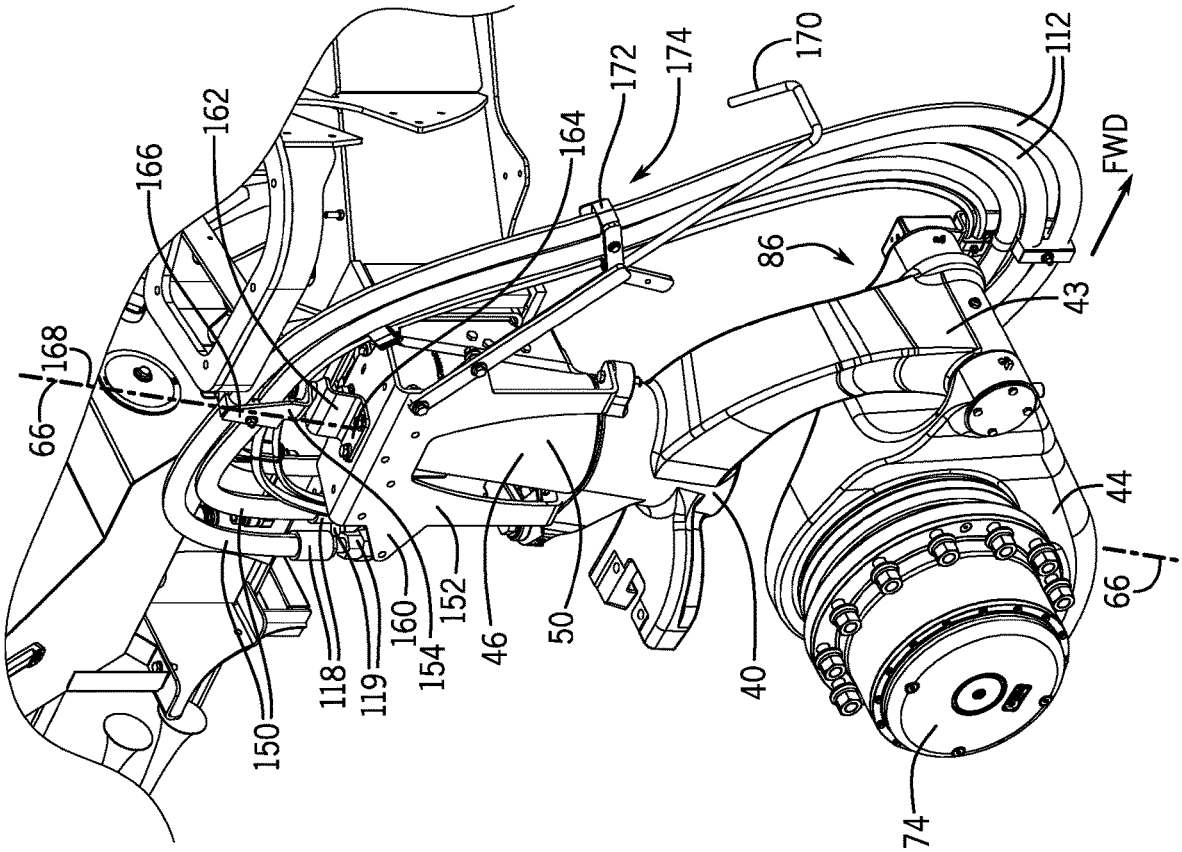
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FIG. 6

ROUTING HYDROSTATIC GROUND DRIVE HOSES IN A SELF-PROPELLED AGRICULTURAL PRODUCT APPLICATOR

FIELD OF THE INVENTION

This invention generally relates to self-propelled agricultural product applicators, and more particularly to hydrostatic ground drive systems in such applicators.

BACKGROUND OF THE INVENTION

Modern agricultural practices rely heavily on precise and timely applications of fertilizers, herbicides, pesticides and other chemicals. In situations where the applications must be made to standing row crops, such as corn or beans, liquid or granular materials are often applied using a high ground clearance, self-propelled applicator.

In order to provide maximum ground clearance, such applicators utilize highly specialized suspension and propulsion systems for connecting the ground engaging wheels of the applicator to a frame of the applicator. Typically, separate hydraulic drive propulsion motors are provided as part of the suspension and propulsion units for each drive wheel, to thereby further enhance ground clearance by minimizing the encroachment of drive train or suspension components into the space between the wheels under the applicator.

Such high ground clearance applicators also typically provide some means for adjusting the track width of the wheels to match the row spacing of the crop being treated.

Routing hydraulic lines to the hydrostatic drive motors provides significant challenges. Because the applicators are large machines carrying heavy loads across uneven terrain, the suspension and drive units must be rugged, and typically require substantial volumes of high-pressure hydraulic fluid during operation. The suspension systems are also often configured to allow adjustment of the height of the applicator above the ground below the applicator.

Action of the suspension systems, the track-width adjustment systems and pivoting motion of steerable wheels of the applicator typically require the use of hoses for providing fluid communication between the hydrostatic drive motors and a source of the pressurized hydraulic fluid mounted to the frame of the applicator. These drive hoses are large, heavy and stiff, and do not lend themselves well to motions inherent in operating the applicator, such as pivoting left and right during steering, vertical movement of the suspension system, and horizontal movement of the track-width adjustment system.

It is a challenge for designers of self-propelled agricultural product applicators to provide an efficient and effective system and method for routing the drive hoses in a manner that keeps hose runs short and direct, while still accommodating all of the various necessary movements of the drive motors relative to the frame of the applicator. It is also a challenge to rout the hoses in a manner that does not result in having the hoses interfere with related mechanisms, such as steering linkages, fenders, tires, or with the crop passing by or under the applicator.

In the past, designers of self-propelled agricultural product applicators often resorted to long hoses, routed to form large or multiple loops of hose, to accommodate all of various motions attendant with operation of the applicator. While this approach has worked, it does not provide effective or efficient solutions to the challenges described above for routing ground drive hoses.

It is desirable, therefore to provide an improved system and method for routing ground drive hydrostatic hoses in a self-propelled agricultural product applicator.

BRIEF SUMMARY OF THE INVENTION

The invention provides an improved ground drive hose routing system and method for a self-propelled agricultural product applicator, by utilizing segments of a hose arrangement that are constrained to lie and move primarily in only one direction, to isolate horizontal hose movement related to track-width adjustment from vertical hose movement resulting from action of suspension members. For steerable wheels, an additional pivotable segment is utilized to accommodate turning motion while maintaining isolation between other primarily horizontally and vertically constrained movable segments of the hose arrangement.

As used herein, the term "horizontally constrained movable hose segment" is intended to mean a hose segment that is constrained to flex and move substantially only in a horizontal direction, as if lying between a pair of horizontally extending surfaces. In similar fashion, the term "vertically constrained movable hose segment," as used herein, is intended to mean a hose segment that is constrained to flex and move substantially only in a vertical direction, as if the vertically constrained movable hose segment were routed between a pair of vertically extending surfaces.

By virtue of this approach, the drive hoses can be shorter, and more uniformly and neatly installed than in prior applicators. In addition, twisting and tangling of the hoses, experienced in prior applicators, is substantially eliminated. Ground clearance is also enhanced, and interference or entanglement with standing crops is precluded.

In one form of the invention, a ground drive hose routing system is provided for a self-propelled agricultural product applicator having a source of pressurized hydraulic fluid mounted on an applicator main frame. The main frame is supported above a ground surface by a ground engaging wheel operatively connected to the frame by an independent suspension and propulsion unit. The independent suspension and propulsion unit is mounted on a horizontally movable axle member for adjusting track width of the wheel. The suspension and propulsion unit includes a hydraulic propulsion motor that is movable horizontally with respect to the frame under action of the movable axle, and also movable vertically with respect to both the frame and the movable axle member under action of the suspension. The ground drive hose routing system includes a hydraulic hose arrangement connected in fluid communication between the source of hydraulic fluid on the frame and the propulsion motor on the independent suspension and propulsion unit.

The hydraulic hose arrangement may define a horizontally constrained movable segment and a vertically constrained movable segment of the hose arrangement. The horizontally constrained segment and the vertically constrained segment are connected in fluid communication with one another in such a manner that movements of the hose arrangement in response to horizontal movement of the axle member, and vertical movement of the propulsion motor under action of the suspension are isolated from one another.

In some forms of the invention, a ground drive hose routing system may have a first end fixedly attached to the frame, a second end fixedly attached to the propulsion motor, and an intermediate hose attachment point disposed between the first and second ends of the hose arrangement. The intermediate hose attachment point may be attached to the movable axle member in a manner constraining the

horizontally constrained movable segment of the hose arrangement to lie and move primarily along a substantially horizontal plane. The intermediate hose attachment point may also be attached to the movable axle member in a manner constraining the vertically movable segment of the hose arrangement to lie and move primarily along a substantially vertical plane, to thereby isolate movements of the hose arrangement in response to horizontal movement of the axle member from movements of the hose arrangement in response to vertical movement of the propulsion motor under action of the suspension.

In some forms of the invention, the frame of the applicator may define substantially perpendicular longitudinal and transverse axes of the frame and applicator, with the longitudinal and transverse axes extending respectively between front and rear ends and left and right sides of the applicator, such that the longitudinal and transverse axes define a horizontal plane extending substantially parallel to a level ground surface under the applicator. The movable axle member may include proximal and distal ends of the movable axle member, with the proximal end being adapted for transversely movable engagement with the frame. The hydrostatic propulsion motor may be operatively connected to the distal end of the movable axle by a vertically movable independent suspension system operatively connecting the wheel and propulsion motor to the distal end of the movable axle member in a manner providing for vertical movement of the wheel and propulsion motor with respect to the distal end of the movable axle element and the frame.

A horizontally constrained movable hose segment, according to the invention, may have a first end fixedly attached to the frame, and a second end fixedly attached to the movable axle member at an intermediate hose connection point for transverse movement of the second end of the transversely movable hose segment with the movable axle member relative to the frame. The horizontally constrained hose segment may also have a length thereof constrained to lie and move in a direction substantially parallel to the horizontal plane defined by the longitudinal and transverse axes of the frame.

In similar fashion, in some forms of the invention, a substantially vertically constrained movable hose segment may have a first end fixedly attached to the movable axle member at an intermediate hose attachment point, and a second end fixedly attached to a propulsion motor for vertical movement of the second end of the vertically movable hose segment with respect to the movable axle member and the frame. The vertically constrained hose segment may also have a length thereof constrained to lie and move in a direction substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes of the frame.

In some forms of the invention, the horizontally constrained movable hose segment has a first end fixedly attached to the frame, and a second end fixedly attached to the movable axle member at the intermediate hose connection point for transverse movement of the second end of the transversely movable hose segment with the movable axle member relative to the frame. The horizontally constrained hose segment also has a length thereof constrained to lie and move in a direction substantially parallel to the horizontal plane defined by the longitudinal and transverse axes of the frame. The substantially vertically constrained movable hose segment has a first end fixedly attached to the movable axle member at the intermediate hose attachment point, and a second end fixedly attached to the propulsion motor for vertical movement of the second end of the vertically movable hose segment with respect to the movable axle member and the frame. The vertically constrained hose segment also has a length thereof constrained to lie and move in a direction substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes of the frame. The first end of the horizontally constrained hose segment is adapted for fluid connection to the source of pressurized hydraulic fluid. The first end of the vertically constrained hose segment is connected in fluid communication with the second end of the vertically constrained hose segment at intermediate hose attachment point, and the second end of the vertically constrained hose segment is connected in fluid communication to the propulsion motor, in such a manner that the ground drive hose routing system provides fluid communication between the source of pressurized hydraulic fluid and the propulsion motor.

The invention may be practiced with both non-steerable and steerable wheels, of a self-propelled agricultural product applicator.

In some forms of the invention, the hydraulic hose arrangement further includes a pivotable hose segment disposed between the horizontally and vertically constrained movable segments of the hose arrangement. This is especially advantageous in practicing the invention with steerable wheels.

Where an independent suspension and propulsion system is pivotably connected to the movable axle at a steering axis such that the wheel is steerable, the vertically constrained segment of the hose arrangement may be routed to substantially pass through the steering axis and be attached to the independent suspension and propulsion system at a second hose attachment point adjacent the steering axis, to thereby define the pivotable hose segment of the hose arrangement. The second hose attachment point may be disposed above the first hose attachment point, such that the pivotable and vertically constrained hose segments substantially loop upward over the movable axle and through the steering axis between the first hose attachment point and the propulsion motor.

The invention may also take the form of a self-propelled agricultural applicator including a ground drive hose routing system in accordance with the invention. An applicator, according to the invention may have multiple non-steerable and/or steerable wheels utilizing a ground drive hose routing system in accordance with the invention.

The invention may further take the form of a method for routing a ground drive hydrostatic hose in a self-propelled agricultural product applicator. Such a method may include connecting a hydraulic hose arrangement in fluid communication between a source of hydraulic fluid attached to the frame and the propulsion motor on an independent suspension and propulsion unit in such a manner that the hydraulic hose arrangement defines a horizontally constrained movable segment and a vertically constrained movable segment of the hose arrangement. The method may further include then further connecting the horizontally constrained segment and the vertically constrained segment in fluid communication with one another in such a manner that movements of the hose arrangement in response to horizontal movement of the axle member, and vertical movement of the propulsion motor under action of the suspension are isolated from one another.

In a method, according to the invention, the hose arrangement may have a first end fixedly attached to the frame, a second end fixedly attached to the propulsion motor, and an intermediate hose attachment point disposed between the first and second ends of the hose arrangement and attached

to the movable axle member in a manner constraining the horizontally constrained movable segment of the hose arrangement to lie and move primarily along a substantially horizontal plane, and also constraining the vertically movable segment of the hose arrangement to lie and move primarily along a substantially vertical plane, to thereby isolate movements of the hose arrangement in response to horizontal movement of the axle member from movements of the hose arrangement in response to vertical movement of the propulsion motor under action of the suspension.

Some forms of a method, according to the invention, may include configuring the hydraulic hose arrangement to also include a pivotable hose segment disposed between the horizontally and vertically constrained movable segments of the hose arrangement.

In forms of the invention where the independent suspension and propulsion system is pivotably connected to the movable axle at a steering axis such that the wheel is steerable, a method, according to the invention, may further include routing the vertically constrained segment of the hose arrangement to substantially pass through the steering axis and attaching the vertically constrained segment at an intermediate point in the vertically constrained segment to the independent suspension and propulsion system at a second hose attachment point, to thereby define the pivotable hose segment of the hose arrangement.

Other aspects, objects and advantages of the invention will be apparent from the following detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of exemplary embodiments of the present invention and, together with the description, serve to explain the invention. In the drawings:

FIG. **1** is an isometric front view of an exemplary embodiment of a self-propelled agricultural applicator, according to the invention;

FIG. **2** is an isometric rear view of a main frame, adjustable axle members, and independent suspension and propulsion units of the self-propelled agricultural product applicator of FIG. **1**;

FIG. **3** is an isometric front view of a ground drive hose routing system of the self-propelled agricultural product applicator of FIG. **1**;

FIG. **4** is bottom orthographic view of the ground drive hose routing system of the self-propelled agricultural product applicator of FIG. **3**;

FIG. **5** is an orthographic left-side view of the ground drive hose routing system of the self-propelled agricultural product applicator of FIG. **3**; and

FIG. **6** is an isometric front view of a right front corner of the frame, and front right suspension and propulsion units of FIG. **2**, and associated elements of the ground drive hose routing system shown in FIGS. **3-5** of the exemplary embodiment of the applicator shown in FIG. **1**.

While the invention is described herein with reference to certain preferred embodiments, there is no intent to limit it to those embodiments. On the contrary, the intent is to cover all alternatives, modifications and equivalents as included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows an exemplary embodiment of a self-propelled agricultural product applicator **10** that includes a main frame **12** supported above a ground surface **14** by four ground engaging wheels LF,RF,LR,RR of the applicator **10**. The exemplary embodiment of the applicator **10** is shown carrying a sprayer arrangement **16**, having a tank **18** for carrying a liquid agricultural product, and a boom-mounted spray nozzle distribution arrangement **20**.

As shown in FIG. **2**, the main frame **12** defines mutually perpendicular longitudinal, transverse and vertical axes **22**,**24**,**26** of the frame **12** and applicator **10**. The longitudinal and transverse axes **22**,**24** extend respectively between front and rear ends **28**,**30** and left and right sides **32**,**34** of the applicator **10**, in such a manner that the longitudinal and transverse axes **22**,**24** define a horizontal plane extending substantially parallel to a level ground surface **14** under the applicator **10**. The vertical axis **26**, in conjunction with the horizontal plane, as defined by the longitudinal and transverse axes **22**,**24**, defines any one of a series of vertical planes extending substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes **20**,**22**, and substantially parallel to the vertical axis **26**.

As illustrated in FIG. **2**, the main frame **12** is connected to the wheels LF,LR,RF,RR by four independent suspension and propulsion units **36**,**38**,**40**,**42**, that are each slidingly connected to the frame **12** by adjustable axle members **46**, for movement in a direction substantially parallel to the transverse axis **24**, in the manner specifically illustrated by arrows **52**,**54** in FIG. **2** for the front and rear left wheels LF,LR of the applicator **10**. Each of the adjustable axle members **46** includes a proximal end **48**, adapted for sliding movement within a front or a rear axle tube **56**,**58** of the frame **12**, under action of a hydraulic track-width adjustment cylinder **60**. Although the details described above are only specifically shown in FIG. **2** for the left side front and rear wheels LF,LR, it will be understood that the movable axle members **46** for the right side front and rear wheels RF,RR are configured to interface and move in the same manner, with respect to the front or a rear axle tubes **56**,**58** of the frame **12**, under action of hydraulic track-width adjustment cylinders that are not visible in FIG. **2**.

As further illustrated in FIG. **2**, each of the movable axle members **46** also includes a distal end **50** adapted for receiving one of the suspension and propulsion units **36**,**38**, **40**,**42**. Upper suspension members **43** of the left and right rear suspension and propulsion units **38**,**42** are fixedly attached to the distal ends **50** of their respective movable axle members **46**, and are non-steerable in the exemplary embodiment of the applicator **10**. The upper suspension members **43** of the left and right front suspension and propulsion units **36**,**40** of the applicator **10** are attached to the distal ends **50** of their respective movable axle members **46** by steerable kingpin arrangements **62**.

The steerable kingpin arrangements are configured to provide pivotable steering movement of the front wheels LF,RF about respective left and right steering axes **64**,**66** that extend substantially parallel to, but slightly angled from the vertical axis **26**, to facilitate proper tracking and steering of the applicator **10**. It will be understood, that in other embodiments of the invention, the rear wheels LR,RR might also be steerable, or the front wheels LF,RF might be fixed and the rear wheels LR,RR might be steerable.

As yet further illustrated in FIG. **2**, each of the left and right front wheels LF,RF and the left and right rear wheels LR,RR are connected to a lower, vertically movable member **44** of their respective suspension and propulsion units **36**,**38**, **40**,**42**, by a respective wheel drive hub arrangement **70**,**72**, **74**,**76**, in a manner that allows the wheel drive hubs **70**,**72**, **74**,**76** and wheels LF,LR,RF,RR to move vertically with

respect to the distal ends **50** of the movable axle members **46** and the frame **12**, as specifically illustrated by arrows **78** for the left front and rear wheels LF,LR in FIG. **2**.

The suspension systems of the independent suspension and propulsion units **36**,**38**,**40**,**42** in the applicator **10** also each include an actively controllable air strut **45**, connected between the upper and lower suspension members **43**,**44**. The air struts **45** are used to selectively raise and lower the height of the main frame **12** above the ground surface **14**, to thereby facilitate various modes of operation, transport and maintenance of the applicator **10**. The air struts **45** also include internal traditional spring and shock absorber suspension components that allow vertical movement of the wheel drive hubs **70**,**72**,**74**,**76** and wheels LF,LR,RF,RR, with respect to the distal ends **50** of the movable axle members **46** and the frame **12**, under action of the suspension, as the applicator **10** traverses the ground surface **14**.

As shown in FIG. **3**, the applicator **10** includes a hose routing system **80**, in accordance with the invention, for a series of ground drive hydrostatic hoses, described in greater detail below, that are connected in fluid communication to four variable displacement hydraulic propulsion motors **82**,**84**,**86**,**88** that are each respectively operatively connected to independently drive one of the hubs **70**,**72**,**74**,**76**, to thereby independently drive the wheels LF,LR,RF,RR of the applicator **10**.

The four variable-displacement hydraulic propulsion motors **82**,**84**,**86**,**88** are connected in fluid communication to a common hydrostatic propulsion pump unit **90**, that is mounted to a crossmember **92** of the frame **12**, and connected by a drive shaft **94** to be driven by the main engine (not shown) of the applicator **10**. The pump unit **90** is connected by a forward supply hose **96** and a reverse supply hose **98** to a common manifold block **100** that is fixedly mounted on a second crossmember (not shown for clarity of illustration) of the frame **12**. The propulsion pump unit **90** and the common manifold block **100** thus constitute sources of pressurized hydraulic fluid attached to the frame **12**.

The ground drive hose routing system **80** of the exemplary embodiment includes four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108**, each consisting of a supply hose and a return hose that run substantially parallel to one another to provide fluid communication between the common manifold **100** on the frame **12** and one of the propulsion motors **82**,**84**,**86**,**88**. The function of a particular hose in each of the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108** will alternate between being a supply hose or a return hose, depending upon whether the applicator **10** is being driven forward, or in reverse by the hydrostatic propulsion pump unit **90**.

In the exemplary embodiment of the applicator **10**, each hydraulic hose arrangement in each of the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108** includes a horizontally constrained movable segment **110** and a vertically constrained movable segment **112** of each particular supply and return hose in a given pair of hydraulic hose arrangements **102**,**104**,**106**,**108**. For each respective supply and return hose arrangement, the horizontally constrained segment **110** and the vertically constrained segment **112** are connected in fluid communication with one another in such a manner that movements of that particular hose arrangement in response to horizontal movement **52**,**54** of the front and rear axle members **46**, and vertical movement of the propulsion motors **82**,**84**,**86**,**88** under action of the suspension systems of the independent suspension and propulsion units **36**,**38**,**40**,**42** are isolated from one another.

With continued reference to FIG. **3**, each of the supply and return hose arrangements in the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108** of the exemplary embodiment of the ground drive hose routing system **80** has a first end fixedly attached to the frame, via the common manifold **100**, as indicated by arrows **114**, a second end fixedly attached to one of the propulsion motors **83**,**84**,**86**,**88**, as indicated by arrows **116**, and an intermediate hose attachment point, as indicated by arrows **118**, disposed between the first and second ends **114**,**116** of each of the supply and return hose arrangements of the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108**.

In some embodiments of the invention, one or more of the supply and return hose arrangements in the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108** may extend continuously in a single span of hose between its respective first and second ends, and the intermediate hose attachment point **118** may be defined by the location of a clamp, or some other appropriate arrangement that anchors the continuous span of hose to its respective movable axle member **46** at the intermediate attachment point **118**.

In the exemplary embodiment of the applicator **10**, however, the intermediate hose attachment points **118** are provided by bulkhead connections, in the form of individual right-angle bulkhead fittings **119** providing fluid communication between the horizontally constrained hose segments **110** and the vertically constrained hose segments **112** at the intermediate connection points **118** of each of the supply and return hose arrangements of the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108**. The right-angle bulkhead fittings **119** for the supply and return hose arrangements of each of the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108** are respectively mounted on a mounting bracket **120**,**122**,**124**,**126** attached to the movable axle member **46** connecting the propulsion motor **82**,**84**,**86**,**88** served by that pair of hydraulic hose arrangements **102**,**104**,**106**,**108**, to move transversely with the movable axle member **36** to which each bracket **120**,**122**,**124**,**126** is attached.

It is noted that, although the mounting brackets **120**,**122**,**124**,**126** attached to the movable axle members **46** in the exemplary embodiments all include a vertically oriented flange configured for receiving the right-angle hydraulic fittings **119**, other embodiments of the invention may employ one or more brackets having a flange oriented horizontally, or at some other angle for receiving the right-angle fittings **119**. Also, in other embodiments of the invention, it is contemplated that alternate approaches for securing the hoses at the intermediate connection points **118** may utilize other types of individual or ganged hydraulic fittings, fluid-directing manifolds, or hose clamping arrangements for securing and/or joining the supply and return hose arrangements of the hose pairs **102**,**104**,**106**,**108** at the intermediate connection points **118**.

The exemplary embodiment of the ground drive hose routing system **80** includes a pair of support bars **128**,**130** fixedly attached to the frame **12** and extending transversely across the underside of the frame **12** for supporting the horizontally constrained movable hose segments **110** in a manner that constrains the horizontally constrained movable segments **110** of the four pairs of hydraulic hose arrangements **102**,**104**,**106**,**108** to lie and move primarily along a substantially horizontal plane extending more-or-less parallel to the horizontal plane defined by the longitudinal and transverse axes **22**,**24** of the frame **12**.

Because the propulsion motors **82**,**84**,**86**,**88** and the intermediate hose attachment points **118** are all mounted on the movable axle members **46**, they move together, when the

movable axle members **46** are extended or retracted, in such a manner that transverse movement of the movable axle members **46**, to adjust track width of the applicator **10**, does not result in any relative movement of the vertically constrained hose segments **112**. Transverse movement of the movable axle members **46** is essentially completely taken up by flexing and bending movement of the horizontally constrained segments **110** along the horizontal plane defined by the front and rear support bars **128**,**130**.

Because the ground drive hoses in a typical self-propelled agricultural product applicator are generally of substantial diameter and reinforced to handle the flow rates and high pressures required for propelling the applicator, and to be rugged enough for use in agricultural environments, these hoses are typically quite stiff. As a result, the front and rear support bars **128**,**130** in the exemplary embodiment of the applicator **10** have been found to provide adequate support to constrain the horizontally constrained hose segments **110** to lie and move along a substantially horizontal plane. In other embodiments of the invention, it is conceived that other forms of support bars, plates, or brackets may also be used with efficacy for constraining the horizontally constrained hose segments **110** to lie and move along a substantially horizontal plane.

As indicated in FIG. **3**, the front and rear support bars **128**,**130** of the exemplary embodiment of the applicator **10** each have respective upper surfaces **129**,**131** that include a plastic sliding surface to reduce wear on the hoses and the support bars **128**,**130**, and to facilitate flexing and bending of the horizontally constrained hose segments **110** as they lie and move along the horizontal plane. In other embodiments of the invention, other surface treatments may be applied to the upper surfaces **129**,**131** of the support bars **128**,**130**. Such other surface treatments might include, for example, using other durable, wear-resistant materials attached to the support bars **128**,**130**, or utilizing wear resistant coatings or sleeves on the support bars **128**,**130** and/or the hoses in areas where the hoses contact the support bars **128**,**130**.

Locating the intermediate hose attachment points **118** and the propulsion motors **82**,**84**,**86**,**88** on the movable axle member also results in constraining the vertically movable segments **112** of the hose arrangements to lie and move primarily along a substantially vertical plane, to thereby isolate movements of the horizontally constrained segments **10** of the hose arrangements in response to horizontal transverse movement of the movable axle members **46**, from movements of the vertically constrained segments **112** of the hose arrangements in response to vertical movement **78** of the propulsion motors **82**,**84**,**86**,**88** under action of the suspension members of the independent suspension and propulsion units **36**,**38**,**40**,**42**.

As shown in FIGS. **4** and **5**, in the exemplary embodiment, the horizontally and vertically constrained hose segments **110**,**112**, are separate hose arrangements, joined together at the intermediate connection points **118** by the right-angle bulkhead fittings **119**. Each of the horizontally constrained movable hose segments **110** has a first end **132** fixedly attached to the frame **12** via the common manifold **100**, and a second end **134** fixedly attached to the movable axle member **46** at one of the hose connection point **118** for transverse movement of the second ends **134** of the horizontally constrained movable hose segments **110** with the movable axle member **46**, relative to the frame **12**. The horizontally constrained hose segments each also have a length **136** thereof constrained to lie and move in a direction substantially parallel to the horizontal plane defined by the longitudinal and transverse axes **22**,**24** of the frame **12**.

In similar fashion, as illustrated in FIG. **5** for the left front and left rear drive hubs, in the exemplary embodiment of the applicator **10**, each substantially vertically constrained movable hose segment **112** has a first end **138** fixedly attached to the movable axle member **46** by a bulkhead fitting **119** at one of the hose attachment points **118**, and a second end **140** fixedly attached for vertical movement **78** of the second end **140** of the vertically constrained movable hose segment **112** with respect to the movable axle member **46** and the frame **12**. Each vertically constrained hose segment **112** also has a length **144** thereof constrained to lie and move in a direction substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes **22**,**24** of the frame **12**.

The first end **138** of each of the vertically constrained hose segments **112** is connected in fluid communication at the hose attachment point **118**, using one of the right-angle bulkhead fittings **119**, with the second end **134** of its corresponding horizontally constrained hose segment **110**, and the second end **140** of each vertically constrained hose segment **112** is connected in fluid communication its respective propulsion motor **82**,**84**,**86**,**88**, in such a manner that the ground drive hose routing system **80** provides separate channels of fluid communication between the common manifold **100** and each of the propulsion motors **82**,**84**,**86**,**88**.

The right-angle bulkhead fittings **119** provide a convenient transition between the horizontally constrained segments **110** to the vertically constrained segments **112**, and help to isolate and orient the horizontally and vertically constrained hose segments **110**,**112** to lie and move along their respective horizontal and vertical planes.

As also indicated in FIGS. **3**-**5**, the mounting brackets **124**,**126** for the rear wheels LR,RR are configured to locate the hose attachment points **118** for the rear wheels LR,RR behind the movable axle members **46** for the rear wheels LR,RR. The mounting brackets **120**,**122** for the front wheels LF,RF are configured to locate the hose attachment points **118** for the front wheels LF,RF forward of the movable axle members **46** for the front wheels LF,RF. As illustrated in FIG. **4**, the mounting brackets **120**,**122** for the front wheels LF,RF are also further configured to have an offset, dog-legged shape when viewed in both horizontal and vertical directions to optimize placement of the intermediate hose attachment points **118** for isolating the horizontally and vertically constrained hose segments **110**,**112** to lie and move along their respective horizontal and vertical planes.

As further shown in FIGS. **3**-**5**, the vertically constrained hose segments **112** of the rear wheels LR,RR are directed downward in a single smooth curved path between the right-angle bulkhead fittings **119** at the rear intermediate hose attachment points **118** and the left and right rear propulsion motors **84**,**88**. Because the rear vertically constrained hose segments **112** are isolated from the effects of transverse, horizontal movement of the movable axle members **46**, and are constrained in the manner described above to lie and move along only a vertical plane, the rear wheel vertically constrained hose segments **112** can advantageously have shorter lengths than were achievable in prior ground drive hose routing systems, and be aligned and constrained in a manner providing increased ground clearance and minimal potential interference with standing row crops passing under the frame **12** of the applicator **10**.

The invention as described thus far may be practiced with both non-steerable and steerable wheels, of a self-propelled agricultural product applicator **10**.

As shown in FIG. **5**, to provide additional isolation of the horizontally constrained hose segments **110** from the vertically constrained hose segments **112** of the front, steerable wheels LF,RF of the exemplary embodiment of the applicator **10**, the vertically constrained hose segments **112** of the front pairs **102**,**106** of supply and return hose arrangements are further configured to provide pivotable hose segments **150** disposed between the horizontally and vertically constrained movable segments **110**,**112** of the supply and return hose arrangements for the front wheels LF,RF. This is especially advantageous in practicing the invention with steerable wheels.

As illustrated in FIG. **5**, the vertically constrained segments **112** of the front wheel supply and return hose arrangements are initially routed upward by orientation of the right-angle bulkhead fittings **119**, from the intermediate hose attachment points **118** attached to the front movable axle members **46**, and then looped downward in a single smooth partial loop to substantially pass through the respective steering axis **64**,**66** for one of the front wheels LF,RF to the respective front wheel propulsion motor **82**,**86** associated with a respective pair of vertically constrained hose segments **112**. The vertically constrained hose segments **112** serving each of the front wheels LF,RF are also attached to their respective movable front axle **46** by a steering axis bracket arrangement **152** at a second hose attachment point **154** adjacent its steering axis **64**,**66**, to thereby define the pivotable hose segments **150** of the supply and return hose arrangements serving the front wheel propulsion motors **82**,**86** as those sections **150** of the vertically constrained segments **112** of the supply and return hose arrangements extending between the first intermediate hose attachment points **118** and the second intermediate hose attachment points **154**.

By virtue of this arrangement, it will be appreciated that the pivotable hose segments **150** are configured and constrained to pivotably accommodate movement of the pivotable segments **150** in response to steering movement of the front independent suspension and propulsion units **36**,**40**, in a manner that isolates the remainder of the vertically constrained front wheel hose segments **112** so that they can continue to lie and move only substantially along a vertically oriented plane. The addition of the pivotable sections **150** for the steerable wheels LF,RF in accordance with the invention, as described above in relation to the exemplary embodiment of the applicator **10**, also maintains isolation of the horizontally constrained movable hose segments **110** serving the front wheels LF,RF to lie and move only along a substantially horizontal plane.

In some embodiments of the invention, it is contemplated that the vertically constrained hose segments may be fixedly clamped to the steering axis bracket arrangement **152** at the second hose attachment point **154** to thereby define the pivotable hose segments **150**, and provide the desired pivotable transition to maintain isolation in the front, steerable wheels LF,RF between the horizontally and vertically constrained hose segments **110**,**112** serving the steerable wheels LF,RF. In the exemplary embodiment of the applicator **10**, however a swiveling hose clamp arrangement **162**, described in more detail below with reference to FIG. **6**, is used to clamp the vertically constrained movable hose segments **112** at the second hose attachment point.

FIG. **6** provides additional detail for swiveling hose clamp arrangements **162** and the steering axis bracket arrangements **152** utilized at the front wheels LF,RF of exemplary embodiment of the applicator **10** for securing the vertically constrained hose segments **112** at second hose attachment points **154** adjacent the steering axes **64**,**66**, to create the pivotable sections **150** of the supply and return hose arrangements of the drive hose pairs **102**,**104** serving the propulsion motors **82**,**84** of the front wheels LF,RF.

Since identical steering axis brackets **152** are used for the left and right front wheels LF,RF of the applicator **10**, the following description, which is specifically directed to the steering axis bracket associated with the right front wheel RF, will also be understood to illustrate the steering axis bracket **152** at the left front wheel LF and its attachment.

As shown in FIG. **6**, each of the steering axis bracket arrangements **152** in the applicator **10** includes a base bracket **160**, and a swiveling hose clamp arrangement **162**. The base bracket **160** for the right front wheel RF is fixedly mounted on the upper member **43** of the suspension and propulsion unit **40** of the right front wheel RF, and extends upward and over the distal end **50** of the movable axle member **46** of the right front wheel RF. Because the upper member **43** of the suspension and propulsion unit **40** does not move vertically with respect to the distal end **50** of the movable axle member **46**, to which the vertically constrained movable hose segments **112** for the right front wheel RF are attached at the intermediate hose attachment points **118** and at the second hose attachment points **154**, the bracket base **160** does not move vertically with respect to the frame **12**, the movable axle member **46**, or the intermediate or second hose attachment points **118**, **154**.

The base bracket **160** pivots with the upper member of the suspension and propulsion unit **40** about the steering axis **66**, in relation to the non-pivoting distal end **50** of the movable axle member **46** and the intermediate hose attachment points **118** attached to the movable axle member **46** of the front right wheel RF.

The swiveling hose clamp arrangement **162** of the steering axis bracket arrangement **152** includes a base **164** and a pivotable hose clamping arrangement **166** that is pivotably attached for rotation about a pivot axis **168** of the swiveling hose clamp arrangement **162**. The base **164** of the swiveling hose clamp arrangement is adapted for fixed attachment to the base bracket **160** of the steering axis bracket arrangement **152** in a manner that substantially aligns the pivot axis **168** of the swiveling hose clamp arrangement **162** and the pivotable hose clamping arrangement **166** for rotation about the steering axis **66**. The pivotable hose clamping arrangement **166** is configured to secure the vertically constrained movable hose segments **112** at the second hose attachment point **154**, to thereby define the pivotable hose segments **150** serving the right front wheel RF.

It will be appreciated that the swiveling hose clamp arrangement **162** allows the hoses to pivot somewhat at the second hose attachment points **154**, to thereby smooth the transition between the pivotable segments **150** and the remainder of the vertically constrained movable hose segments **112**, under steering action of the front wheels LF,RF, while still essentially isolating the remainder of the vertically constrained movable hose segments **112** to lie in and move along a vertical plane. It will also be appreciated that, as stated above, in other embodiments of the invention, the swiveling hose clamp arrangements **162** may be replaced with other arrangements for fixedly or pivotably securing the hose segments **112**,**150** to the bracket base **160** of the steering axis clamping arrangement **162**.

As further illustrated in FIG. **6**, the exemplary embodiment of the applicator **10** includes additional clamping and guiding elements **170** that are fixedly attached to the suspension and propulsion unit **40**, for constraining and guiding the remainders of the vertically constrained movable hose

segments **112** of the front wheels LF,RF to lie in and move along a vertical plane, substantially isolated from steering motion of the front wheels LF,RF by the pivotable segments **150**.

In the exemplary embodiment of the applicator **10**, the additional clamping and guiding elements **170** include a clamping arrangement **172** that fixedly attaches the vertically constrained hose segments **112** serving the front wheels LF,RF to the pivotable upper suspension members **43** of the front suspension and propulsion units **36**,**30**. By virtue of this arrangement, a third intermediate hose attachment point **174** is defined by the clamping arrangement **172**, such that the effective length of the pivotable hose segments **150** is increased, to extend from the first intermediate hose attachment points **118**, through the swiveling hose clamp arrangements **162** at the second intermediate hose attachment points **154**, all the way to the third intermediate attachment points **174**.

The addition of the third intermediate attachment point **174**, in combination with the swiveling hose clamp **162** at the second intermediate attachment point **154** provides significant advantages over embodiments of the invention in which the vertically constrained hose segments are fixedly clamped to the steering axis hose brackets **152**, and also over embodiments of the invention in which the swiveling hose clamp **162** is used without the third intermediate attachment point **174**. Without the third intermediate hose attachment points **174**, the pivotable hose segments **150** between the first and second intermediate hose attachment points **118**, **154** would need to have additional length to provide enough slack for proper turning movement of the front wheels LF,RF, without overstressing the pivotable hose segments **150**. This additional length is undesirable for a number of reasons. For example, longer hoses in this area would tend to flex and sway when the applicator **10** is not turning, which would inherently increase stress and wear on the pivotable hose segments **150**. If the range of flexing motion were great enough to cause the pivotable hose segments **150** to contact the frame **12**, the wheels LF,RF, or other parts of the applicator **10** such as fenders, the possibility of wear could potentially be exacerbated. Also, having the pivotable hose segments **150** be shorter, through use of the third intermediate attachment points **174**, allows fenders and other components of the applicator **10** to be positioned more effectively and efficiently in the space around the front wheels LF,RF.

As illustrated in several of the drawing figures, additional fluid lines and wire harnesses associated with the independent suspension and propulsion units **36**,**38**,**40**,**42** of the exemplary embodiment of the applicator **10** may also be routed with, or in similar fashion to the supply and return hoses described in the exemplary embodiments. Such additional fluid lines and wire harnesses may include related hydraulic lines, such as case drain lines for each of the propulsion motors **82**,**84**,**86**,**88**, brake lines connected to the drive hubs, and cables or harnesses for electrical, pneumatic or other control and monitoring devices associated with the independent suspension and propulsion units **36**,**38**,**40**,**42**.

Those having skill in the art will appreciate that, in the above described exemplary embodiments of the applicator **10** having and ground drive hose routing arrangement **80**, the supply and return hose arrangements in the pairs of **102**,**104**,**16**,**108** can be shorter and more uniformly and neatly installed than in prior applicators, thereby providing considerable improvements over prior approaches. In addition, twisting and tangling of the hoses, and potential interference with standing crops, as experienced in some prior applicators, is substantially eliminated.

The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) is to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

Preferred embodiments of this invention are described herein, including the best mode known to the inventor for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

I claim:

1. A ground drive hose routing system for a self-propelled agricultural product applicator having a source of pressurized hydraulic fluid mounted on an applicator main frame supported above a ground surface by a ground engaging wheel operatively connected to the frame by an independent suspension and propulsion unit mounted on a horizontally movable axle member for adjusting track width of the wheel, the suspension and propulsion unit also having a hydraulic propulsion motor that is movable horizontally with respect to the frame under action of the movable axle, and movable vertically with respect to both the frame and the movable axle member under action of the suspension, the ground drive hose routing system comprising:

a hydraulic hose arrangement connected in fluid communication between the source of hydraulic fluid on the frame and the propulsion motor on the independent suspension and propulsion unit;

the hydraulic hose arrangement also defining a horizontally constrained movable segment and a vertically constrained movable segment of the hose arrangement;

the horizontally constrained segment and the vertically constrained segment being connected in fluid communication with one another in such a manner that movements of the hose arrangement in response to horizontal movement of the axle member, and vertical movement of the propulsion motor under action of the suspension are isolated from one another.

2. The ground drive hose routing system of claim 1, wherein the hose arrangement has a first end fixedly attached to the frame, a second end fixedly attached to the propulsion motor, and an intermediate hose attachment point disposed between the first and second ends of the hose arrangement and attached to the movable axle member in a manner constraining the horizontally constrained movable segment of the hose arrangement to lie and move primarily along a substantially horizontal plane, and also constraining the vertically movable segment of the hose arrangement to lie and move primarily along a substantially vertical plane, to thereby isolate movements of the hose arrangement in response to horizontal movement of the axle member from movements of the hose arrangement in response to vertical movement of the propulsion motor under action of the suspension.

3. The ground drive hose routing system of claim 2, wherein:

the frame defines substantially perpendicular longitudinal and transverse axes of the frame and applicator, with the longitudinal and transverse axes extending respectively between front and rear ends and left and right sides of the applicator, such that the longitudinal and transverse axes define a horizontal plane extending substantially parallel to a level ground surface under the applicator;

the movable axle member has proximal and distal ends thereof, with the proximal end being adapted for transversely movable engagement with the frame;

the hydrostatic propulsion motor is operatively connected to the distal end of the movable axle by a vertically movable independent suspension system operatively connecting the wheel and propulsion motor to the distal end of the movable axle member in a manner providing for vertical movement of the wheel and propulsion motor with respect to the distal end of the movable axle element and the frame.

4. The ground drive hose routing system of claim 3, wherein:

the horizontally constrained movable hose segment has a first end fixedly attached to the frame, and a second end fixedly attached to the movable axle member at the hose connection point for transverse movement of the second end of the transversely movable hose segment with the movable axle member relative to the frame; and

the horizontally constrained hose segment also has a length thereof constrained to lie and move in a direction substantially parallel to the horizontal plane defined by the longitudinal and transverse axes of the frame.

5. The ground hose routing system of claim 3, wherein:

the substantially vertically constrained movable hose segment has a first end fixedly attached to the movable axle member at the hose attachment point, and a second end fixedly attached for vertical movement of the second end of the vertically movable hose segment with respect to the movable axle member and the frame; and

the vertically constrained hose segment also has a length thereof constrained to lie and move in a direction substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes of the frame.

6. The ground drive hose routing system of claim 3, wherein:

the horizontally constrained movable hose segment has a first end fixedly attached to the frame, and a second end fixedly attached to the movable axle member at the hose connection point for transverse movement of the second end of the transversely movable hose segment with the movable axle member relative to the frame;

the horizontally constrained hose segment also has a length thereof constrained to lie and move in a direction substantially parallel to the horizontal plane defined by the longitudinal and transverse axes of the frame;

the substantially vertically constrained movable hose segment has a first end fixedly attached to the movable axle member at the hose attachment point, and a second end fixedly attached for vertical movement of the second end of the vertically movable hose segment with respect to the movable axle member and the frame;

the vertically constrained hose segment also has a length thereof constrained to lie and move in a direction substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes of the frame;

the first end of the horizontally constrained hose segment is adapted for fluid connection to the source of pressurized hydraulic fluid;

the first end of the vertically constrained hose segment being connected in fluid communication at the hose attachment point with the second end of the vertically constrained hose segment; and

the second end of the vertically constrained hose segment is connected in fluid communication to the propulsion motor, in such a manner that the ground drive hose routing system provides fluid communication between the source of pressurized hydraulic fluid and the propulsion motor.

7. The ground drive hose routing system of claim 1, wherein the hydraulic hose arrangement further includes a pivotable hose segment disposed between the horizontally and vertically constrained movable segments of the hose arrangement.

8. The ground drive hose routing system of claim 7, wherein the independent suspension and propulsion system is pivotably connected to the movable axle at a steering axis such that the wheel is steerable, and the vertically constrained segment of the hose arrangement is routed to substantially pass through the steering axis and be attached to the independent suspension and propulsion system at a second hose attachment point adjacent the steering axis, to thereby define the pivotable hose segment of the hose arrangement.

9. The ground drive hose routing system of claim 8, wherein the second hose attachment point is disposed above the first hose attachment point, such that the pivotable and vertically constrained hose segments substantially loop upward over the movable axle and through the steering axis between the first hose attachment point and the propulsion motor.

10. A self-propelled agricultural product applicator having a source of pressurized hydraulic fluid mounted on an applicator main frame supported above a ground surface by a ground engaging wheel operatively connected to the frame by an independent suspension and propulsion unit mounted on a horizontally movable axle member for adjusting track width of the wheel and having a hydraulic propulsion motor that is movable horizontally with respect to the frame under action of the movable axle, and movable vertically with respect to both the frame and the movable axle member under action of the suspension, and a ground drive hose routing system comprising:

a hydraulic hose arrangement connected in fluid communication between the source of hydraulic fluid on the

frame and the propulsion motor on the independent suspension and propulsion unit;

the hydraulic hose arrangement also defining a horizontally constrained movable segment and a vertically constrained movable segment of the hose arrangement;

the horizontally constrained segment and the vertically constrained segment being connected in fluid communication with one another in such a manner that movements of the hose arrangement in response to horizontal movement of the axle member, and vertical movement of the propulsion motor under action of the suspension are isolated from one another.

11. The self-propelled applicator of claim **10**, wherein the hose arrangement has a first end fixedly attached to the frame, a second end fixedly attached to the propulsion motor, and an intermediate hose attachment point disposed between the first and second ends of the hose arrangement and attached to the movable axle member in a manner constraining the horizontally constrained movable segment of the hose arrangement to lie and move primarily along a substantially horizontal plane, and also constraining the vertically movable segment of the hose arrangement to lie and move primarily along a substantially vertical plane, to thereby isolate movements of the hose arrangement in response to horizontal movement of the axle member from movements of the hose arrangement in response to vertical movement of the propulsion motor under action of the suspension.

12. The self-propelled applicator of claim **11**, wherein:

the frame defines substantially perpendicular longitudinal and transverse axes of the frame and applicator, with the longitudinal and transverse axes extending respectively between front and rear ends and left and right sides of the applicator, such that the longitudinal and transverse axes define a horizontal plane extending substantially parallel to a level ground surface under the applicator;

the movable axle member has proximal and distal ends thereof, with the proximal end being adapted for transversely movable engagement with the frame;

the hydrostatic propulsion motor is operatively connected to the distal end of the movable axle by a vertically movable independent suspension system operatively connecting the wheel and propulsion motor to the distal end of the movable axle member in a manner providing for vertical movement of the wheel and propulsion motor with respect to the distal end of the movable axle element and the frame.

13. The self-propelled applicator of claim **12**, wherein:

the horizontally constrained movable hose segment has a first end fixedly attached to the frame, and a second end fixedly attached to the movable axle member at the hose connection point for transverse movement of the second end of the transversely movable hose segment with the movable axle member relative to the frame;

the horizontally constrained hose segment also has a length thereof constrained to lie and move in a direction substantially parallel to the horizontal plane defined by the longitudinal and transverse axes of the frame;

the substantially vertically constrained movable hose segment has a first end fixedly attached to the movable axle member at the hose attachment point, and a second end fixedly attached for vertical movement of the second end of the vertically movable hose segment with respect to the movable axle member and the frame;

the vertically constrained hose segment also has a length thereof constrained to lie and move in a direction substantially perpendicular to the horizontal plane defined by the longitudinal and transverse axes of the frame;

the first end of the horizontally constrained hose segment is adapted for fluid connection to the source of pressurized hydraulic fluid;

the first end of the vertically constrained hose segment being connected in fluid communication at the hose attachment point with the second end of the vertically constrained hose segment; and

the second end of the vertically constrained hose segment is connected in fluid communication to the propulsion motor, in such a manner that the ground drive hose routing system provides fluid communication between the source of pressurized hydraulic fluid and the propulsion motor.

14. The self-propelled applicator of claim **10**, wherein the hydraulic hose arrangement further includes a pivotable hose segment disposed between the horizontally and vertically constrained movable segments of the hose arrangement.

15. The self-propelled applicator of claim **14**, wherein the independent suspension and propulsion system is pivotably connected to the movable axle at a steering axis such that the wheel is steerable, and the vertically constrained segment of the hose arrangement is routed to substantially pass through the steering axis and be attached to the independent suspension and propulsion system at a second hose attachment point, to thereby define the pivotable hose segment of the hose arrangement.

16. The self-propelled applicator of claim **15**, wherein the second hose attachment point is disposed above the first hose attachment point, such that the vertically pivotable and vertically constrained hose segments substantially loop upward over the movable axle and through the steering axis between the first hose attachment point and the propulsion motor.

17. A method for routing a ground drive hydrostatic hose in a self-propelled agricultural product applicator having a source of pressurized hydraulic fluid mounted on an applicator main frame supported above a ground surface by a ground engaging wheel operatively connected to the frame by an independent suspension and propulsion unit mounted on a horizontally movable axle member for adjusting track width of the wheel and having a hydraulic propulsion motor that is movable horizontally with respect to the frame under action of the movable axle, and movable vertically with respect to both the frame and the movable axle member under action of the suspension, the method comprising:

connecting a hydraulic hose arrangement in fluid communication between the source of hydraulic fluid on the frame and the propulsion motor on the independent suspension and propulsion unit in such a manner that the hydraulic hose arrangement defines a horizontally constrained movable segment and a vertically constrained movable segment of the hose arrangement; and

further connecting the horizontally constrained segment and the vertically constrained segment in fluid communication with one another in such a manner that movements of the hose arrangement in response to horizontal movement of the axle member, and vertical movement of the propulsion motor under action of the suspension are isolated from one another.

18. The method for routing a ground drive hydrostatic hose in a self-propelled agricultural product applicator of claim **17**, wherein the hose arrangement has a first end fixedly attached to the frame, a second end fixedly attached

to the propulsion motor, and an intermediate hose attachment point disposed between the first and second ends of the hose arrangement and attached to the movable axle member in a manner constraining the horizontally constrained movable segment of the hose arrangement to lie and move primarily along a substantially horizontal plane, and also constraining the vertically movable segment of the hose arrangement to lie and move primarily along a substantially vertical plane, to thereby isolate movements of the hose arrangement in response to horizontal movement of the axle member from movements of the hose arrangement in response to vertical movement of the propulsion motor under action of the suspension.

19. The method for routing a ground drive hydrostatic hose in a self-propelled agricultural product applicator of claim **17**, further comprising configuring the hydraulic hose arrangement to also include a pivotable hose segment disposed between the horizontally and vertically constrained movable segments of the hose arrangement.

20. The method for routing a ground drive hydrostatic hose in a self-propelled agricultural product applicator of claim **19**, wherein the independent suspension and propulsion system is pivotably connected to the movable axle at a steering axis such that the wheel is steerable, and the method further includes routing the vertically constrained segment of the hose arrangement to substantially pass through the steering axis and be attached to the independent suspension and propulsion system at a second hose attachment point adjacent the steering axis, to thereby define the pivotable hose segment of the hose arrangement.

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