US Patent & Trademark Office
Patent Public Search | Text View

United States Patent	12382848
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Lovett; Benjamin M. et al.

Pressure to hold or raise the head for a work implement

Abstract

An agricultural machine includes a controller disposed in communication with a work implement, an output, and an input. Left and right float cylinders are attached to and interconnected with a frame and left and right connecting arms. A desired operating condition from a plurality of predefined settings is then solicited from an operator via the input, wherein the desired operating condition corresponds to a designated pressure setting of the left and right float cylinders. The work implement is operated in a float mode of operation and then commanded to a raised position. The controller automatically determines a maximum pressure and a position that the maximum pressure corresponds to for the left and right float cylinders. The controller automatically modifies the designated pressure setting of the left and right float cylinders in the database based on the maximum pressure and position for each of the left and right float cylinders.

Inventors: **Lovett; Benjamin M. (Ottumwa, IA), Laugen; Austin M. (Davenport, IA), Scherer; Conrado W. (Ottumwa, IA), Tacke; Kevin M. (Oskaloosa, IA)**

Applicant: **Deere & Company** (Moline, IL)

Family ID: **1000008750149**

Assignee: **Deere & Company (Moline, IL)**

Appl. No.: **18/359451**

Filed: **July 26, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20250031595 A1	Jan. 30, 2025

Publication Classification

Int. Cl.: **A01B61/02** (20060101); **A01B63/10** (20060101); **A01B63/108** (20060101)

U.S. Cl.:

CPC **A01B61/02** (20130101); **A01B63/1006** (20130101); **A01B63/108** (20130101);

Field of Classification Search

CPC: A01B (61/02); A01B (63/1006); A01B (63/108); A01B (63/008); A01B (63/22); B60W (2300/17); E02F (3/76); E02F (3/7609); E02F (3/7613); E02F (3/7636); E02F (3/764); E02F (3/422); E02F (3/3414); E02F (3/431); E02F (9/2004); E02F (9/2203); E02F (9/262); E02F (3/96); E02F (9/2292); E02F (9/2296); E02F (3/06); E02F (3/966); E02F (9/264); F04B (49/04); F04B (49/08); F04B (49/12); F04B (2201/0201); F04B (2201/0206); F04B (2201/00); F04B (35/004); F15B (2201/00); F15B (2215/00); F15B (19/00); F15B (21/087); F15B (2211/6313); F15B (2211/6653); F15B (2211/76)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
4625690	12/1985	Morita	123/399	F02P 5/1455
4773379	12/1987	Hashimoto	123/568.28	F02D 41/0077
5607209	12/1996	Narita	303/15	B60T 8/3275
9097247	12/2014	Cushing	N/A	F04B 49/065
10349571	12/2018	Fink	N/A	A01B 63/32
2006/0246834	12/2005	Masumoto	454/109	B60H 1/00378
2007/0095059	12/2006	VerKuilen	60/468	E02F 9/2296
2017/0108882	12/2016	Dissing	N/A	F04B 49/065
2019/0230857	12/2018	Thomson	N/A	A01D 41/141
2022/0061218	12/2021	Karst	N/A	A01B 63/10
2022/0117143	12/2021	Kraus	N/A	A01D 41/141
2024/0391286	12/2023	Anderson	N/A	H02K 7/14
2024/0409375	12/2023	Pfetsch	N/A	B66C 13/54

Primary Examiner: Jabr; Fadey S.

Assistant Examiner: Shaikh; Faris Asim

Attorney, Agent or Firm: Taft Stettinius & Hollister LLP

Background/Summary

FIELD OF THE DISCLOSURE

(1) The disclosure generally relates to an agricultural machine configured to support an attachable work implement, and a method of controlling the work implement.

BACKGROUND OF THE DISCLOSURE

(2) Some agricultural machines are configured to receive or connect to an attachable work implement. The work implement may include, but is not limited to, a crop harvesting head for harvesting crop material, or a cutter head for cutting standing crop material. Such agricultural machines may be configured to operate with several different styles and/or sizes of work

implements. Each different size and/or style of work implement may have different recommended operating settings for a implement linkage system connecting the work implement to the agricultural vehicle.
(3) The agricultural machine and the attached work implement may be configured to cut different crop materials. The crop materials may include, but are not limited to, forages and grains. Because the crop materials have different characteristics, the implement linkage system and work implements may have to be positioned differently for different crop materials, or different work implements may have to be used for different crop materials.
(4) As noted above, the work implement may include a cutter head for cutting standing crop materials. Two commonly used styles of cutter heads include rotary style cutter heads, which are often used for cutting forage crops, and draper style cutter heads which are often used for cutting grain crops. Each of the rotary style cutter heads and the draper style cutter heads May additionally come in different sizes. Because the draper style cutter heads are often used to cut grain crops, which are often close to a ground surface, the implement linkage system may be operated in a float operating condition that allows the cutter head to vertically track the ground surface during horizontal movement over the ground surface. The rotary style cutter heads are often used to cut forage crops, which are formed into a windrow.
(5) It is useful for the operator of the agricultural machine to set a float pressure of one or more lift cylinders of the work implement for a specified float operating condition over a field. Over time, the configurations or tolerances of the work implement and the agricultural machine change. Additionally, the field conditions and crops change from year to year over the same field which also affects the float operating settings and condition of the one or more lift cylinders. Occasionally the work implements are changed for the agricultural machine wherein each work implement will have its own preferred float operating setting and condition. The operating settings for each respective or different work implement are dependent upon the specific weight, size, length, etc. of that specific work implement. The one or more lift cylinders may have different float operating setting to account for each side of a specific work implement. Moreover, operators who often cut standing crop are less skilled than operators for other types of equipment and may find the adjustment of the float operating settings challenging. Improper adjustment of the float operating settings can lead to damage of the work implement during use of the work implement.
(6) Thus there is a need for improvement for adjustment of performance parameters for a lift and float system of a work implement for an agricultural machine.

SUMMARY

(7) According to one embodiment of the present disclosure, an agricultural machine comprising: a frame; an implement linkage system attached to the frame and configured for attaching a selected work implement from a plurality of different work implements to the frame, wherein the implement linkage system includes a left connecting arm and a right connecting arm; a left float cylinder attached to and interconnected with the frame and the left connecting arm; a right float cylinder attached to and interconnected with the frame and the right connecting arm; wherein the implement linkage system is controllable in a float operating condition allowing the selected work implement to vertically track a ground surface during horizontal movement over the ground surface; an output operable to convey a message to an operator; an input operable to receive instructions from the operator; a controller including a processor and a memory having a float control algorithm stored thereon, wherein the processor is operable to execute the float control algorithm to: identify the selected work implement from the plurality of different work implements; solicit a desired operating condition from a plurality of predefined settings from the operator via the input, wherein the desired operating condition corresponds to a designated pressure setting of the left and right float cylinders in a database; operate the work implement in a float mode of operation; command the work implement to a raised position; automatically determine a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders; and

automatically modify the designated pressure setting of the left and right float cylinders in the database based on the maximum pressure and position for each of the left and right float cylinders.
(8) In one example, wherein the processor is operable to execute the float control algorithm to automatically determine if the maximum pressure is within an acceptable tolerance for each of the left and right float cylinders.
(9) In another example, wherein when the maximum pressure is within the acceptable tolerance for each of the left and right float cylinders then the designated pressure setting of the left and right float cylinders in the database is not changed.
(10) In yet another example, wherein when the maximum pressure is within the acceptable tolerance for one of the left and right float cylinders then the designated pressure setting of that one of left and right float cylinders in the database is not changed, and wherein when the maximum pressure is not within the acceptable tolerance for the other of the left and right float cylinders then the designated pressure setting of the other of the left and right float cylinders in the database is modified.
(11) In yet another example, wherein modification of the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the other of the left and right float cylinders to determine a plurality of corrected pressures required to raise the work implement.
(12) In another example, wherein the processor is operable to execute the float control algorithm to automatically replace the designated pressure settings of the other of left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.
(13) In yet another example, wherein when the maximum pressure is not within the acceptable tolerance for the left and right float cylinders then the designated pressure setting of the left and right float cylinders in the database is modified.
(14) In another example, wherein modification of the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the left and right float cylinders to determine a plurality of corrected pressures required to raise the work implement.
(15) In another example, wherein the processor is operable to execute the float control algorithm to automatically replace the designated pressure settings of the left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.
(16) In another example, wherein the automatically determine a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs while the work implement is moving to the raised position.
(17) In another example, wherein the automatically determine a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs after the work implement has moved to the raised position.
(18) According to another embodiment of the present disclosure, a method of controlling an agricultural machine, the method comprising: providing an agricultural machine having a frame, an implement linkage system attached to the frame and configured for attaching a selected work implement from a plurality of different work implements to the frame, wherein the implement linkage system includes a left connecting arm and a right connecting arm, a left float cylinder attached to and interconnected with the frame and the left connecting arm, a right float cylinder attached to and interconnected with the frame and the right connecting arm, wherein the implement linkage system is controllable in a float operating condition allowing the selected work implement to vertically track a ground surface during horizontal movement over the ground surface, a controller including a processor and a memory having a float control algorithm **6** stored thereon; identifying via the controller the selected work implement from the plurality of different work implements; soliciting a desired operating condition from a plurality of predefined settings from the operator via an input operable to receive instructions from the operator, wherein the desired

operating condition corresponds to a designated pressure setting of the left and right float cylinders in a database; operating the work implement in a float mode of operation; commanding the work implement to a raised position; automatically determining via the controller a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders; and automatically modifying, via the controller, the designated pressure setting of the left and right float cylinders in the database based on the maximum pressure and position for each of the left and right float cylinders.
(19) In one example, further comprising: automatically determining if the maximum pressure is within an acceptable tolerance for each of the left and right float cylinders, wherein when the maximum pressure is within the acceptable tolerance for any of the left and right float cylinders then the designated pressure setting of the corresponding float cylinder in the database is not changed, and wherein when the maximum pressure is not within the acceptable tolerance for any of the left and right float cylinders then the designated pressure setting of the corresponding right float cylinder in the database is modified.
(20) In another example, wherein modifying the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the left and right float cylinders to determine a plurality of corrected pressures required to raise the work implement.
(21) In another example, further comprising: automatically replacing the designated pressure settings of the left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.
(22) In another example, wherein when the maximum pressure is not within the acceptable tolerance for the left and right float cylinders then the designated pressure setting of the left and right float cylinders in the database is modified.
(23) In another example, wherein modifying the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the left and right float cylinders to determine a plurality of corrected pressures required to raise the work implement.
(24) In another example, further comprising: automatically replacing the designated pressure settings of the left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.
(25) In yet another example, wherein the automatically determining a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs while the work implement is moving to the raised position.
(26) In yet another example, wherein the automatically determining a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs after the work implement has moved to the raised position.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The above-mentioned aspects of the present disclosure and the manner of obtaining them will become more apparent and the disclosure itself will be better understood by reference to the following description of the embodiments of the disclosure, taken in conjunction with the accompanying drawings, wherein:
(2) FIG. **1** is a schematic perspective view of an agricultural machine with a rotary cutter head attached.
(3) FIG. **2** is a schematic perspective view of the agricultural machine with a draper cutter head attached.

(4) FIG. **3** is a schematic diagram of a first embodiment of a hydraulic system of the agricultural machine.
(5) FIG. **4** is a schematic perspective view of a frame and a implement linkage system of the agricultural machine.
(6) FIG. **5** is a schematic diagram of a second embodiment of a hydraulic system of the agricultural machine.
(7) FIG. **6** is a schematic perspective view of a frame and a implement hydraulic system of the agricultural machine.
(8) FIGS. **7***a*-**7***b* is a flowchart representing a method of controlling the work implement of the agricultural machine of either FIG. **1** or FIG. **2**.
(9) FIG. **8** is a schematic diagram of an exemplary user interface for the work implement of either FIG. **1** or FIG. **2**.
(10) Corresponding reference numerals are used to indicate corresponding parts throughout the several views.

DETAILED DESCRIPTION

(11) The embodiments of the present disclosure described below are not intended to be exhaustive or to limit the disclosure to the precise forms in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may appreciate and understand the principles and practices of the present disclosure.
(12) Those having ordinary skill in the art will recognize that terms such as “above,” “below,” “upward,” “downward,” “top,” “bottom,” etc., are used descriptively for the figures, and do not represent limitations on the scope of the disclosure, as defined by the appended claims. Furthermore, the teachings may be described herein in terms of functional and/or logical block components and/or various processing steps. It should be realized that such block components may be comprised of any number of hardware, software, and/or firmware components configured to perform the specified functions.
(13) Terms of degree, such as “generally”, “substantially” or “approximately” are understood by those of ordinary skill to refer to reasonable ranges outside of a given value or orientation, for example, general tolerances or positional relationships associated with manufacturing, assembly, and use of the described embodiments.
(14) Some of the benefits of the present disclosure include a unique technique to hold, adjust, and/or raise a head or float pressure for each of right and left float cylinders of a work implement attached to an agricultural machine. The user interface or input includes a selection of pressures relevant to operation of a specific work implement that is mounted on the agricultural vehicle. The present disclosure simplifies the user interface or input of the agricultural machine to allow the user or operator to set a float pressure of each of right and left float cylinders or both of these cylinders by selecting from the user interface one of a plurality of desired header down forces that corresponds to a plurality of float pressures stored in a lookup table for the specific work implement. In one embodiment, a plurality of header down force selections include very light, light, typical, heavy, and very heavy are displayed on the user interface for the operator to select. These header down force selections are exemplary and fewer or more of these selections are contemplated by this disclosure as well as other types of selections that are displayed on the user interface. The description of each of the header down force selection may change as desired.
(15) The adjustment of the corresponding selected header down force or nominal header down force for each of the right and left float cylinders is desired over time as the agricultural machine and work implement age or are used in the field and thus change due to operating conditions. The agricultural machine and work implement will have variances over time that will influence a target float pressure for each of these right and left float cylinders which affect the actual amount of header down force that is applied to a ground surface. For example, the work implement May be modified from its original manufactured state to include additional attachments that increase the

mass and weight of the work implement. Or the work implement may be modified to remove elements of the work implement that decrease the mass and weight of the work implement. Over time, the function of pivots of the work implement also change. Some examples of pivots include lift arms or connecting arms that include a bushing, a seal, grease fittings, roller bearings, etc. that may fail or become lodged with soil at these locations. While the work implement is being raised, due to these failures or changes in the pivots, the amount of load or force required to raise the work implement changes and the present disclosure determines how to account for these variances. The present disclosure identifies variances from nominal amount of header down force and adjusts the target float pressure of the right and left float cylinders to provide a consistent amount of header down force for the right and left float cylinders and thereby a consistent performance of the work implement.

(16) Referring to the Figures, wherein like numerals indicate like parts throughout the several views, an agricultural machine is generally shown at **20** in FIGS. **1** and **2**. The example embodiment of the agricultural machine **20** shown in FIGS. **1** and **2** includes, but is not limited to, a self-propelled windrower. However, it should be appreciated that the teachings of this disclosure may be applied to machines other than the example windrower depicted in FIGS. **1** and **2**.

(17) Referring to FIGS. **1** and **2**, the agricultural machine **20** includes a frame **22**, which supports a prime mover **24**. The prime mover **24** may include, but is not limited to, an internal combustion engine, an electric motor, a combination of both, or some other device capable of generating torque to power the agricultural machine **20**. A left front drive wheel **26** and a right front drive wheel **28** are each mounted to the frame **22**, adjacent a forward end **30** of the frame **22**. The left front drive wheel **26** and the right front drive wheel **28** are rotatable about a transverse axis **32**. The transverse axis **32** is generally perpendicular to a longitudinal axis **34** of the frame **22**.

(18) As understood by those skilled in the art, the left front drive wheel **26** and the right front drive wheel **28** may be simultaneously rotated in the same rotational direction and at the same rotational speed about the transverse axis **32** to drive the agricultural machine **20** forward or rearward, depending upon the direction of rotation. Additionally, the left front drive wheel **26** and the right front drive wheel **28** may be rotated in the same rotational direction at different rotational speeds about the transverse axis **32**, or in opposite rotational directions at the same or different rotational speeds about the transverse axis **32**, in order to turn the agricultural vehicle.

(19) Referring to FIGS. **1** and **2**, the agricultural machine **20** further includes a left rear caster wheel **36** and a right rear caster wheel (not shown) attached to the frame **22**. As used herein, the term “caster wheel” should be understood to include a wheel that is able to rotate a full three hundred sixty degrees (360°) about a respective generally vertical axis. As such, each of the left rear caster wheel **36** and the right rear caster wheel are rotatable a full three hundred sixty degrees (360°) about a respective generally vertical axis. The left rear caster wheel **36** and the right rear caster wheel may be attached to the frame **22** in a suitable manner. The specific manner in which the left rear caster wheel **36** and the right rear caster wheel are attached to the frame **22** is not pertinent to the teachings of this disclosure, are understood by those skilled in the art, and are therefore not described in detail herein.

(20) Referring to FIG. **3**, the agricultural machine **20** includes a first embodiment of a hydraulic system. The hydraulic system includes a pressure source **38** configured to supply a flow of pressurized fluid. The pressure source **38** may include, but is not limited to, an auxiliary fluid pump that is drivenly coupled to the prime mover **24**. The pressure source **38** draws fluid from a tank **40**, and circulates the fluid through the hydraulic system. The tank **40** receives the fluid from the hydraulic system, stores the fluid, and supplies the fluid to the pressure source **38**, e.g., the auxiliary fluid pump. Fluid flow and/or pressure may be used to operate various components of the agricultural machine **20**, as described in greater detail below.

(21) Referring to FIG. **4**, the agricultural machine **20** includes a first embodiment of an implement linkage system **42** attached to the frame **22**. In the implementation shown in the Figures and

described herein, the implement linkage system **42** is attached to the frame **22** adjacent the forward end **30** of the frame **22**. The implement linkage system **42** is configured for attaching a selected work implement **44** from a plurality of different work implements to the frame **22**. In the example implementation shown in the Figures and described herein, the plurality of different work implements may include a rotary cutter **46** such as shown in FIG. **1**, or a draper cutter **48** such as shown in FIG. **2**. It should be appreciated that the plurality of different work implements may further include different sizes of each of the rotary cutter **46** and the draper cutter **48**. Additionally, it should be appreciated that the work implements may include devices other than the example draper cutter **48** and the example rotary cutter **46**, and that the agricultural machine **20** is not limited to the self-propelled windrower shown in the figures and desired herein.

(22) Referring to FIGS. **3** and **4**, the implement linkage system **42** includes a rockshaft **50** rotatably mounted to the frame **22** for rotational movement about a shaft axis **52** that extends transverse to the longitudinal axis **34** of the frame **22**. A lift cylinder **54** is attached to and interconnects the rockshaft **50** and the frame **22**. The lift cylinder **54** is operable to rotate the rockshaft **50** about the shaft axis **52** in order to raise and lower the selected work implement **44** relative to a ground surface. As such, the lift cylinder **54** is operated to control a vertical height of the selected work implement **44** above the ground surface. In the example implementation described herein, the lift cylinder **54** is a single acting hydraulic cylinder disposed in fluid communication with the hydraulic system. A lift control valve **58** controls fluid communication between the lift cylinder **54** and the pressure source **38**. In other embodiments, the lift cylinder **54** may include a double acting hydraulic cylinder, an electrically actuated linear actuator, or some other device capable of extending and retracting. The lift cylinder **54** extends in response to fluid pressure and/or flow from the hydraulic system in the usual manner, and is retracted by gravitational forces acting on the implement linkage system **42** and/or the selected work implement **44** attached to the implement linkage system **42** as understood by those skilled in the art.

(23) The implement linkage system **42** further includes a left connecting arm **60** and a right connecting arm **62**. The left connecting arm **60** is rotatably attached to the frame **22** below the rockshaft **50**, on a left side of the frame **22**. A left linkage **64** is attached to and interconnects the left connecting arm **60** and the rockshaft **50**. A left float cylinder **66** is attached to and interconnects the frame **22** and the left linkage **64**. A respective forward end **30** of the left float cylinder **66** is attached to the left linkage **64**. The left float cylinder **66** extends rearward and vertically upward to a respective rearward end of the left float cylinder **66**, which is attached to the frame **22**. The right connecting arm **62** is rotatably attached to the frame **22** below the rockshaft **50**, on a right side of the frame **22**. A right linkage **68** is attached to and interconnects the right connecting arm **62** and the rockshaft **50**. A right float cylinder **70** is attached to and interconnects the frame **22** and the right linkage **68**. A respective forward end **30** of the right float cylinder **70** is attached to the right linkage **68**. The right float cylinder **70** extends rearward and vertically upward to a respective rearward end of the right float cylinder **70**, which is attached to the frame **22**.

(24) The left float cylinder **66** is disposed in fluid communication with a left accumulator **72**. The left float cylinder **66** and the left accumulator **72** cooperate to form a volume. Fluid pressure within the volume defined by the left float cylinder **66** and the left accumulator **72** may be controlled to provide a resistance against retraction or compression of the left float cylinder **66**. A left float control valve **74** controls fluid communication between the left float cylinder **66** and the pressure source **38**. The right float cylinder **70** is disposed in fluid communication with a right accumulator **76**. The right float cylinder **70** and the right accumulator **76** cooperate to form a volume. Fluid pressure within the volume defined by the right float cylinder **70** and the right accumulator **76** may be controlled to provide a resistance against retraction or compression of the right float cylinder **70**. A right float control valve **78** controls fluid communication between the right float cylinder **70** and the pressure source **38**. The left float cylinder **66** and the right float cylinder **70** are each operable to provide a bias or resistance force against upward movement of the left connecting arm **60** and the

right connecting arm **62** respectively.

(25) In the example implementation described herein, the left float cylinder **66** and the right float cylinder **70** are each single acting hydraulic cylinders disposed in fluid communication with the hydraulic system. In other embodiments, the left float cylinder **66** and the right float cylinder **70** may include a double acting hydraulic cylinder, an air cushion or spring device, or some other device capable of biasing the left connecting arm **60** and the right connecting rod downward toward the ground surface.

(26) The implement linkage system **42** may further include a tilt cylinder **80**. The tilt cylinder **80** is attached to and interconnects the frame **22** and the selected work implement **44** attached to the implement linkage system **42**. The tilt cylinder **80** is operable to rotate the selected work implement **44** attached to the implement linkage system **42** relative the ground surface. More specifically, the tilt cylinder **80** rotates the selected work implement **44** about a tilt axis **82**, which extends transverse to the longitudinal axis **34** of the frame **22** and through distal ends of the left connecting arm **60** and the right connecting arm **62**. In the example implementation described herein, the tilt cylinder **80** is a double acting hydraulic cylinder disposed in fluid communication with the hydraulic system. In other embodiments, the tilt cylinder **80** may include a single acting hydraulic cylinder, an electrically actuated linear actuator, or some other device capable of extending and retracting. The tilt cylinder **80** extends and retracts in response to fluid pressure and/or flow from the hydraulic system in the usual manner as understood by those skilled in the art.

(27) The implement linkage system **42** is controllable between a float operating condition and a fixed height operating condition. When configured for the float operating condition, the implement linkage system **42** allows the selected work implement **44** to vertically track the ground surface during horizontal movement of the agricultural machine **20** over the ground surface. When configured for the float operating condition, the lift control valve **58** is closed to block fluid communication between the pressure source **38** and the lift cylinder **54**. A return valve **88** may be opened to allow fluid communication between the lift cylinder **54** and the tank **40**, which allows the lift cylinder **54** to extend and retract freely. Additionally, when the implement linkage system **42** is configured for the float operating condition, a desired amount of fluid pressure is supplied to the left float cylinder **66** and the right float cylinder **70** to provide a desired amount of resistance against upward vertical movement, thereby keeping the selected work implement **44** in contact with the ground surface while allowing the selected work implement **44** to track the ground surface. A left pressure sensor **84** may be included to sense and monitor the fluid pressure applied to the left float cylinder **66**. Similarly, a right pressure sensor **86** may be included to sense and monitor the fluid pressure applied to the right float cylinder **70**.

(28) The fixed height operating condition fixes a position of the selected work implement **44** relative to the frame **22** during horizontal movement of the agricultural machine **20** over the ground surface. When the implement linkage system **42** is configured in the fixed height operating condition, the return valve **88** is closed, and the lift control valve **58** is opened to allow fluid communication between the pressure source **38** and the lift cylinder **54** to extend the lift cylinder **54** to a desired position and position the selected work implement **44** at a desired height above the ground surface, after which the lift control valve **58** is closed to block fluid communication between the pressure source **38** and the lift cylinder **54** to secure the lift cylinder in the desired position. A position sensor **90** may be positioned to sense a position of the lift cylinder **54** and/or a position of the selected work implement **44** to determine the position of the selected work implement **44** relative to the ground surface. Once the position of the lift cylinder **54** is set, the return valve **88** may be opened so that fluid flow from the pressure source **38** is directed to the tank **40**.

(29) Referring to FIG. **5**, the agricultural machine **20** includes a second embodiment of a hydraulic system. The hydraulic system illustrated in FIG. **5** is similar to the hydraulic system illustrated in FIG. **3** wherein both hydraulic systems are exemplary embodiments that can be used with the

present application. The hydraulic system includes a pressure source **138** configured to supply a flow of pressurized fluid. The pressure source **138** may include, but is not limited to, an auxiliary fluid pump that is drivenly coupled to the prime mover **24**. The pressure source **138** draws fluid from a tank **140**, and circulates the fluid through the hydraulic system. The tank **140** receives the fluid from the hydraulic system, stores the fluid, and supplies the fluid to the pressure source **138**, e.g., the auxiliary fluid pump. Fluid flow and/or pressure may be used to operate various components of the agricultural machine **20**, as described in greater detail below. The pressure source **138** is also connected to an open center valve **188** which is operatively connected to a raise/lower valve **186** and a pressure holding valve **184** that is configured to vent left and right accumulators **172** and **176** in case of a pressure failure.
(30) Referring to FIG. **6**, the agricultural machine **20** includes an implement linkage system **142** attached to a frame **122**. The frame **122** illustrated in FIG. **6** is similar to the frame **22** illustrated in FIG. **4** and therefore will not be described again. The frames **22** and **122** are exemplary embodiments that can be used with the present application. In the implementation shown in the Figures and described herein, the implement linkage system **142** is attached to the frame **122** adjacent a forward end **130** of the frame **122**. The implement linkage system **142** is configured for attaching the selected work implement **44** from a plurality of different work implements to the frame **122**. In the example implementation shown in the Figures and described herein, the plurality of different work implements may include the rotary cutter **46** such as shown in FIG. **1**, or the draper cutter **48** such as shown in FIG. **2**. It should be appreciated that the plurality of different work implements may further include different sizes of each of the rotary cutter **46** and the draper cutter **48**. Additionally, it should be appreciated that the work implements may include devices other than the example draper cutter **48** and the example rotary cutter **46**, and that the agricultural machine **20** is not limited to the self-propelled windrower shown in the figures and desired herein.
(31) Referring to FIGS. **5** and **6**, the implement linkage system **142** further includes a left connecting arm **160** and a right connecting arm **162**. The left connecting arm **160** is rotatably attached to the frame **122**, on a left side of the frame **122**. A left float cylinder **166** is attached to and interconnects the frame **122** and the left connecting arm **160**. A respective forward end of the left float cylinder **166** is attached to the left connecting arm **160**. The left float cylinder **166** extends rearward and vertically upward to a respective rearward end of the left float cylinder **166**, which is attached to the frame **122**. The right connecting arm **162** is attached to the frame **122**, on a right side of the frame **122**. A right float cylinder **170** is attached to and interconnects the frame **122** and the right connecting arm **162**. A respective forward end of the right float cylinder **170** is attached to the right connecting arm **162**. The right float cylinder **170** extends rearward and vertically upward to a respective rearward end of the right float cylinder **170**, which is attached to the frame **122**.
(32) The left float cylinder **166** is disposed in fluid communication with a left accumulator **172**. The left float cylinder **166** and the left accumulator **172** cooperate to form a volume. Fluid pressure within the volume defined by the left float cylinder **166** and the left accumulator **172** may be controlled to provide a resistance against retraction or compression of the left float cylinder **166**. A left float control valve **174** controls fluid communication between the left float cylinder **166** and the pressure source **138**. A left accumulator lockout valve **180** is in fluid communication with the left float control valve **174** and the left accumulator **172** to expel any pressurized compressed air in the lines such as for maintenance and/or emergency situations. The left float cylinder **166** is disposed in communication with a left cylinder position sensor **190** to determine a position of the left float cylinder **166**. The left float cylinder **166** is disposed in communication with a left cylinder lockout valve **192** to prevent access to the left float cylinder **166**. The left float cylinder **166** is operatively coupled to a left float pressure transducer **194** that transforms pressure into an analog electrical signal.
(33) The right float cylinder **170** is disposed in fluid communication with a right accumulator **176**. The right float cylinder **170** and the right accumulator **176** cooperate to form a volume. Fluid

pressure within the volume defined by the right float cylinder **170** and the right accumulator **176** may be controlled to provide a resistance against retraction or compression of the right float cylinder **170**. A right float control valve **178** controls fluid communication between the right float cylinder **170** and the pressure source **138**. A right accumulator lockout valve **182** is in fluid communication with the right float control valve **178** and the right accumulator **176** to expel any pressurized compressed air in the lines such as for maintenance and/or emergency situations. The right float cylinder **170** is disposed in communication with a right cylinder position sensor **200** to determine a position of the right float cylinder **170**. The right float cylinder **170** is disposed in communication with a right cylinder lockout valve **202** to prevent access to the right float cylinder **170**. The right float cylinder **170** is operatively coupled to a right float pressure transducer **204** that transforms pressure into an analog electrical signal.

(34) The left float cylinder **166** and the right float cylinder **170** are each operable to move the left connecting arm **160** and the right connecting arm **62** respectively. In the example implementation described herein, the left float cylinder **166** and the right float cylinder **170** are each single acting hydraulic cylinders disposed in fluid communication with the hydraulic system. In other embodiments, the left float cylinder **166** and the right float cylinder **170** may include a double acting hydraulic cylinder, an air cushion or spring device, or some other device capable of moving the left connecting arm **160** and the right connecting arm **162** downward toward the ground surface. In the embodiment illustrated in FIGS. **5** and **6**, the implement linkage system **142** is controlled in a float operating condition.

(35) Returning to FIGS. **1** and **2**, the agricultural machine **20** further includes an operator station **92**, which houses control components of the agricultural machine **20**. The control components may include, but are not limited to, an output **94** and an input **96**. The output **94** is operable to convey a message to an operator. The input **96** is operable to receive instructions from the operator. In the example implementation described herein, the input **96** and the output **94** are combined and implemented as a touch screen display **99**. Messages may be communicated to the operator through the display **99**, and data may be entered by the operator by touching the display **99** as is understood by those skilled in the art. It should be appreciated that the input **96** and the output **94** may differ from the example implementation described herein and may be separate or combined components. For example, the output **94** may include, but is not limited to, a video only display, an audio speaker, a light board, etc. The input **96** may include, but is not limited to, a mouse, a keyboard, a microphone, etc.

(36) One embodiment of the touch screen display **99** is illustrated in FIG. **8**. The input **96** includes a plurality of predefined settings **97***a*-**97***e* that are illustrated as a very light header down force **97***a*, a light header down force **97***b*, a typical header down force **97***c*, a heavy header down force **97***d*, and a very heavy header down force **97***e* and are displayed on the user interface or the touch screen display **99** from which the operator selects one of them as a designated or nominal setting. The operator can change the selected setting as desired. The plurality of predefined settings **97***a*-**97***e* can include more or less settings as desired in other embodiments. Each of the plurality of settings **97***a*-**97***e* corresponds to a desired left float pressure of the left float cylinders **66**, **166** and a desired right float pressure of the right float cylinders **70**, **170** as determined by the specific work implement **44** or **48** that is attached to the agricultural machine as described in more detail below. The desired left and right float pressures of the left and right float cylinders **66**, **166**, **70**, **170**, can be stored in a lookup table that is accessible by the controller **100** as described below. The desired left and right float pressures of the left and right float cylinders **66**, **166**, **70**, **170**, can include a specific float pressure for each. Alternatively, the desired left and right float pressures of the left and right float cylinders **66**, **166**, **70**, **170**, can include a range of float pressures for each. In any embodiment, the desired left and right float pressures of the left and right float cylinders **66**, **166**, **70**, **170**, are independent of each other. The rotary cutter **46** or the draper cutter **48** may not be symmetric about a center line of the agricultural machine **20** in terms of where the center of gravity is located.

Therefore, it is beneficial to tailor or specify the left and right float pressures of the left and right float cylinders **66**, **166**, **70**, **170** in an effort to obtain equal force on the ground that is applied by the rotary cutter **46** or the draper cutter **48** via the left and right float cylinders **66**, **166**, **70**, **170**.

(37) In one exemplary embodiment, the predefined setting **97***a* is a very light header down force of the left float pressure of the left float cylinder **166** corresponds to 1500 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***a* is a very light header down force of the right float pressure of the right float cylinder **170** corresponds to 1400 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***b* is light header down force of the left float pressure of the left float cylinder **166** corresponds to 1300 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***b* is light header down force of the right float pressure of the right float cylinder **170** corresponds to 1200 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***c* is typical header down force of the left float pressure of the left float cylinder **166** corresponds to 1100 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***c* is typical header down force of the right float pressure of the right float cylinder **170** corresponds to 1000 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***d* is heavy header down force of the left float pressure of the left float cylinder **166** corresponds to 1000 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***d* is heavy header down force of the right float pressure of the right float cylinder **170** corresponds to 900 psi with an acceptable tolerance band of #25 psi. The predefined setting **97***e* is very heavy header down force of the left float pressure of the left float cylinder **166** corresponds to 800 psi with an acceptable tolerance band of ±25 psi. The predefined setting **97***e* is very heavy header down force of the right float pressure of the right float cylinder **170** corresponds to 700 psi with an acceptable tolerance band of ±25 psi.

(38) The agricultural machine **20** may further include an attachment identifier **98**. The attachment identifier **98** may be disposed in communication with a controller **100** and operable to identify the selected work implement **44** from other types of work implements. In one implementation, the attachment identifier **98** may be embodied as a Radio Frequency Identification (RFID) reader. The RFID reader may emit a signal and receive a response from a RFID tag attached to the selected work implement **44**. The response from the RFID tag of the selected work implement **44** may include identification data that identifies the selected work implement **44**. The identification data may include, but is not limited to, a make and model of the selected work implement **44**, a year of manufacture, a weight of the selected work implement **44**, etc. The RFID reader may then communicate the identification data to the controller **100** for use as described below.

(39) In an alternative implementation, the attachment identifier **98** may be embodied as an image sensor combined with image recognition software. The image recognition software May be saved on the controller **100** and executable by the controller **100**. Upon the selected work implement **44** being positioned near the forward end **30** of the frame **22**, the image sensor May capture an image of the selected work implement **44** and communicate that image to the image recognition software. The image recognition software may analyze the image to identify the selected work implement **44** and obtain the identification data therefore, for example, from a database including the identification data for each of the plurality of different work implements. The features and operation of image recognition software are known to those skilled in the art and are therefore not described in greater detail herein.

(40) Regarding FIGS. **3** and **4**, the controller **100** is disposed in communication with the input **96**, the output **94**, the attachment identifier **98**, the lift cylinder **54**, the left float cylinder **66** and the right float cylinder **70**. The controller **100** is operable to receive data entry from the input **96**, send messages through the output **94**, receive identification data from the attachment identifier **98**, and control the operation of the lift cylinder **54**, the left float cylinder **66** and the right float cylinder **70**. Regarding FIGS. **5** and **6**, the controller **100** is disposed in communication with the input **96**, the output **94**, the attachment identifier **98**, the left float cylinder **166** and the right float cylinder **170**.

(41) While the controller **100** is generally described herein as a singular device, it should be appreciated that the controller **100** may include multiple devices linked together to share and/or communicate information therebetween. Furthermore, it should be appreciated that all or parts of the controller **100** may be located on the agricultural machine **20** or located remotely from the agricultural machine **20**.
(42) The controller **100** may alternatively be referred to as a computing device, a computer, a controller, a control unit, a control module, a module, etc. Regarding FIGS. **3** and **4**, the controller **100** includes a processor **102**, a memory **104**, and all software, hardware, algorithms, connections, sensors, etc., necessary to manage and control the operation of the input **96**, the output **94**, the attachment identifier **98**, the lift cylinder **54**, the left float cylinder **66** and the right float cylinder **70**. Regarding FIGS. **5** and **6**, the controller **100** manages and controls the operation of the left float cylinder **166** and the right float cylinder **170** instead of the left float cylinder **66** and the right float cylinder **70** from FIGS. **3** and **4**.
(43) In any embodiment, a method may be embodied as a program or algorithm operable on the controller **100**. It should be appreciated that the controller **100** may include any device capable of analyzing data from various sensors, comparing data, making decisions, and executing the required tasks.
(44) As used herein, “controller” is intended to be used consistent with how the term is used by a person of skill in the art, and refers to a computing component with processing, memory, and communication capabilities, which is utilized to execute instructions (i.e., stored on the memory **104** or received via the communication capabilities) to control or communicate with one or more other components. In certain embodiments, the controller **100** may be configured to receive input signals in various formats (e.g., hydraulic signals, voltage signals, current signals, CAN messages, optical signals, radio signals), and to output command or communication signals in various formats (e.g., hydraulic signals, voltage signals, current signals, CAN messages, optical signals, radio signals).
(45) The controller **100** may be in communication with other components on the agricultural machine **20**, such as hydraulic components, electrical components, and operator inputs within the operator station **92**. The controller **100** may be electrically connected to these other components by a wiring harness such that messages, commands, and electrical power may be transmitted between the controller **100** and the other components. Although the controller **100** is referenced in the singular, in alternative embodiments the configuration and functionality described herein can be split across multiple devices using techniques known to a person of ordinary skill in the art.
(46) The controller **100** may be embodied as one or multiple digital computers or host machines each having one or more processors, read only memory (ROM), random access memory (RAM), electrically-programmable read only memory (EPROM), optical drives, magnetic drives, etc., a high-speed clock, analog-to-digital (A/D) circuitry, digital-to-analog (D/A) circuitry, and any required input/output (I/O) circuitry, I/O devices **96**, **94**, and communication interfaces, as well as signal conditioning and buffer electronics.
(47) The computer-readable memory **104** may include any non-transitory/tangible medium which participates in providing data or computer-readable instructions. The memory **104** may be non-volatile or volatile. Non-volatile media may include, for example, optical or magnetic disks and other persistent memory. Example volatile media may include dynamic random access memory (DRAM), which may constitute a main memory. Other examples of embodiments for memory include a floppy, flexible disk, or hard disk, magnetic tape or other magnetic medium, a CD-ROM, DVD, and/or any other optical medium, as well as other possible memory devices such as flash memory.
(48) The controller **100** includes the tangible, non-transitory memory **104** on which are recorded computer-executable instructions, including a float control algorithm **106**. The processor **102** of the controller **100** is configured for executing the float control algorithm **106**. The float control

algorithm **106** implements a method of controlling the agricultural machine **20**, described in detail below. When a new selected work implement **44** is positioned near the front **8** of the agricultural machine **20**, and the agricultural machine **20** is equipped with the attachment identifier **98**, the method includes soliciting instructions from the operator regarding a desired attachment identification technique for identifying the selected work implement **44**. The step of requesting the desired attachment identification technique is generally indicated by box **220** in FIG. **7**. The request or solicitation may be made using the output **94** displaying a message to the operator, requesting that the operator select the desired attachment identification technique. The possible attachment identification techniques may include, but are not limited to, an automatic technique using the attachment identifier **98**, or a manual entry technique. If the agricultural machine **20** is not equipped with attachment identifier **98**, then the controller **100** may proceed to request identification data related to the selected work implement **44** following the manual entry technique described below.

(49) In response to the controller **100** requesting the desired attachment identification technique from the operator, the operator may respond by entering a selection into the input **96**, thereby defining the desired attachment identification technique as one of the automatic technique, or the manual entry technique. The controller **100** may then proceed to identify the selected work implement **44** from the plurality of different work implements. The step of identifying the selected work implement is generally indicated by box **222** in FIG. **7**.

(50) When the operator selects the automatic technique, the controller **100** engages the attachment identifier **98** to identify the selected work implement **44**. The attachment identifier **98** may be implemented in different manners. For example, if the attachment identifier **98** includes the RFID reader, the engaging the attachment identifier **98** may include emitting a signal from the RFID reader, and receiving a response signal from the RFID tag attached to the selected work implement **44**. The response signal from the RFID tag may include the identification data that identifies the make, model, and/or properties of the selected work implement **44**. If the selected work implement **44** does not include the RFID tag and the RFID reader fails to receive the response signal, then the controller **100** may proceed to identify the selected work implement **44** using the manual entry technique, described below.

(51) Alternatively, if the attachment identifier **98** includes an image sensor and image recognition software, then the controller **100** may engage the image sensor to capture an image **6** of the selected work implement **44**, and then proceed to use the image recognition software to analyze and identify the make, model, and/or properties of the selected work implement **44**. If the image recognition software is unable to identify the selected work implement **44**, then the controller **100** may proceed to identify the selected work implement **44** using the manual entry technique described below.

(52) When the operator selects the manual entry technique the controller **100** may request the identification data related to the selected work implement **44** from the operator. The request or solicitation may be made using the output **94** displaying a message to the operator, requesting that the operator enter the requested identification data for the selected work implement **44**. For example, the controller **100** may request that the operator enter a make and model of the controller **100**. In other implementations, the controller **100** may request that the operator enter a width, length, and weight of the selected work implement **44**. In response to the controller **100** requesting the identification data from the selected work implement **44** from the operator, the operator may respond by entering the identification data into the input **96**.

(53) Once the controller **100** has identified the selected work implement **44**, or otherwise obtained the identification data for the selected work implement **44**, the controller **100** may then determine at box **224** whether the work implement **44** is in a float operating condition or some other operating condition in FIG. **7***a*.

(54) The controller **100** determines if the work implement **44** is engaged at box **226**. If the work implement **44** is not engaged then a message is displayed to the operator to engage the work

implement **44** at box **227**. If the work implement **44** is engaged then the controller **100** determines if the engine speed of the prime mover **24** is greater than a threshold speed or output (RPM) at box **228**. If the engine speed of the prime mover **24** is not greater than the threshold speed or output, then a message is displayed to the operator to engage the prime mover **24** to increase the engine speed above the threshold speed or output at box **229**. If the engine speed of the prime mover **24** is above the threshold speed or output, then the controller **100** determines if the ground speed of the work implement **44** or the right and left wheels **28** and **32** is greater than a threshold speed. If the ground speed of the work implement **44** or the right and left wheels **28** and **32** is less than the threshold speed, then a message is displayed to the operator to increase the speed of the work implement **44** and the right and left wheels **28** and **32** at box **231**. If the ground speed of the work implement **44** or the right and left wheels **28** and **32** is greater than the threshold speed, then the controller **100** determines if a float mode of operation of the work implement **44** is engaged for greater than a threshold time in box **232**.

(55) In box **232**, the controller **100** determines a float mode engagement if the following conditions are met for a period of time that is greater than a threshold period of time: the work implement **44** is engaged, the engine speed of the prime mover **24** is greater than the threshold **11** speed, and the ground speed of the work implement **44** or the right and left wheels **28** and **32** is greater than the threshold speed. If any of these conditions are not met or sustained for the period of time that is greater than the threshold period of time, then a message is displayed to the operator to continue operation of the work implement **44** being engaged, the engine speed of the prime mover **24** being greater than the threshold speed, and the ground speed of the work implement **44** or the right and left wheels **28** and **32** being greater than the threshold speed for a float mode period of time that meets or exceeds the threshold time period at box **233**. If these conditions are met for the period of time that is greater than the threshold period of time, then the controller **100** determines if the position sensor **90** or the left and right cylinder position sensors **190** and **200** are not faulted in box **234**. If any of the position sensors **90**, **190**, or **200** are faulted then a message is displayed to the operator to lower the appropriate one or more of left and right float cylinders **66**, **70**, or **166**, **170** at box **235**. If none of the position sensors **90**, **190**, or **200** are faulted then the controller **100** determines that the left and right float cylinders **66**, **70** or **166**, **170** are primed at box **236**.

(56) In box **238**, the operator commands a header raise operation in which the work implement **44** is commanded to raise upwardly. In box **240**, in one embodiment, after the work implement **44** has reached its commanded position then the controller **100** collects the pressure data of the left and right float cylinders **66**, **70**, or **166**, **170** for the duration of the work implement **44** being in this commanded position. In this embodiment, the controller **100** collects the pressure data statically after the work implement **44** has reached its commanded position. In box **240**, in another embodiment, while the work implement **44** is moving to its commanded position the controller **100** collects the pressure data of the left and right float cylinders **66**, **70**, or **166**, **170** for the duration of the work implement **44** moving into this commanded position. In this embodiment, the controller **100** collects the pressure data dynamically.

(57) Concurrently with box **240**, in box **242**, the controller **100** is monitoring and determining a position of each of the left and right connecting arms **60**, **62** or **160**, **162**. Concurrently with box **240**, in box **244** the controller **100** is monitoring and determining a maximum pressure and a position that this maximum pressure occurred for each of the left and right float cylinders **66**, **70**, or **166**, **170**.

(58) In box **246**, the controller **100** modifies or adjusts the maximum pressure to reflect a pressure at a standard position due to any lift geometry variation through a lift range of the work implement **44**. In box **248**, the controller **100** determines if the maximum pressure is above or below the acceptable tolerance band for each of the plurality of predefined settings **97*a*-97*e***. If the maximum pressure is within the acceptable tolerance band for any of the float pressure values of plurality of predefined settings **97*a*-97*e***, then no changes are made to those particular float pressure values for

settings **97***a*-**97***e* and the float control algorithm **106** ends at box **250**. If the maximum pressure is below or above the acceptable tolerance band for any of the float **17** pressure values of the plurality of predefined settings **97***a*-**97***e*, then changes or adjustments are made to those particular float pressure values of the plurality of predefined settings **97***a*-**97***e* to create a corresponding set or plurality of corrected pressure values associated with the plurality of predefined settings **97***a*-**97***e* at box **252**. The controller **100** determines the plurality of corrected pressure values by averaging corresponding prior float pressure values of the predefined settings **97***a*-**97***e* with the maximum pressure for each of the left and right float cylinders **66**, **70**, or **166**, **170** as determined in box **246** to establish a plurality of corrected pressure s required to raise the work implement **44** at each of the predefined settings **97***a*-**97***e*. Any previous values of the plurality of corrected pressures required to raise the work implement **44** are discarded by the controller **100**. The float pressure required to raise the work implement **44** is used to correct or adjust the float pressure values of the plurality of predefined settings **97***a*-**97***e* in FIG. **8** of each the left and right float cylinders **66**, **70**, or **166**, **170**. Alternatively, the float pressure required to hold the raised head or work implement **44** can be used to correct or adjust the float pressure values of the plurality of predefined settings **97***a*-**97***e* in FIG. **8** of each the left and right float cylinders **66**, **70**, or **166**, **170**. The float control algorithm **106** ends at box **254**.

(59) The present disclosure provides a stable or consistent performance as operation of the work implement **44** changes due to factors such as wear, corrosion, dirt or debris accumulation, or customer modification of the work implement **44**. The present disclosure minimizes the need for an operator to make manual adjustments to the float settings of each the left and right float cylinders **66**, **70**, or **166**, **170** as the present disclosure can automatically adjust the float settings to account for these factors in an effort to obtain equal force on the ground that is applied by the rotary cutter **46** or the draper cutter **48** via the left and right float cylinders **66**, **70**, or **166**, **170**. The present disclosure identifies variances from an acceptable tolerance band that will influence the target float pressure and then adjusts the target float pressure of the left and right float cylinders **66**, **70**, or **166**, **170** to provide for consistent performance of the work implement **44**.

(60) As used herein, “e.g.” is utilized to non-exhaustively list examples and carries the same meaning as alternative illustrative phrases such as “including,” “including, but not limited to,” and “including without limitation.” As used herein, unless otherwise limited or modified, lists with elements that are separated by conjunctive terms (e.g., “and”) and that are also preceded by the phrase “one or more of,” “at least one of,” “at least,” or a like phrase, indicate configurations or arrangements that potentially include individual elements of the list, or any combination thereof. For example, “at least one of A, B, and C” and “one or more of A, B, and C” each indicate the possibility of only A, only B, only C, or any combination of two or more of A, B, and C (A and B; A and C; B and C; or A, B, and C). As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. Further, “comprises,” “includes,” and like phrases are intended to specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof.

(61) While this disclosure has been described with respect to at least one embodiment, the present disclosure can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the disclosure using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this disclosure pertains.

Claims

1. An agricultural machine comprising: a frame; an implement linkage system attached to the frame and configured for attaching a selected work implement from a plurality of different work

implements to the frame, wherein the implement linkage system includes a left connecting arm and a right connecting arm; a left float cylinder attached to and interconnected with the frame and the left connecting arm; a right float cylinder attached to and interconnected with the frame and the right connecting arm; wherein the implement linkage system is controllable in a float operating condition allowing the selected work implement to vertically track a ground surface during horizontal movement over the ground surface; an output operable to convey a message to an operator; an input operable to receive instructions from the operator; a controller including a processor and a memory having a float control algorithm stored thereon, wherein the processor is operable to execute the float control algorithm to: identify the selected work implement from the plurality of different work implements; solicit a desired operating condition from a plurality of predefined settings from the operator via the input, wherein the desired operating condition corresponds to a designated pressure setting of the left and right float cylinders in a database; operate the work implement in a float mode of operation; command the work implement to a raised position; automatically determine a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders; and automatically modify the designated pressure setting of the left and right float cylinders in the database based on the maximum pressure and position for each of the left and right float cylinders.

2. The agricultural machine of claim 1, wherein the processor is operable to execute the float control algorithm to automatically determine if the maximum pressure is within an acceptable tolerance for each of the left and right float cylinders.

3. The agricultural machine of claim 2, wherein when the maximum pressure is within the acceptable tolerance for each of the left and right float cylinders then the designated pressure setting of the left and right float cylinders in the database is not changed.

4. The agricultural machine of claim 2, wherein when the maximum pressure is within the acceptable tolerance for one of the left and right float cylinders then the designated pressure setting of that one of left and right float cylinders in the database is not changed, and wherein when the maximum pressure is not within the acceptable tolerance for the other of the left and right float cylinders then the designated pressure setting of the other of the left and right float cylinders in the database is modified.

5. The agricultural machine of claim 4, wherein modification of the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the other of the left and right float cylinders to determine a plurality of corrected required to raise the work implement.

6. The agricultural machine of claim 4, wherein the processor is operable to execute the float control algorithm to automatically replace the designated pressure settings of the other of left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.

7. The agricultural machine of claim 2, wherein when the maximum pressure is not within the acceptable tolerance for the left and right float cylinders then the designated pressure setting of the left and right float cylinders in the database is modified.

8. The agricultural machine of claim 7, wherein modification of the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the left and right float cylinders to determine a plurality of corrected pressures required to raise the work implement.

9. The agricultural machine of claim 8, wherein the processor is operable to execute the float control algorithm to automatically replace the designated pressure settings of the left and right float cylinders with the plurality of corrected pressure s required to raise the work implement in the database.

10. The agricultural machine of claim 2, wherein the automatically determine a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float

cylinders occurs while the work implement is moving to the raised position.
11. The agricultural machine of claim 2, wherein the automatically determine a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs after the work implement has moved to the raised position.
12. A method of controlling an agricultural machine, the method comprising: providing an agricultural machine having a frame, an implement linkage system attached to the frame and configured for attaching a selected work implement from a plurality of different work implements to the frame, wherein the implement linkage system includes a left connecting arm and a right connecting arm, a left float cylinder attached to and interconnected with the frame and the left connecting arm, a right float cylinder attached to and interconnected with the frame and the right connecting arm, wherein the implement linkage system is controllable in a float operating condition allowing the selected work implement to vertically track a ground surface during horizontal movement over the ground surface, a controller including a processor and a memory having a float control algorithm stored thereon; identifying via the controller the selected work implement from the plurality of different work implements; soliciting a desired operating condition from a plurality of predefined settings from the operator via an input operable to receive instructions from the operator, wherein the desired operating condition corresponds to a designated pressure setting of the left and right float cylinders in a database; operating the work implement in a float mode of operation; commanding the work implement to a raised position; automatically determining via the controller a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders; and automatically modifying, via the controller, the designated pressure setting of the left and right float cylinders in the database based on the maximum pressure and position for each of the left and right float cylinders.
13. The method of claim 12, further comprising: automatically determining if the maximum pressure is within an acceptable tolerance for each of the left and right float cylinders, wherein when the maximum pressure is within the acceptable tolerance for any of the left and right float cylinders then the designated pressure setting of the corresponding float cylinder in the database is not changed, and wherein when the maximum pressure is not within the acceptable tolerance for any of the left and right float cylinders then the designated pressure setting of the corresponding right float cylinder in the database is modified.
14. The method of claim 12, wherein modifying the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the left and right float cylinders to determine a plurality of corrected pressures required to raise the work implement.
15. The method of claim 14, further comprising: automatically replacing the designated pressure settings of the left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.
16. The method of claim 12, wherein when the maximum pressure is not within the acceptable tolerance for the left and right float cylinders then the designated pressure setting of the left and right float cylinders in the database is modified.
17. The method of claim 16, wherein modifying the designated pressure setting in the database includes averaging corresponding pressure values of the predefined settings with the maximum pressure for the left and right float cylinders to determine a plurality of corrected required to raise the work implement.
18. The method of claim 17, further comprising: automatically replacing the designated pressure settings of the left and right float cylinders with the plurality of corrected pressures required to raise the work implement in the database.
19. The method of claim 12, wherein the automatically determining a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs while the work implement is moving to the raised position.

20. The method of claim 12, wherein the automatically determining a maximum pressure and a position that the maximum pressure corresponds to for each of the left and right float cylinders occurs after the work implement has moved to the raised position.