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(54) **LAWN MOWER WITH DECK LIFT SYSTEM THAT RAISES AND LOWERS DECK WITH RESPECT TO FRAME AND HANDLE CONTROL ASSEMBLY**

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A01D 34/82	(2006.01)

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CPC ***A01D 34/74*** (2013.01); ***A01D 34/824*** (2013.01); ***A01D 69/03*** (2013.01)

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CPC A01D 34/74; A01D 69/03
USPC 56/17.1, 10.8, 11.9, 15.8, 15.2, 14.9, 56/11.4, 11.8; 180/19.1
See application file for complete search history.

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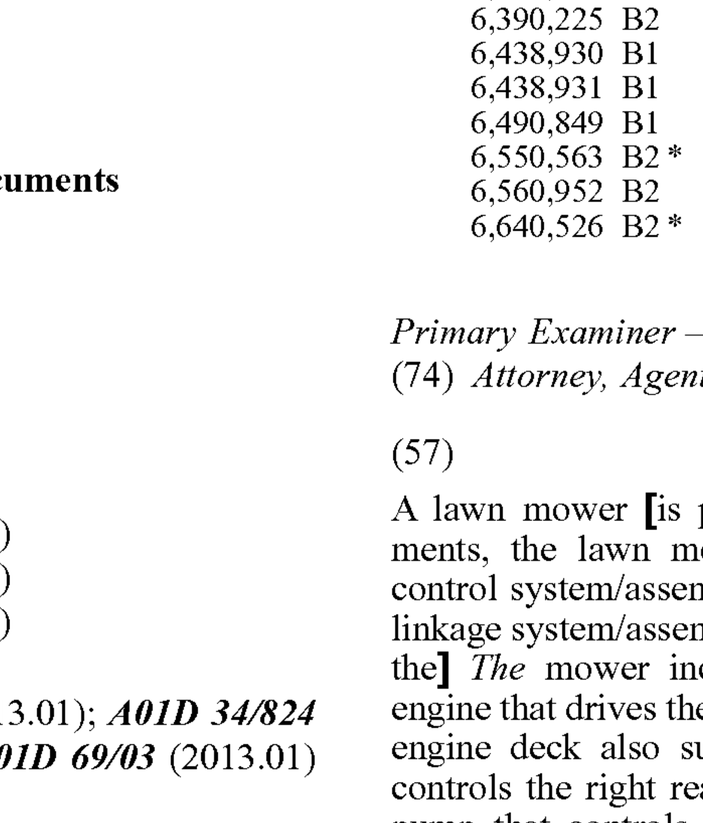
(57) **ABSTRACT**

A lawn mower **[**is provided. In certain example embodiments, the lawn mower**]** includes an improved steering control system/assembly and/or an improved pump control linkage system/assembly. **[**In certain example embodiments, the**]** *The* mower includes an engine deck supporting an engine that drives the at least one blade for cutting grass, the engine deck also supporting a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel. A deck lift system is for raising/lowering the engine deck relative to both a frame of the mower and a handle control assembly.

36 Claims, 12 Drawing Sheets



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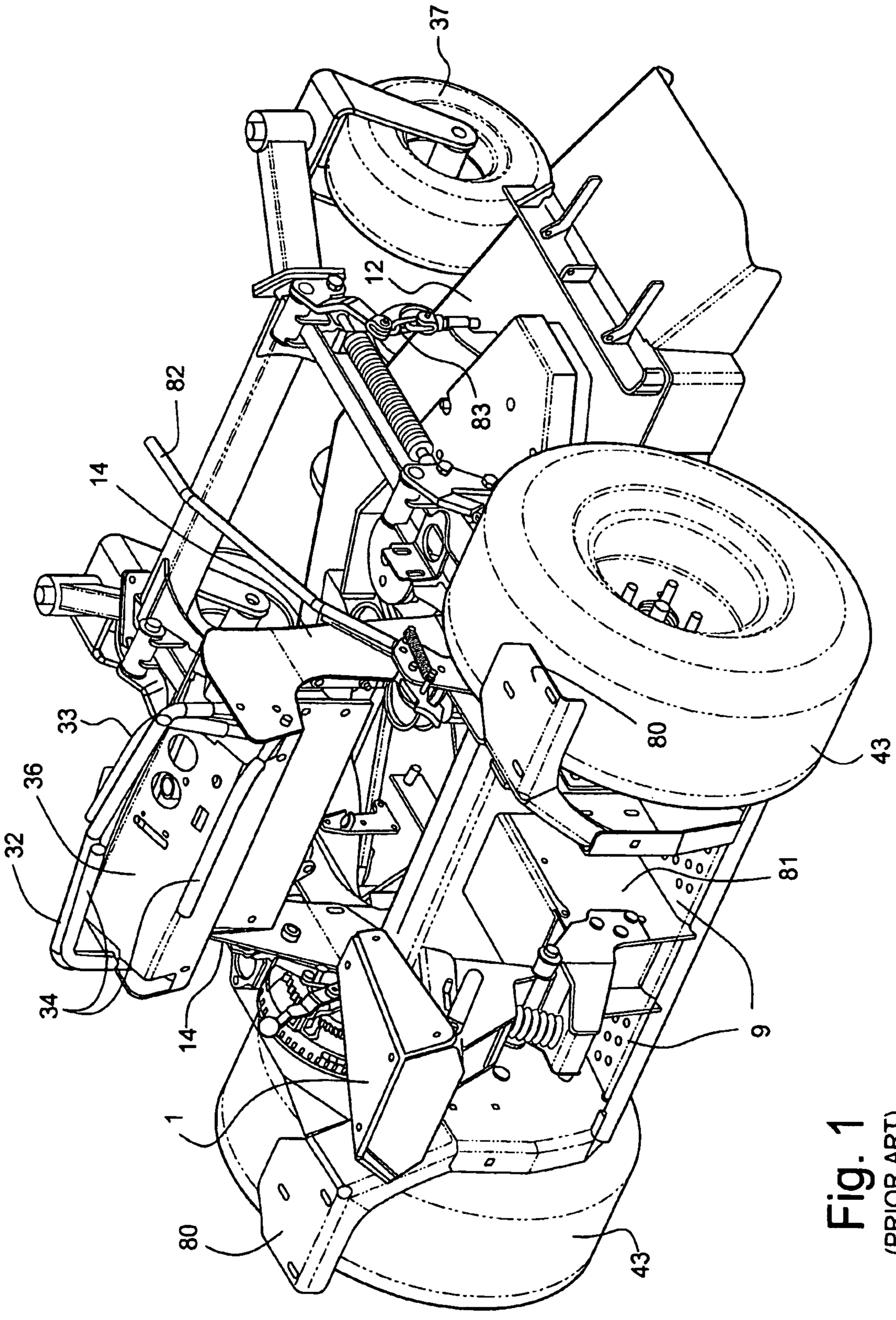


Fig. 1
(PRIOR ART)

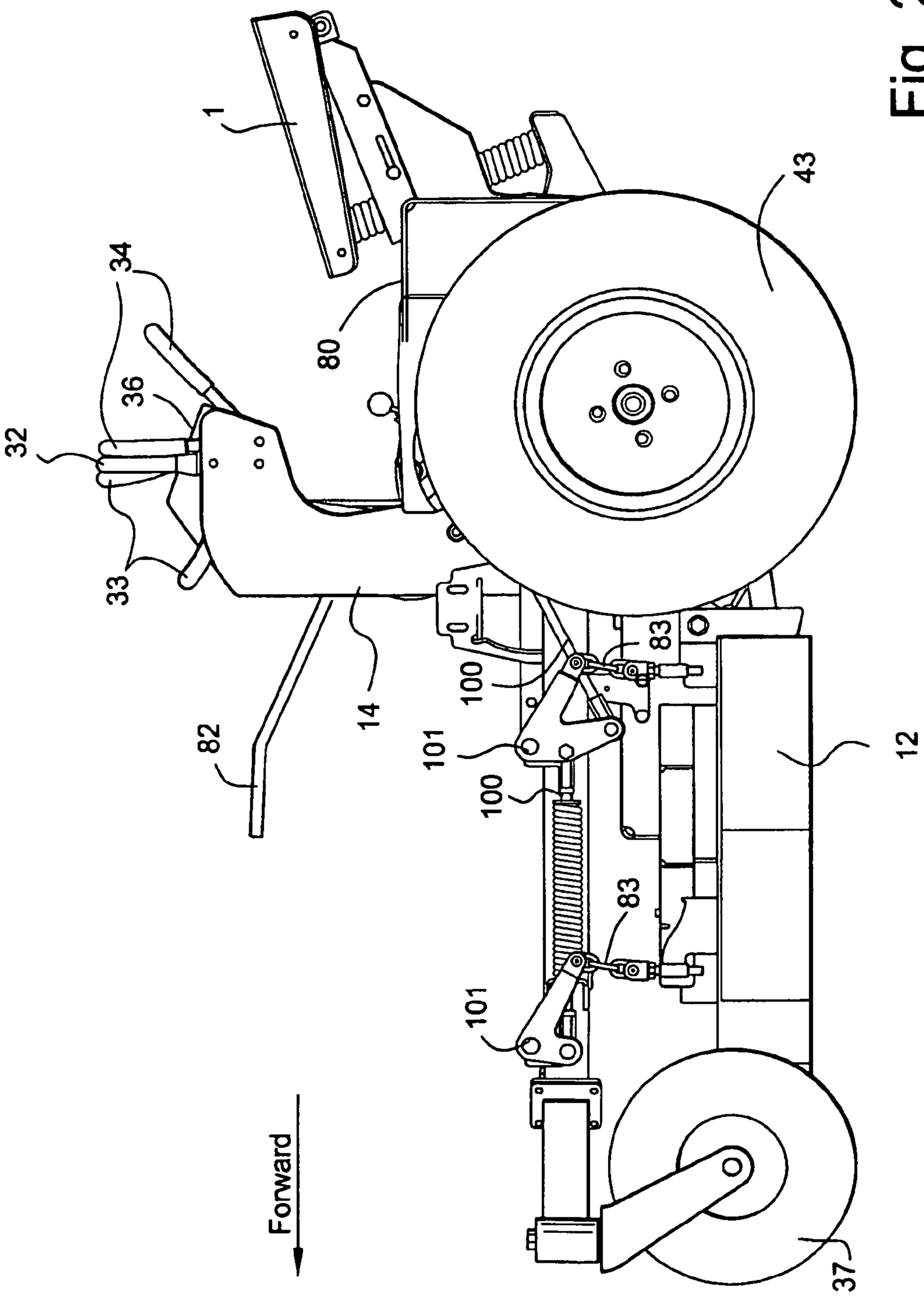
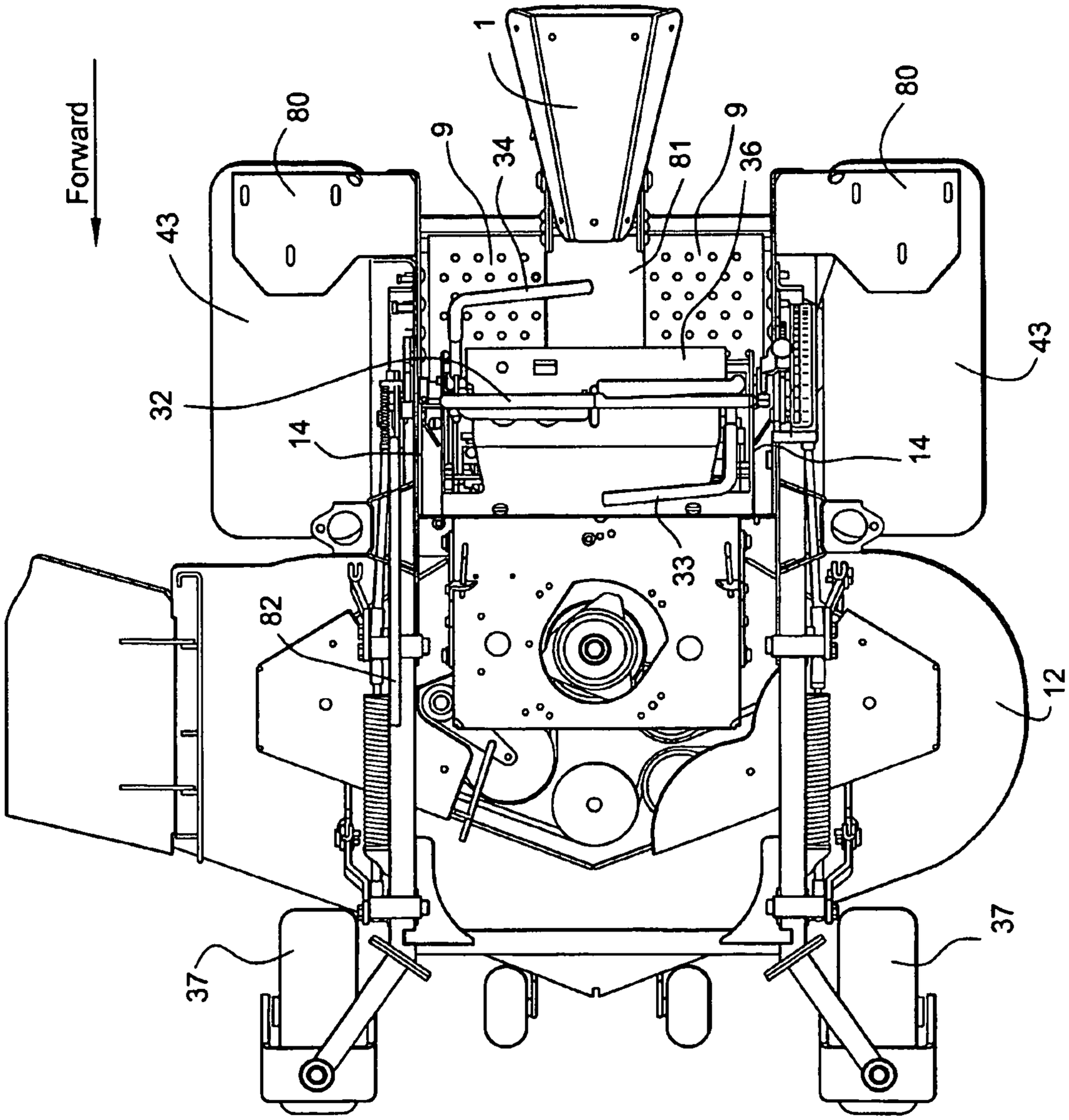


Fig. 2
(PRIOR ART)

Fig. 3
(PRIOR ART)



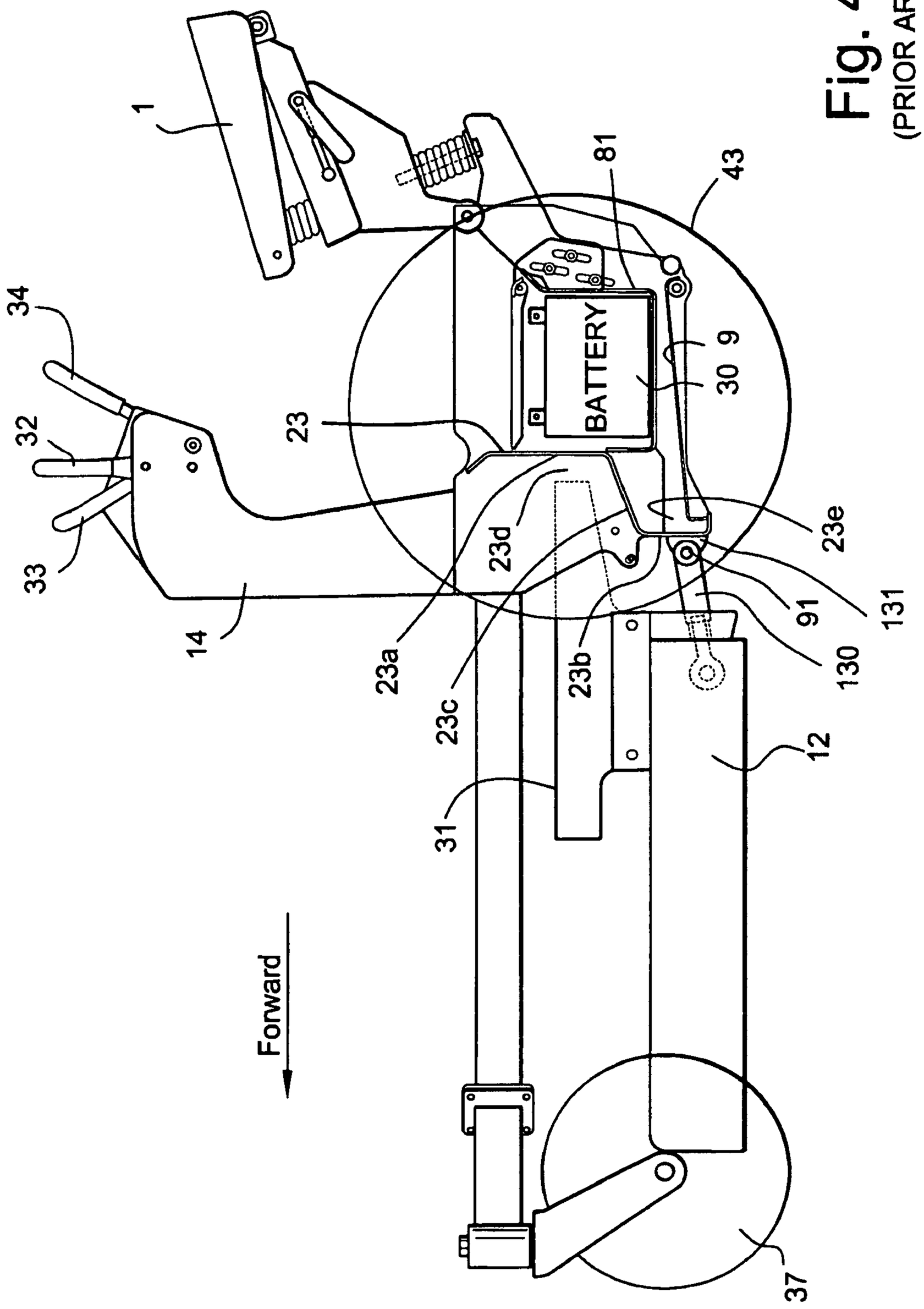


Fig. 4
(PRIOR ART)

Fig. 5

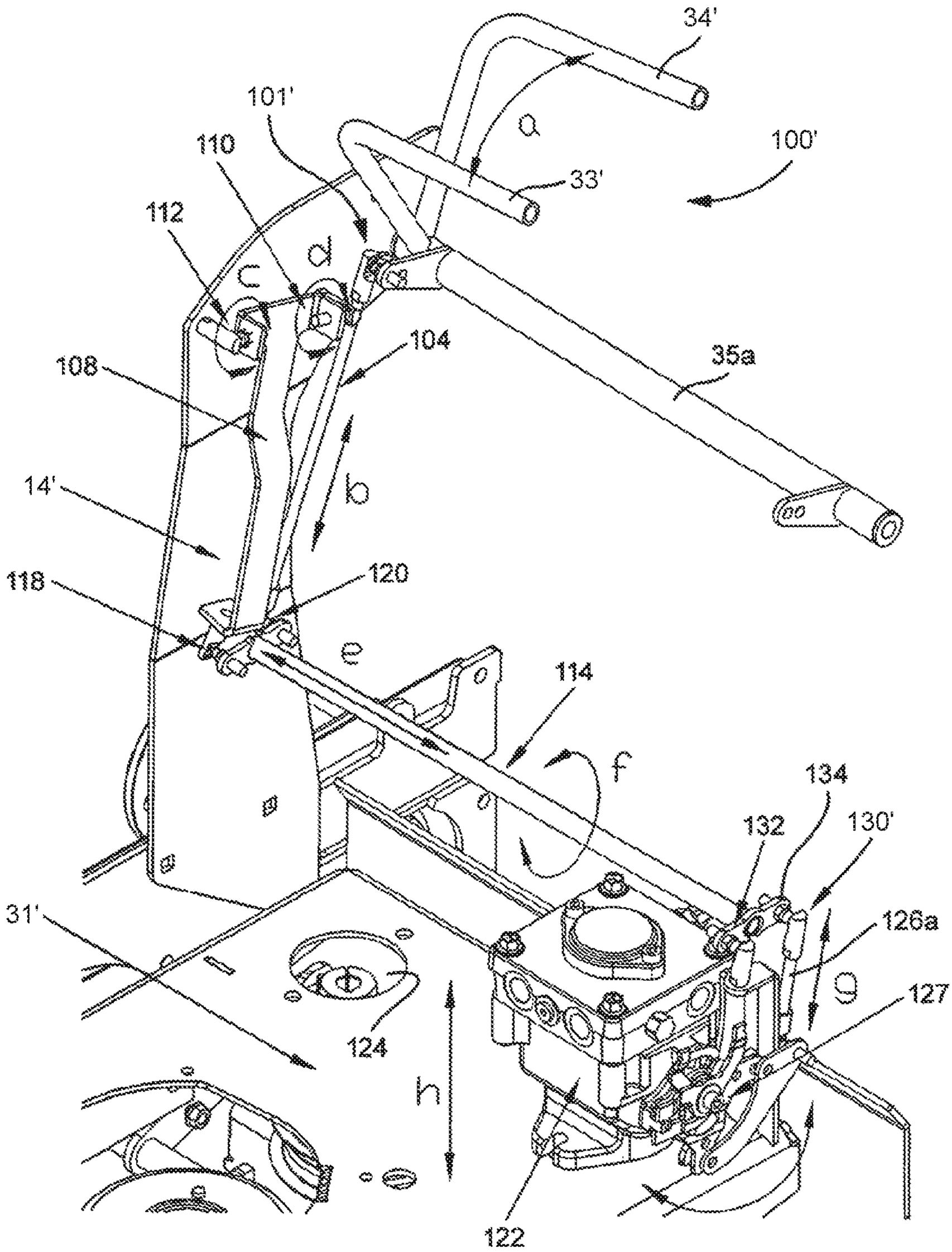


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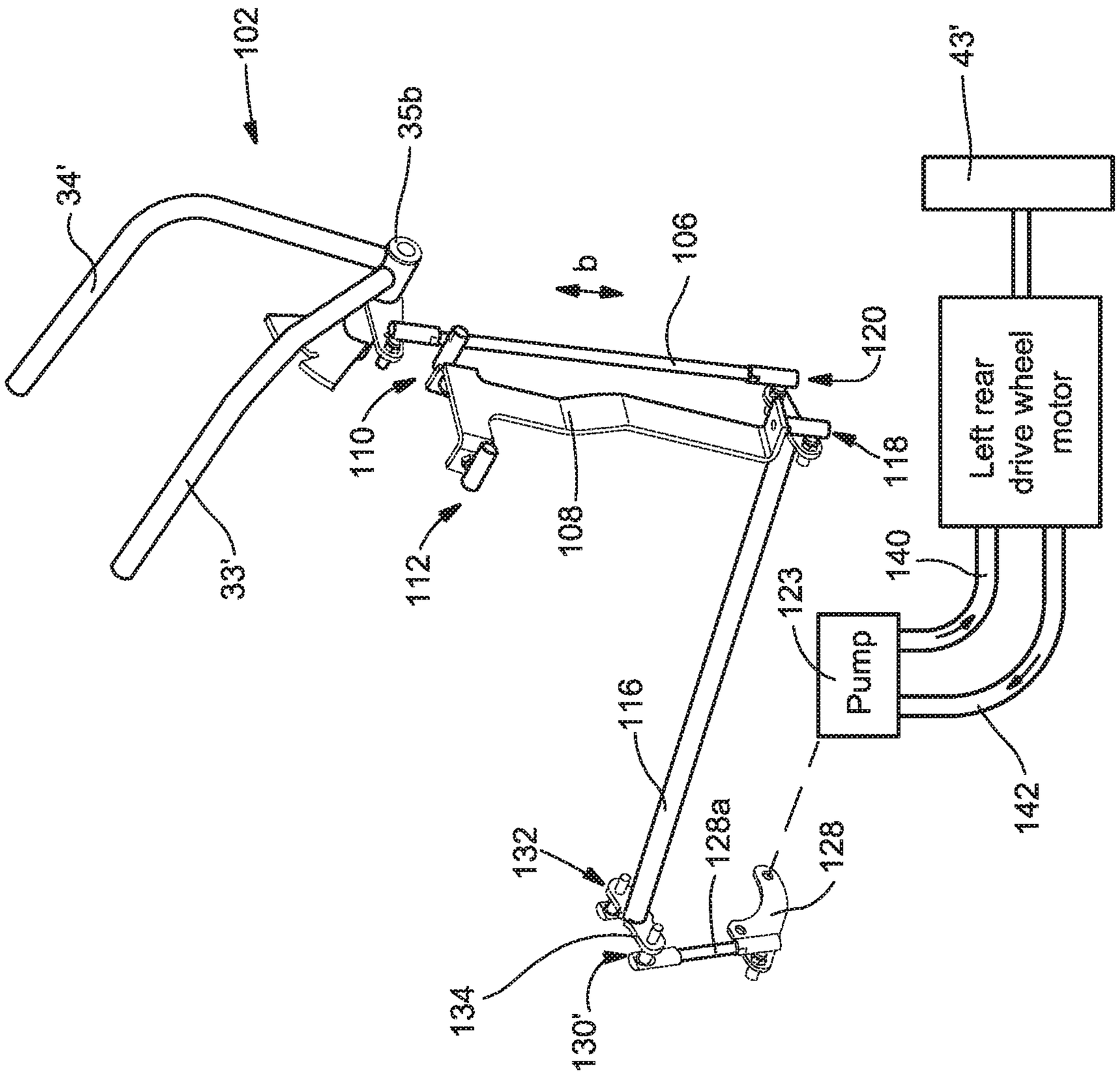
Fig. 6



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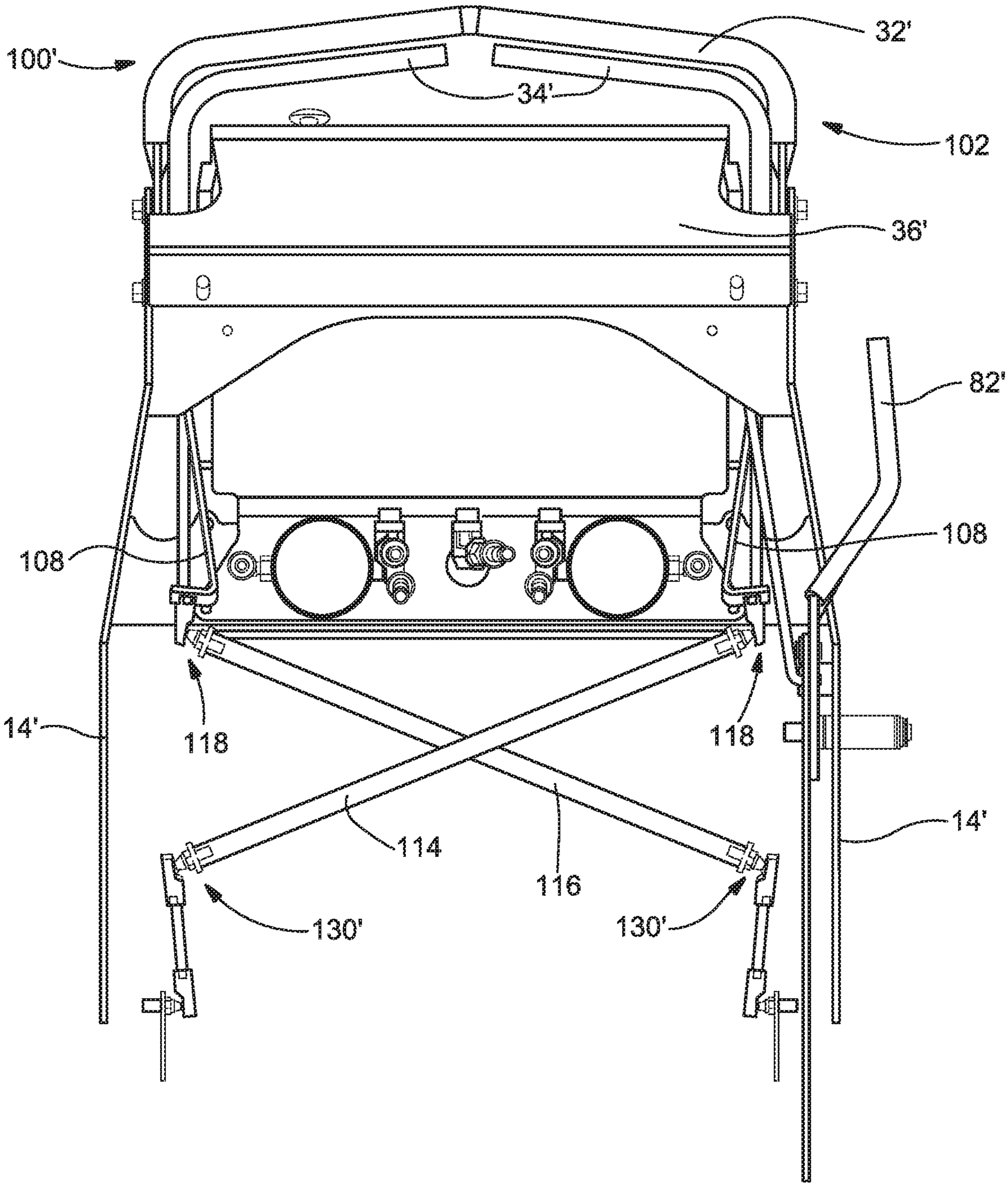

Fig. 7

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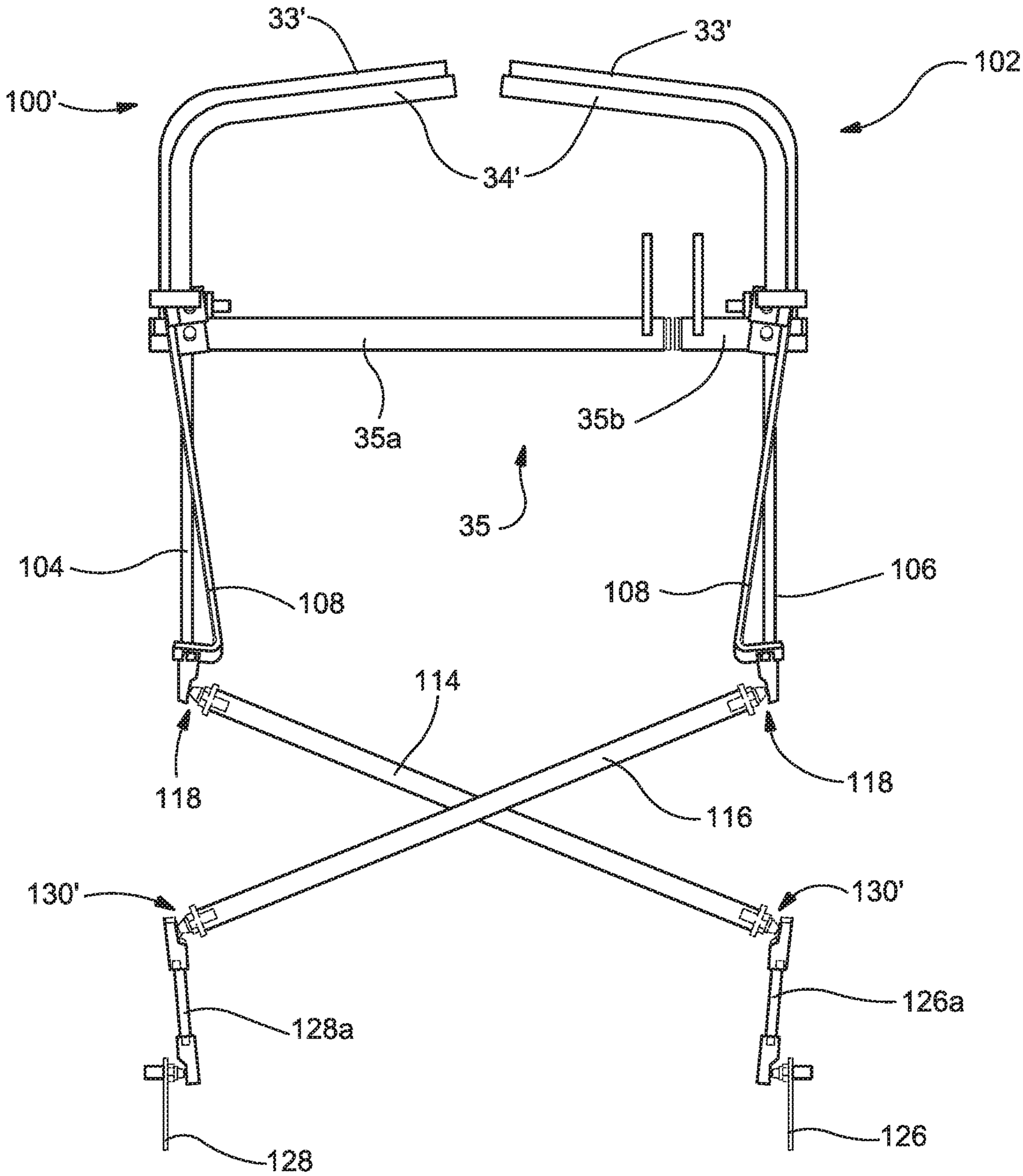

Fig. 8

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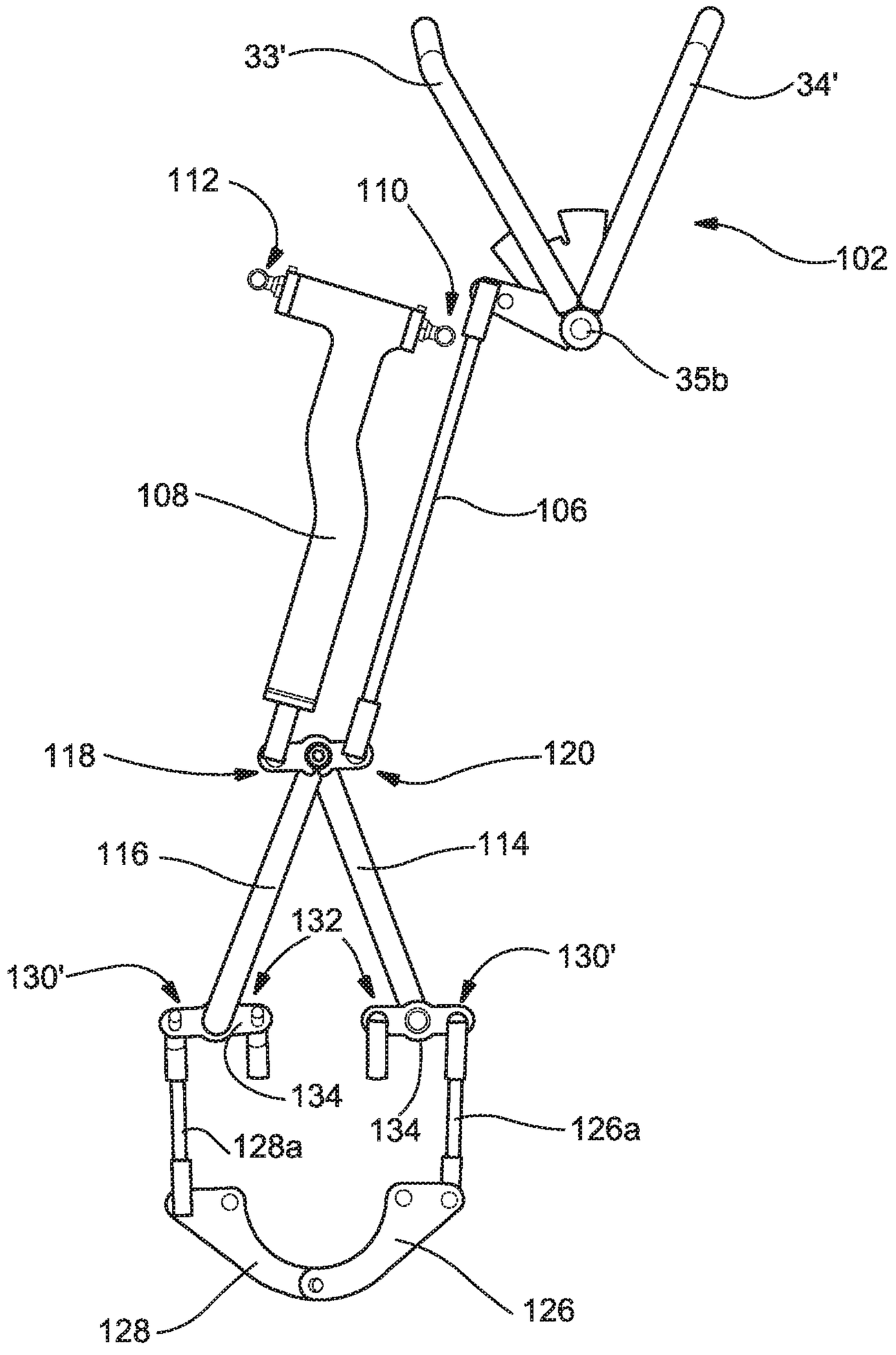

Fig. 9

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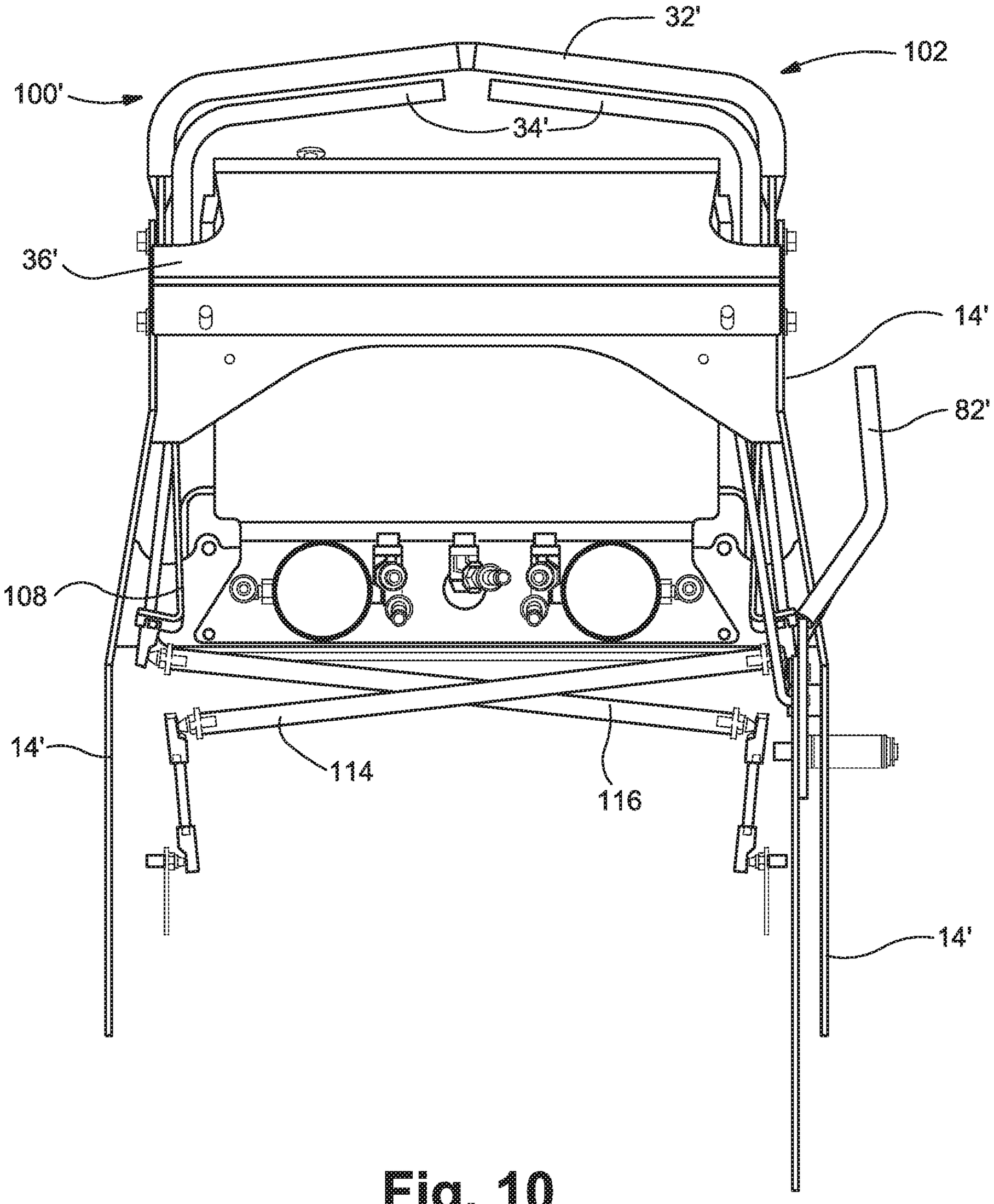

Fig. 10

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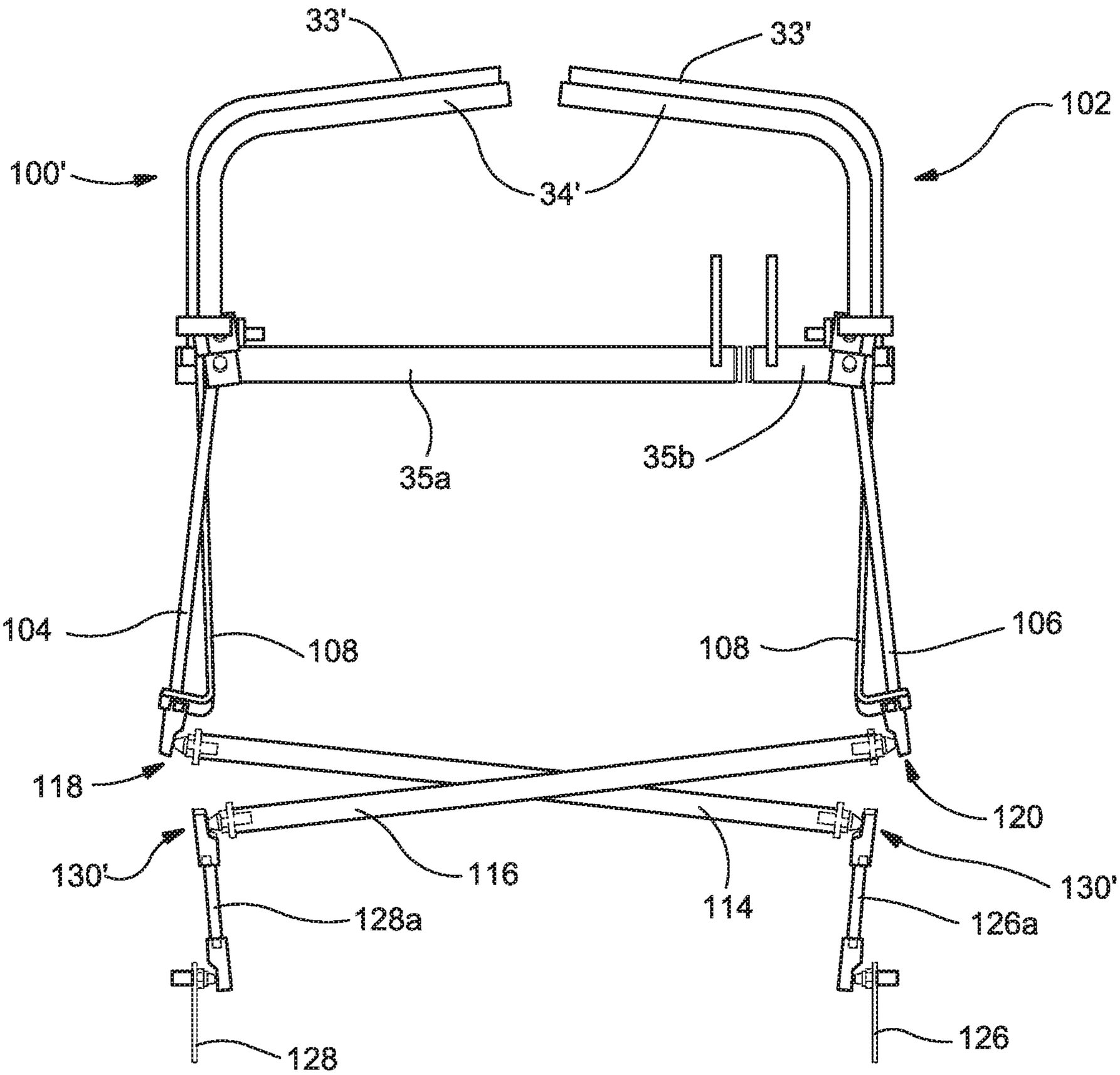

Fig. 11

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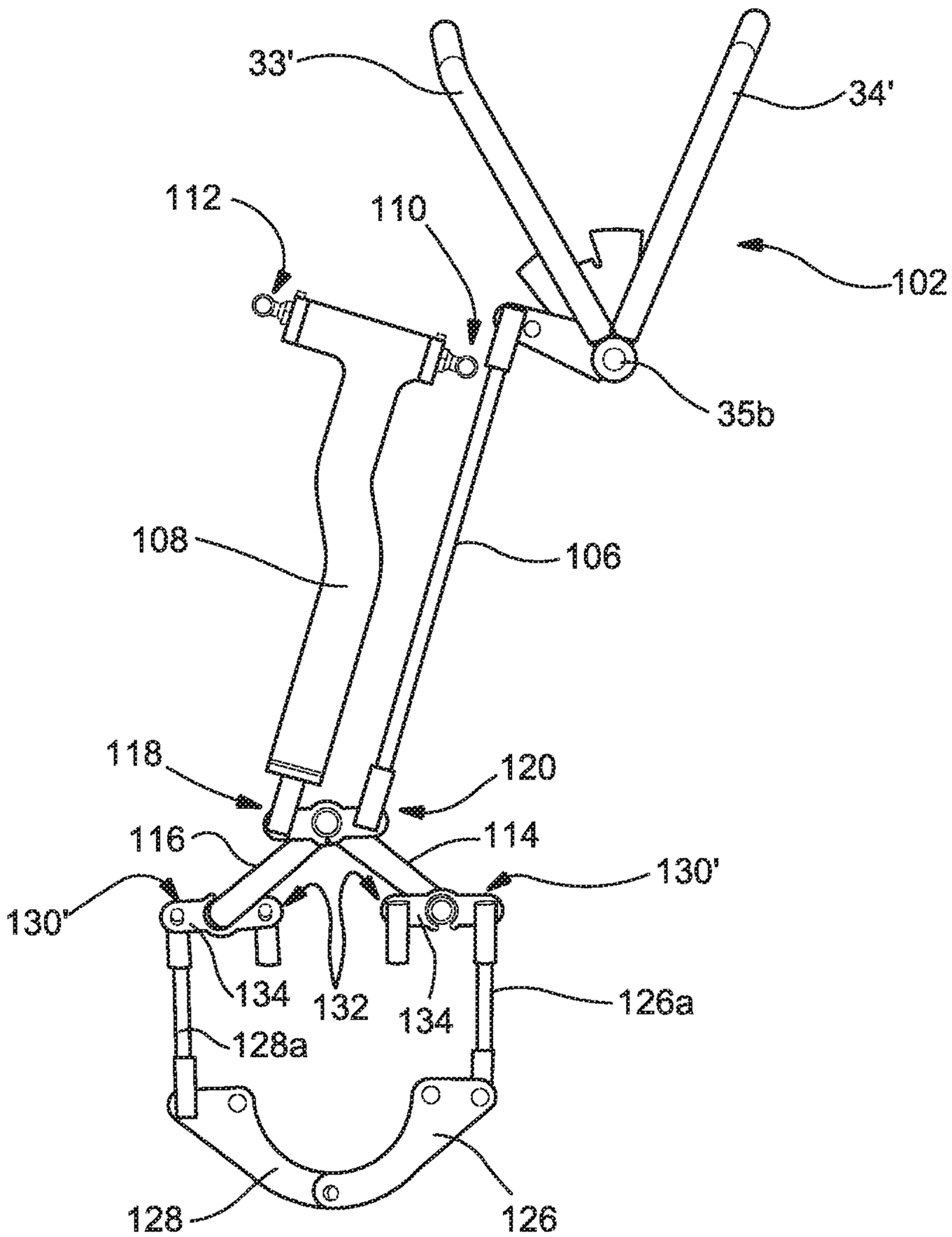

Fig. 12

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LAWN MOWER WITH DECK LIFT SYSTEM THAT RAISES AND LOWERS DECK WITH RESPECT TO FRAME AND HANDLE CONTROL ASSEMBLY

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

This application is an application for reissue of U.S. Pat. No. 7,325,388, which issued from U.S. application Ser. No. 11/214,034, filed Aug. 30, 2005.

This invention relates to a lawn mower. In certain example embodiments, the lawn mower includes an improved steering control and/or pump control assembly/system.

BACKGROUND OF THE INVENTION

Lawn mowers are known in the art. For example, stand-on mowers are discussed in U.S. Pat. Nos. 6,138,446, 6,390,225, 6,688,089, 6,438,931, 6,189,304, 6,438,930, 6,658,831, 6,560,952, and 5,964,082, the disclosures of all of which are all hereby incorporated herein by reference. Example walk-behind lawn mowers are discussed in U.S. Patent Documents 2005/0126146 and U.S. Pat. No. 4,920,733, the disclosures of which are all hereby incorporated herein by reference. Example mower operable by seated occupants are discussed in U.S. Patent Documents 2001/0001170, 2002/0059788, U.S. Pat. Nos. 6,438,930, 6,438,931, 6,688,089, 6,658,831, and 6,560,952, the disclosures of which are all hereby incorporated herein by reference.

FIGS. **1-4** illustrate an example lawn mower operable by a seated and/or standing occupant, from U.S. Pat. No. 6,688,089, the disclosure of which is incorporated herein by reference. The mower of FIGS. **1-4** is a zero radius turning self-propelled power lawn mower. This mower includes first and second hydro pumps for controlling first and second corresponding wheel motors, so that the first and second rear drive wheels **43** may he driven independently in order to conduct zero radius turns as discussed above. The mower further includes: independently drivable rear drive wheels **43**; cutter deck assembly **12** below which the cutting blades cut grass; front caster wheels **37**; foot platform **9** for supporting feet of a standing or sitting operator; optional seat **1**; gas tank supports **80** for supporting respective gas tanks; battery housing structure **81** for housing a battery **30** and which also functions to help support the seat assembly; steering control levers **33-34** (which work in conjunction with rigid hand grip bar **32**) which allow the rear drive wheels **43** to be independently drivable in opposite directions at the same time so as to enable the mower to perform zero radius turns about a vertical zero radius turning axis; vertically extending support plates or weldments **14** which support console **36** and handle grips **32-34**; and deck lift lever **82** which allows the cutter deck assembly **12** together with the engine deck **31** (the combustion engine is mounted on the engine deck **31**), wherein the engine and cutter decks are raised/lowered together as one unit by the deck lift system in order to adjust the height of the mower cut. Steering control levers **33** and **34** are operatively connected to flexible cables (not shown) which run straight down from the dash area to the pump area of the mower for controlling the pumps associated with the respective steering control levers. The flexible cables do not cross each other, and are flexible to account for the movement of the decks and pumps relative to the steering control levers. With respect to the deck lift system which raises/lower the decks (and the hydro pumps mounted on the engine deck), when deck lift lever **82** is pulled upwardly, the cutter deck assembly **12** together with the engine deck **31** (and engine) is raised so as increase the height of the mower cut. Chain linkage **83** suspends the deck assembly **12** and **31** and permits it to be raised and lowered in accordance with the position of lever **82**.

When deck lift lever **82** is pulled upwardly in a clockwise pivoting fashion ("clockwise" as defined from the port side of the mower as in FIGS. **2** and **4**) by an operator, this causes a deck lift rod (not shown) traversing the mower frame to also rotate in a clockwise direction. This deck lift rod, attached to deck lift rods **100** on either side of the mower, causes rods **100** to be pulled toward the rear of the mower so that lift brackets pivot counterclockwise about pivot axes **101** in order to lift the cutter deck assembly **12** together with the engine deck **31** and engine upwardly via chains **83** in order to raise the cut of the mower. Since the handle grips **32-34** and weldments (or vertically upright support members) **14** are attached to the frame and not the engine or cutter deck(s), the grips **32-34** and upright support members **14** do not move up/down along with the cutter deck assembly **12**, engine, and engine deck **31**. In a similar manner, when lever **82** is lowered from a locked position, the weight of the deck assemblies and engine causes the illustrated brackets to rotate clockwise ("clockwise" as defined in, for example, FIG. **2**) about axes **101** and rods **100** to move in a forward direction so that the cutter deck assembly **12** is lowered along with the engine deck **31** and engine. In this respect, control arms **130** (see FIG. **4**) maintain the lateral position of the cutter deck assembly **12** and engine deck **31** (and the engine) during lower/raising by the deck lift system. Control arms pivot about pivot axis **91** during raising and lower of the decks, and tabs **131** are provided for supporting the pivot axis area.

As review of U.S. Pat. No. 6,688,089 will show that the tractor frame (and thus the handle controls and vertical weldments/supports **14** supported thereby) does not move up/down along with the decks. FIG. **4** illustrates that the tractor frame includes cross member or front wall **23** that is shaped so as to include approximately parallel portions **23**a and **23**b that are connected by angled portion **23**c. The presence of angled portion **23**c enables portions **23**a and **23**b to be approximately parallel to one another yet offset from one another thereby creating space **23**d above angled portion **23**c where the rear edge of engine deck **31** can move up and down relative to the tractor frame during cutting height adjustment initiated by the deck lift system. In other words, the presence of angled portion **23**c creates space **23**d so that the space above the toes of the operator (the toes would be at area **23**e) may be used for enabling the engine deck to move up/down relative to the frame.

Further details of the mower of FIGS. **1-4** may be found in U.S. Pat. No. 6,688,089, incorporated herein by reference. While the mower of FIGS. **1-4** is excellent in many respects. systems therein may be subject to improvement in certain instances.

BRIEF SUMMARY OF EXAMPLE EMBODIMENTS OF THE INVENTION

This invention relates to a lawn mower. In certain example embodiments, the lawn mower includes an steering control system/assembly.

In certain example embodiments of this invention, there is provided a lawn mower comprising: at least one cutting blade for cutting grass; a right rear drive wheel and a left rear drive wheel; an engine deck supporting an engine that drives the at least one blade for cutting grass, the engine deck also supporting a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel; a deck lift system for raising/lowering the engine deck relative to both a frame of the mower and a handle control assembly, the handle control assembly for allowing an operator of the mower to steer the mower by controlling the right and left rear drive wheels independent of one another; and wherein the first hydraulic pump that controls the right rear drive wheel is located on a left half portion of the engine deck, and the second hydraulic pump that controls the left rear drive wheel is located on a right half portion of the engine deck. The lawn mower may be a stand-on type mower and/or a riding type mower in different example embodiments of this invention.

In other example embodiments of this invention, there is provided a lawn mower comprising: at least one cutting blade for cutting grass; a right rear drive wheel and a left rear drive wheel; a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel; and wherein linkage between a right hand control member and the first hydraulic pump includes a first rotatable torsion bar, and linkage between a left hand control member and the second hydraulic pump includes a second rotatable torsion bar, and wherein the first and second torsion bars cross one another so as to form an X when viewed from a rear and/or front of the mower. The shape of the X may vary upon different elevations of the deck caused by the deck lift system in certain example embodiments of this invention.

In still further example embodiments of this invention, there is provided a lawn mower comprising: a right rear drive wheel and a left rear drive wheel; a first hydraulic pump that controls the right rear drive wheel, and a second hydraulic pump that controls the left rear drive wheel; a right hand control members that pivots about an axis and controls speed and direction of the right rear drive wheel via the first hydraulic pump; and wherein pivoting and/or rotation of the right hand control member causes a substantially vertically oriented control rod to move upward and/or downward, wherein movement of the substantially vertically oriented control rod upward and/or downward causes a torsion bar to rotate, the torsion bar forming an angle of from about 10 to 50 degrees relative to the horizontal for at least one location of an engine deck of the mower, and wherein rotation of the torsion bar causes a pump control lever to pivot in a manner to control operation of the first pump that controls the right rear drive wheel.

In still further example embodiments of this invention, there is provided a lawn mower comprising: a right rear drive wheel and a left rear drive wheel; a first hydraulic pump that controls the right rear drive wheel, and a second hydraulic pump that controls the left rear drive wheel; a right hand control members that pivots about an axis and controls speed and direction of the right rear drive wheel via the first hydraulic pump; and wherein pivoting and/or rotation of the right hand control member causes a torsion bar to rotate, the torsion bar forming an angle of from about 10 to 50 degrees relative to the horizontal for at least one elevation of an engine deck of the mower, and wherein rotation of the torsion bar causes a pump control lever to pivot in a manner to control operation of the first pump that controls the right rear drive wheel, and wherein the angle of the torsion bar relative to the horizontal changes as an elevation of an engine deck of the mower changes relative to a frame of the mower. In certain example embodiments, the change in angle of the rotatable torsion bar relative to the horizontal as a function of the elevation of the engine deck is advantageous in that it substantially preserves the effect different positions of the handle control lever(s) have on the pump(s) so as to substantially maintain its range and effect on the speed and direction of the mower.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a conventional lawn mower including a deck lift system.

FIG. **2** is a side plan view of the mower of FIG. **1**.

FIG. **3** is a top view of the mower of FIGS. **1-2**.

FIG. **4** is a schematic diagram illustrating certain components of the mower of FIGS. **1-3**.

FIG. **5** is a perspective view of components of a steering to and/or pump control assembly/system according to an example embodiment of this invention (the system for only the right rear drive wheel control is illustrated in this figure for purposes of simplicity).

FIG. **6** is a perspective view of certain components of the is steering and/or pump control assembly/system (parts for the system for only the left rear drive wheel control are illustrated in FIG. **6** for purposes of simplicity).

FIG. **7** is a front plan view of certain components of the steering and/or pump control assembly/system of FIGS. **5-6** (this view illustrating the system when the engine deck is in a relatively low position relative to the mower's frame—viewed from the front of the mower).

FIG. **8** is a front plan view of certain components of the steering and/or pump control assembly/system of FIGS. **5-7** (this view differs from FIG. **7** in that the dash has been removed to permit more parts to be seen) (this view illustrating the system when the engine deck is in a relatively low position relative to the mower's frame).

FIG. **9** is a side plan view of certain components of the steering and/or pump control assembly/system of FIGS. **5-8** (this view illustrating the system when the engine deck is in a relatively low position relative to the mower's frame, in the same position as in FIGS. **7-8**).

FIG. **10** is a front plan view of certain components of the steering and/or pump control assembly/system of FIGS. **5-9** (this view illustrating the system when the engine deck is in a relatively high position, compared to the engine deck position of FIGS. **7-9**, relative to the mower's frame—viewed from the front of the mower).

FIG. **11** is a front plan view of certain components of the steering and/or pump control assembly/system of FIGS. **5-10** (this view differs from FIG. **10** in that the dash has been removed to permit more parts to be seen) (this view illustrating the system when the engine deck is in a relatively high position, compared to the engine deck position of FIGS. **7-9**, relative to the mower's frame).

FIG. **12** is a side plan view of certain components of the steering and/or pump control assembly/system of FIGS. **5-11** (this view illustrating the system when the engine deck is in a relatively high position relative to the mower's frame, in the same position as in FIGS. **10-11**).

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE INVENTION

Referring more particularly to the accompanying drawings in which like reference numerals indicate like parts throughout the several views.

The mowers of certain example embodiments of this invention discussed herein may be the same as the mower discussed above with respect to FIGS. **1-4** except for the changes illustrated in the figures herein and/or described herein. **[**As**]** *Similar to the mowers* shown in FIGS. **1-4**, mowers according to certain example embodiments of this invention are zero radius turning self-propelled power lawn mowers. This mower includes first and second hydro pumps for controlling first and second corresponding wheel motors, so that the first and second rear drive wheels **[43]** may be driven independently in order to conduct zero radius turns as discussed above. The mower further includes: independently drivable rear drive wheels **[43]**; cutter deck assembly **[12]** below which the cutting blades cut grass; front caster wheels**[37]**; foot platform **[9]** for supporting feet of a standing or sitting operator; optional seat**[1]**; gas tank supports **[80]** for supporting respective gas tanks; battery housing structure **[81]** for housing a battery **[30]** and which also functions to help support the seat assembly; steering control levers **[33-34]** *33'-34'* (which work in conjunction with rigid hand grip bar **[32]**) which allow the rear drive wheels **[43]** to be independently drivable in opposite directions at the same time so as to enable the mower to perform zero radius turns about a vertical zero radius turning axis; vertically extending support plates or weldments **[14]** *14'* which support console/dash **[36]** and handle grips **[32-34]** *33'-34'*; and deck lift lever **[82]** which allows the cutter deck assembly **[12]** together with the engine deck **[31]** *31'* (the combustion engine is mounted on the engine deck **[31]***31'*) to be raised/lowered, wherein the engine and cutter decks are raised/lowered together as one unit by the deck lift system in order to adjust the height of the mower cut. With respect to the deck lift system which raises/lower the decks (and the hydro pumps mounted on the engine deck), when deck lift lever **[82]** is pulled upwardly, the cutter deck assembly **[12]** together with the engine deck **[31]** *31'* (and engine and hydro pumps) is raised so as increase the height of the mower cut. Direction "h" in FIG. **5** illustrates the direction that the engine deck **[31]** *31'*, engine, cutter deck, and pumps move when raised/lowered by the deck lift system. Chain linkage **[83]** suspends the deck assembly **[12]** and **[31]** *31'* and permits it to be raised and lowered in accordance with the position of lever **[82]**. The mower and engine decks are raised/lowered relative to the frame of the mower. Thus, the frame of the mower is not raised/lowered with the decks. The frame of the mower includes vertical weldments/supports **[14]** *14'*, as well as the tractor frame which includes components **[23**a, **23**b, **23**c, **23**d and **23**e,**]** as well as the vertical sidewalls at the sides of the foot platform (the weldments/supports **[14]** *14'* are attached to the tractor frame). Thus, the vertical weldments/supports **[14]** *14'* and the handle control assembly **[32-34]** *33'-34'* supported by **[14]** *14'* do not go up and down along with the decks when the cut height is changed.

The cutter deck assembly **[12]** includes a cutter deck below which the grass cutting blades are mounted, a pulley system housing that is covered by a lid to house pulleys and belts for driving the cutting blades. The mower's combustion engine (mounted on engine deck **[31]** *31'* and having a shaft extending through and/or below an aperture defined in the engine deck **[31]**) *31'*) drives the belts under the cutter deck lid thereby driving the cutting blade(s) of the mower so that grass can be cut.

FIGS. **5-12** illustrate an improved handle/pump control system or assembly for use with such a mower according to an example embodiment of this invention. FIG. **5** is a perspective view of components of the steering and/or pump control assembly/system (illustrating the right rear drive wheel control system only for purposes of simplicity), whereas FIG. **6** is a perspective view of certain components of the steering and/or pump control assembly/system (illustrating components of the left rear drive wheel control system only for purposes of simplicity). FIGS. **7-9** are various views of parts of the steering and/or pump control assembly/system when the engine deck is in a relatively low position relative to the mower's frame. FIGS. **10-12** are various views of parts of the steering and/or pump control assembly/system illustrating the system when the engine deck is in a relatively high position, compared to the lower engine deck position of FIGS. **7-9**, relative to the mower's frame.

Referring to FIGS. **5-12**, the handle/pump control system or assembly includes vertically upright supports or weldments **[14]** *14'* which support the handle control assembly, rigid handle bar**[32]**, right hand handle control member **[100]** *100'* which includes a front handle control lever **[33]** *33'* and a rear handle control lever **[34]** *34'* affixed to rotatable horizontal bar **35**a, wherein the right hand levers **[33]** *33'* and **[34]** *34'* are adapted to be moved or gripped by a right hand of the mower operator (the right hand control member **[100]** *100'* and the levers **[33-34]** *33'-34'* thereof control the speed and driving direction of the right rear drive wheel **[43]** of the mower), left hand handle control member **102** which includes a front handle control lever **[33]** *33'* and a rear handle control lever **[34]** *34'* affixed to rotatable horizontal bar **35**b, wherein the left hand levers **[33]** *33'* and **[34]** *34'* are adapted to be moved or gripped by a left hand of the mower operator (the left hand control member **102** and the levers **[33-34]** *33'-34'* thereof control the speed and driving direction of the left rear drive wheel **[43]** of the mower), right hand control rod **104** which is oriented substantially vertically and whose up/down movement in direction "b" (see "b" in FIG. **5**) is caused by pivoting of the levers **[33-34]** *33'-34'* of the right hand control member **[100]** *100'* in direction "a" (see "a" in FIG. **5**) about the axis of bar **35**a, similar left hand control rod **106** which is oriented substantially vertically (i.e., vertically plus/minus about 20 degrees in any direction) and whose up/down movement in direction "b" (see "b" in FIG. **6**) is caused by pivoting of the levers **[33-34]** *33'-34'* of the left hand control member **102** about the axis of bar **35**b, elongated hinges **108** on both the right and left hand sides of the mower, static upper hinge swivel points **110**, **112** for each of the two hinges **108**, crossing torsion rods **114** and **116** where right wheel torsion rod **114** rotates in direction "f" (see "f" in FIG. **5**) controls the right rear drive wheel **[43]** of the mower and is rotated when right hand levers **[33-34]** *33'-34'* of right hand control **[100]** *100'* are pivoted and left wheel torsion rod **116** controls the left rear drive wheel **[43]** of the mower and is rotated when left hand levers **[33-34]** *33'-34'* of left hand control **102** are pivoted, floating (floating relative to the mower's frame) lower hinge swivel points **118**, **120** for each of the two hinges **108** which permit the torsion bars to pivot/swivel relative to the lower portions of the hinges, hydraulic (or hydro) pump **122** for controlling the right rear drive wheel **[43]** of the mower (but located on the left side of the engine deck **[31]**) *31'*, a similar hydraulic pump (see **123** in FIG. **6**) positioned over hole **124** in the engine deck **[31]** *31'* for controlling the left rear drive wheel **[43]** of the mower (but located on the right side of the engine deck **[31]**) *31'*, pump control lever **126** for pump **122** that controls the right rear drive wheel **[43]** and pivots about pump pivot point **127**, pump control lever **128** for the other pump **123** that controls the left rear drive wheel**[43]**, substantially

vertically oriented pump control rods **126**a and **128**a which move up/down in direction "g" for the corresponding pumps and which are pivotally attached to the pump levers **126**, **128**, floating pump control rod swivel points **[130]** *130'* at upper portions of the pump control rods **126**a, **128**a, and static swivel points **132** about which levers **134** pivot.

Direction "e" in FIG. **5** depicts substantially horizontal movement of the torsion bar **114** and the bottom of hinge **108** as the engine deck **[31]** *31'* (and the engine, and pump **122**) move up/down relative to the mower's frame via the deck lift system. In this same respect, "c" and "d" in FIG. **5** depict rotation or pivoting of the hinge **108** at a top portion thereof relative to the vertical support **[14]** *14'* thereby allowing the bottom portion of the hinge **108** to move in direction "e" thus permitting the system to compensate for up/down movement of the engine deck, pumps and engine via the deck lift system. FIG. **5** illustrates the control system for the right rear drive wheel**[43]**, for purposes of simplicity; and the control system for the left rear drive wheel **[43]** is identical to that shown in FIG. **5** except that the respective parts are on the other side (e.g., right vs. left, or vice versa) of the mower. FIG. **6** illustrates only parts of the control system for the left rear drive wheel**[43]**, again for purposes of simplicity.

The right hand levers **[33-34]** *33'-34'* pivot independently from the left hand levers **[33-34]** *33'-34'*. In other words, movement of the right hand levers **[33-34]** *33'-34'* does not result in movement of the left hand levers **[33-34]** *33'-34'* . It is noted that rotating cross bar **35** includes first and second sections **35**a and **35**b which are axially aligned but rotate independently of one another, the first section **35**a rotating with the right hand levers **[33-34]** *33'-34'* and the second section **35**b rotating with the left hand levers **[33-34]** *33'-34'*. Thus, the right and left hand control rods **104** and **106** also move up/down independently of each other. While only one hydro pump **122** is shown in the FIG. **5**, another hydro pump **123** (see FIG. **6**) is mounted on the engine deck **[31]** *31'* over hole **124** in a similar manner for controlling the other drive wheel. Example hydraulic pumps are described in U.S. Pat. No. 6,782,797, the disclosure of which is hereby incorporated herein by reference. First and second hydraulic fluid hoses **140**, **142** (see FIG. **6**) extend between each pump **122**, **123** and the motor that drives the corresponding rear drive wheel **[43]** of the mower, and for a given drive direction one of these hoses taking fluid to the motor from the pump, and the other hose taking fluid from the motor to the pump **122** (the pump flow directions change when the driving direction of the motor changes).

Accordingly, it will be appreciated that in the system of FIGS. **5-12**, the right handle control **[100]** *100'* controls the right rear drive wheel**[43]**, but the hydro pump **122** for this drive wheel is on the left side of the mower (i.e., on the opposite side of a conventional mower). In a similar manner, the left handle control **102** controls the left rear drive wheel**[43]**, but the hydro pump **123** for this drive wheel is on the right side of the mower (i.e., on the opposite side of a conventional mower). The driving of the rear drive wheels by respective hydro pumps which are on the opposite sides of the mower than the wheels they drive is implemented by way of the use of torsion bars **114** and **116** that extend downwardly from the handles and "cross" each other to form an X as viewed from the front or rear of the mower (e.g., see FIGS. **7-8** and **10-11**). The shape of the X formed by the crossing of the rotatable torsion bars **114** and **116** changes depending on the position of the engine deck **[31]** *31'* (and thus the pumps supported by the engine deck, and the cutter deck) (e.g., whether the engine deck is in a raised or lowered position as determined by the deck lift system); compare the X shown in FIGS. **7-8** where the engine deck **[31]** *31'* is in a fairly low position versus the X shown in FIGS. **10-11** where the engine deck **[31]** *31'* is in a higher position relative to the mower frame and weldment/support **[14]** *14'*. In other words, the angles of the torsion bars relative to the vertical and horizontal change as a function of the height of the engine deck **[31]** *31'*. The angles of both torsion bars **114** and **116** change together when the engine deck **[31]** *31'* is raised/lowered because the bottom ends of both torsion bars are operatively associated with, or attached indirectly, to the engine deck **[31]** *31'*. In other words, for each torsion bar **114** and **116**, the pivots at the upper end of the torsion bar changes elevation with respect to the pivots at the lower end of the torsion bar when the deck **[31]** *31'* is raised/lowered via the deck lift system. Thus, the hand controls **[32-34]** *33'-34'* and pumps **122**, **123** can move vertically relative to one another, and the system is able to accommodate height change and still transmit the motion proportional to hand levers to control the pumps. In certain example embodiments, the pump levers **126** and **128** face opposite directions (so as to control one pump from the back and one from the front), thereby allowing one torsion bar to be located ahead of the other torsion bar.

This X (i.e., the crossing of the torsion bars for the respective pumps **122** and **123**) permits the system to avoid the use of flexible cables in a system where the engine deck can be raised/lowered relative to the frame and handle controls. This is advantageous because flexible cables can be inefficient with respect to transmitting motion, and can introduce inefficiencies into the system.

Referring especially to FIGS. **5-12**, an example operation of the steering/pump control system will now be described. When an operator of the mower pulls backward on either of levers **[33, 34]** *33', 34'* of the right hand drive wheel control **[100]** *100'* shown in FIG. **5**, the right hand control **[100]** *100'* (including levers **[33, 34]** *33', 34'* which move together) pivots/rotates clockwise about a horizontal axis defined by bar **35**a ("clockwise" is determined as viewed from the port side of the mower—namely from the viewpoint shown in FIG. **5**). Such pulling backward on lever **[33]** *33'* and/or **[34]** *34'* of right rear drive wheel control **[100]** *100'* causes the right rear drive wheel to either reduce its forward speed, or to start movement in reverse or increase speed in reverse (in a similar manner, pushing forward on lever **[33]** *33'* and/or **[34]** *34'* of the right rear drive wheel control **[100]** *100'* causes the right rear drive wheel to either increase forward speed, or reduce reverse speed). When levers **[33, 34]** *33', 34'* is/are pulled back and the right rear drive wheel control **[100]** *100'* rotates clockwise in direction "a" as shown in FIG. **5**, this causes right hand control rod **104** to move upwardly in direction "b" due to the pivotal connection at **[101]** *101'* between the control **[100]** *100'* and rod **104**. When right hand control rod **104** moves upwardly in direction "b", this causes torsion bar **114** to rotate counterclockwise about its own elongate axis in direction "f" shown in FIG. **5** (again, counterclockwise is determined as viewed from the port side of the mower). This counterclockwise rotation/pivoting of torsion bar **114** in turn causes lever **134** connected thereto to pivot counterclockwise about a horizontal axis defined at **132** which causes the lever **134** to raise pump control rod **126**a vertically in direction "g." This rising of the pump control rod **126**a causes the pump control lever **126** to pivot counterclockwise about the pump's axis **127** thereby controlling the pump **122** to either cause the right rear drive wheel **[43]** to reduce its forward speed, or to start movement of the wheel in reverse or increase its speed in

reverse. Hoses (e.g., see hoses **140**, **142** in FIG. **6**) from the pump **122** control the wheel motor of the right rear drive wheel **[43]** in a known manner. Movement forward of the levers **[33, 34]** *33', 34'* causes the components to move in the opposite directions described. Moreover, the control system of the left rear drive wheel (e.g., see FIG. **6**) functions in a similar manner.

The example embodiment illustrated in FIGS. **5-12** utilizes torsion bars **114** and **116** that cross and form a variable "X" when viewed from the rear and/or front of the mower. However, this invention is not so limited. In other example embodiments, the torsion bard **114**, **116** may still form an angle of from about 10 to 50 degrees with the horizontal as in the FIG. **5-12** embodiment, but instead extend for/aft within the footprint of the mover (instead of left-right across the width of the mower) in which case the rotatable torsion bars need not cross each other when viewed from the front or rear of the mower.

In the example non-limiting embodiment discussed above, the left pump controls the right drive wheel, and the right pump controls the left drive wheel. However, this invention is not so limited. According to an alternative embodiment of this invention, movement of the right control **[100]** *100'* could cause vertical movement of the left control rod **106**, while movement of the left control **102** causes movement of the right control rod **104**. The same torsion bars and so forth would still be used. In this alternative embodiment, this would permit the left pump to control the left drive wheel, and the right pump to control the right drive wheel.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

The invention claimed is:

1. A lawn mower comprising:

at least one cutting blade for cutting grass;

a right rear drive wheel and a left rear drive wheel;

an engine deck supporting an engine that drives the at least one blade for cutting grass, the engine deck also supporting a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel;

a deck lift system for raising/lowering the engine deck relative to both a frame of the mower and a handle control assembly, the handle control assembly for allowing an operator of the mower to steer the mower by controlling the right and left rear drive wheels independent of one another;

wherein the first hydraulic pump that controls the right rear drive wheel is located on a left half portion of the engine deck, and the second hydraulic pump that controls the left rear drive wheel is located on a right half portion of the engine deck; and

wherein a first linkage between a right hand control member and the first hydraulic pump includes a first rotatable torsion bar, and a second linkage between a left hand control member and the second hydraulic pump includes a second rotatable torsion bar, and wherein the first and second torsion bars cross one another so as to form an X when viewed from a rear and/or front of the mower.

2. The mower of claim **1**, wherein an end of the first torsion bar is supported by a first substantially vertically extending hinge, and an end of the second torsion bar is supported by a second substantially vertically extending hinge, and wherein upper ends of the first and second hinges are pivotally attached to respective substantially vertically oriented supports that are affixed to or are part of the frame of the mower.

3. The mower of claim **1**, wherein the first and second torsion bars each form an angle of from about 10 to 50 degrees relative to the horizontal for at least one location of the engine deck.

4. The mower of claim **1**, wherein angles formed between the first and second torsion bars in the X vary as a function of the elevation of the engine deck relative to the frame of the mower.

5. The mower of claim **1**, wherein the deck lift system lifts and lowers together the engine deck, engine, a cutter deck, and the pumps of the mower.

6. The mower of claim **1**, further comprising a foot platform for supporting feet of an operator who may operate the mower from a standing position.

7. The mower of claim **1**, further comprising a seat for supporting an operator of the mower.

8. The mower of claim **1**, wherein the mower is a zero turning radius mower capable of performing zero radius turns.

9. A zero turning radius lawn mower comprising:

at least one cutting blade for cutting grass;

a right rear drive wheel and a left rear drive wheel;

an engine deck supporting an engine that drives the at least one blade for cutting grass, the engine deck also supporting a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel so that the mower is a zero turning radius mower capable of performing zero radius turns via the right and left rear drive wheels;

a deck lift system comprising a deck lift lever for raising/lowering the engine deck relative to both a frame of the mower and a handle control assembly, the handle control assembly including first and second upright supports and a plurality of steering levers for allowing an operator of the mower to steer the mower by controlling the right and left rear drive wheels independent of one another;

wherein the first hydraulic pump that controls the right rear drive wheel is located on a left half portion of the engine deck, and the second hydraulic pump that controls the left rear drive wheel is located on a right half portion of the engine deck; and

wherein a first linkage between a right hand control member and the first hydraulic pump includes a first rotatable torsion bar, and a second linkage between a left hand control member and the second hydraulic pump includes a second rotatable torsion bar, and wherein the first and second torsion bars cross one another so as to form an X when viewed from a rear and/or front of the mower.

10. The mower of claim **9**, wherein an end of the first torsion bar is supported by a first substantially vertically extending hinge, and an end of the second torsion bar is supported by a second substantially vertically extending hinge, and wherein upper ends of the first and second hinges are pivotally attached to respective substantially vertically oriented supports that are affixed to or are part of the frame of the mower.

11. The mower of claim **9**, wherein the first and second torsion bars each form an angle of from about 10 to 50 degrees relative to the horizontal for at least one location of the engine deck.

12. The mower of claim **9**, wherein angles formed between the first and second torsion bars in the X vary as a function of the elevation of the engine deck relative to the frame of the mower.

13. The mower of claim **9**, wherein the deck lift system lifts and lowers together the engine deck, engine, a cutter deck, and the pumps of the mower.

14. The mower of claim **9**, further comprising a foot platform for supporting feet of an operator who may operate the mower from a standing position.

15. The mower of claim **9**, further comprising a seat for supporting an operator of the mower.

16. A lawn mower comprising:

at least one cutting blade for cutting grass;

a right rear drive wheel and a left rear drive wheel;

an engine that drives the at least one blade for cutting grass, a first hydraulic pump that controls the right rear drive wheel, and a second hydraulic pump that controls the left rear drive wheel;

a deck lift system for raising/lowering the engine relative to both a frame of the mower and a handle control assembly, the handle control assembly for allowing an operator of the mower to steer the mower by controlling the right and left rear drive wheels independent of one another;

wherein the first hydraulic pump that controls the right rear drive wheel is located on one half portion of the mower, and the second hydraulic pump that controls the left rear drive wheel is located on the other half portion of the mower; and

wherein a first linkage between at least a right hand control member and the first hydraulic pump includes a first rotatable torsion bar that rotates about an axis that extends in a same direction that the first rotatable torsion bar extends, and a second linkage between at least a left hand control member and the second hydraulic pump includes a second rotatable torsion bar that rotates about an axis, and wherein the first and second rotatable torsion bars extend downwardly in different directions, and wherein at least rotation of the first and second rotatable torsion bars controls speed of the respective rear drive wheels.

17. The mower of claim 16, wherein an end of the first torsion bar is supported by a movable portion of a first hinge support, and an end of the second torsion bar is supported by a movable portion of a second hinge support, and wherein fixed portions of the first and second hinge supports are attached to respective supports that are affixed to or are part of the frame of the mower.

18. The mower of claim 16, wherein the first and second torsion bars each form an angle of from about 10 to 50 degrees relative to the horizontal for at least one location of the engine during operation of the deck lift system.

19. The mower of claim 16, wherein the deck lift system lifts and lowers together the engine, a cutter deck, and the pumps.

20. The mower of claim 16, further comprising a foot platform for supporting feet of an operator who may operate the mower from a standing position.

21. The mower of claim 16, wherein the first and second rotatable torsion bars cross each other during at least some normal operations of the mower.

22. The mower of claim 16, wherein the first and second rotatable torsion bars cross each other in a manner to form an X shape.

23. The mower of claim 16, wherein the pumps are mounted on an engine deck, and wherein lower ends of the torsion bars raise and lower together with the engine deck when the engine is lifted/lowered by the deck lift system.

24. A lawn mower comprising:

at least one cutting blade for cutting grass;

a right rear drive wheel and a left rear drive wheel;

an engine that drives the at least one blade for cutting grass, at least one support structure that supports a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel;

a deck lift system for raising/lowering the engine relative to both a frame of the mower and a handle control assembly, the handle control assembly for allowing an operator of the mower to steer the mower by controlling the right and left rear drive wheels independent of one another;

wherein a first linkage between at least a right hand control member and the first hydraulic pump includes a first rotatable torsion bar that rotates about an axis that extends in a same direction that the first rotatable torsion bar extends, and a second linkage between at least a left hand control member and the second hydraulic pump includes a second rotatable torsion bar that rotates about an axis that extends in a same direction that the second rotatable torsion bar extends, and wherein each of the first and second rotatable torsion bars has an upper end and from the upper end extends at least downwardly to a lower end that operatively connects to the corresponding pump, and wherein at least rotation of the first and second rotatable torsion bars controls speed of the respective rear drive wheels.

25. The mower of claim 24, wherein a first pump control rod is provided to operatively link an end portion of the first torsion bar and the first pump, and a second pump control rod is provided to operatively link an end portion of the second torsion bar and the second pump, and an end of the first torsion bar is supported by a first hinging support and an end of the second torsion bar is supported by a second hinging support.

26. The mower of claim 24, wherein the first and second torsion bars each form an angle of from about 10 to 50 degrees relative to the horizontal for at least one location of the engine.

27. The mower of claim 24, wherein the deck lift system lifts and lowers together the engine, a cutter deck, and the pumps.

28. The mower of claim 24, further comprising a foot platform for supporting feet of an operator who may operate the mower from a standing position.

29. The mower of claim 24, wherein hoses between the first pump and a motor for the right rear drive wheel, and hoses between the second pump and a motor for the left rear drive wheel, cross each other.

30. The mower of claim 24, wherein an angle at which the first rotatable torsion bar is oriented relative to an upper surface of an engine deck changes when the engine deck is raised/lowered, and an angle at which the second rotatable torsion bar is oriented relative to the upper surface of the engine deck changes when the engine deck is raised/lowered.

31. The mower of claim 24, wherein pivots at the upper ends of the respective first and second rotatable torsion bars change elevation with respect to pivots at lower ends of the respective first and second torsion bars when an engine deck is raised/lowered via the deck lift system.

32. A lawn mower comprising:

at least one cutting blade for cutting grass;

a right rear drive wheel and a left rear drive wheel;

an engine that drives the at least one blade for cutting grass, at least one support structure that supports a first hydraulic pump that controls the right rear drive wheel and a second hydraulic pump that controls the left rear drive wheel;

a deck lift system for raising/lowering the engine relative to both a frame of the mower and a handle control assembly, the handle control assembly for allowing an operator of the mower to steer the mower by controlling the right and left rear drive wheels independent of one another;

wherein a first linkage between at least a right hand control member and the first hydraulic pump includes a first rotatable torsion member that rotates about an axis that extends in a same direction that the first rotatable torsion member is oriented, and a second linkage between at least a left hand control member and the second hydraulic pump includes a second rotatable torsion member that rotates about an axis that extends in a same direction that the second rotatable torsion member is oriented, and wherein each of the first and second rotatable torsion members are operatively connected to the corresponding pump, and wherein at least rotation of the first and second rotatable torsion members controls speed of the respective rear drive wheels.

33. The mower of claim 32, wherein the first and second torsion members comprise respective bars that each form an angle of from about 10 to 50 degrees relative to the horizontal for at least one location of the engine.

34. The mower of claim 32, wherein the deck lift system lifts and lowers together the engine, a cutter deck, and the pumps.

35. The mower of claim 32, further comprising a foot platform for supporting feet of an operator who may operate the mower from a standing position.

36. The mower of claim 32, wherein pivots at the upper ends of the respective first and second rotatable torsion members change elevation with respect to pivots at lower ends of the respective first and second torsion members when an engine deck is raised/lowered via the deck lift system.

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