(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 578 754 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.04.2013 Bulletin 2013/15

(51) Int Cl.:
E02F 3/76 *(2006.01)* ***E02F 3/84*** *(2006.01)*

(21) Application number: **12187472.1**

(22) Date of filing: **05.10.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **07.10.2011 US 201113269157**

(71) Applicant: **DEERE & COMPANY**
Moline, Illinois 61265-8098 (US)

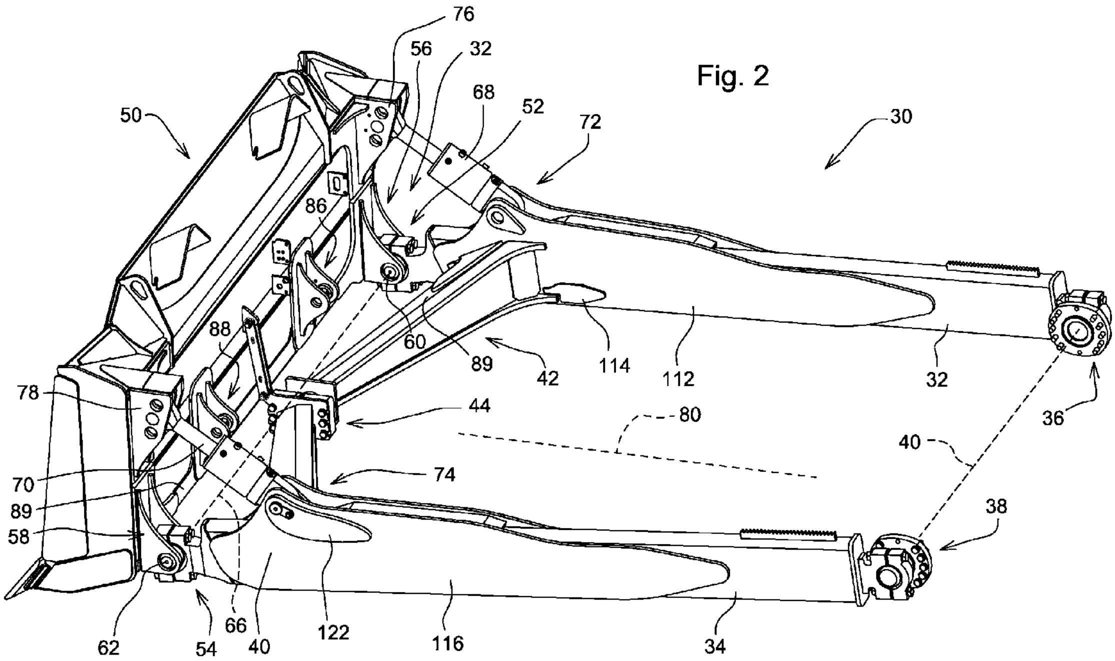
(72) Inventor: **Sulzer, Bryan D**
Dubuque, IA 52003 (US)

(74) Representative: **Münch, Christian**
John Deere GmbH & Co. KG
Global Intellectual Property Services
John-Deere-Straße 70
68163 Mannheim (DE)

(54) **Dual cylinders for effecting tilt and pitch functions of a dozer blade**

(57) A blade 50 of a work vehicle 10 is coupled to the forward ends of right and left push-beams 32, 34 of a push frame 30 for having the blade pitch adjusted about a transverse axis 66 defined by pivotal connections of the blade 50 with the push-beams 32, 34; and right and left push-beam cylinders 68, 70 are provided between the push-beams 32, 34 and blade 50 for effecting pitch adjustments and for effecting tilt adjustments of the blade 50 about a longitudinal axis 80 located midway between the push-beams 32, 34. The push frame 30 is mounted for pivoting vertically about a second transverse axis 40 so as to adjust the height of the blade 50, with a pair of lift cylinders 82 being coupled between the work vehicle 10 and the blade 50 for effecting this adjustment. An electro-hydraulic control system 100 including an electronic controller 130 is provided for effecting individual or simultaneous control of the push-beam cylinders 68, 70 for effecting blade tilt and pitch adjustments in accordance with operator inputs, with position feedback being provided by cylinder position sensors 140, 142, 144, 146.

Fig. 2



EP 2 578 754 A2

Description

Field of the Invention

[0001] The present invention relates to bulldozers, and, more particularly relates to a hydraulic cylinder arrangement for effecting tilt and pitch control of a blade coupled to a dozer blade support frame.

Background of the Invention

[0002] It has long been known to equip crawler-tractors with a transverse blade for scraping the ground or pushing material along the ground. These arrangements are commonly called "bulldozers", with the transverse blade being located forwardly of the bulldozer and coupled to forward ends of right and left, fore-and-aft extending push-beams of a push frame having rear ends respectively pivotally coupled to rear locations of track frames located at opposite sides of the bulldozer, with a forward end of the push frame being supported by right and left extensible and retractable lift hydraulic cylinders respectively coupled between the bulldozer chassis and the blade for controlling the height of the blade. Coupled between the right and left push-beams and the blade for selectively effecting tilt and pitch changes in the blade are right and left push-beam cylinders.

[0003] U.S. Patents 3,184,869 and 5,996,703 each disclose a system including individual valves for controlling operation of right and left push-beam cylinders, but a selector valve is included by which tilt and pitch modes of operation are selected. Thus, no simultaneous tilt and pitch operations are possible for effecting a "blended" tilt and pitch movement of the dozer blade. Further, each control system includes right and left lift cylinders which are operative for raising and lowering the dozer blade, but this operation will also affect the pitch setting of the blade since the blade swings about the transverse axis defined by the coupling assemblies by which the push-beams are secured to the track frames.

[0004] These prior art blade control arrangements have the disadvantage of lacking accuracy which is desirable in order to contour the earth surface to a desired degree of evenness by using the dozer blade in a grading operation rather than having to use a specialized piece of leveling equipment.

[0005] It is desired then to provide a bulldozer blade tilt and pitch adjustment arrangement for orienting a dozer blade so as to accurately grade the surface of the ground to a desired contour.

Summary of the Invention

[0006] According to the present invention, there is provided an improved control arrangement for a bulldozer blade.

[0007] An object of the present invention is to provide a bulldozer blade mounted at the front of a push frame for being pitched about a transverse axis defined by the coupling of the blade with the push frame and for being tilted about a longitudinal axis centered between opposite ends of the blade by simultaneous or separate operation of right and left push-beam cylinders.

Brief Description of the Drawings

[0008]

FIG. 1 is a side elevation view of a work vehicle in the form of, for example, a crawler dozer having a push frame interconnecting a tractor and a blade;

FIG. 2 is a perspective view showing the push frame attached to the blade.

Fig. 3 is a schematic of an electro-hydraulic control system for controlling tilt and pitch functions of the dozer blade.

Description of the Preferred Embodiment

[0009] Referring to FIG. 1, there is shown a work vehicle 10 exemplarily configured as a bulldozer. The vehicle 10 includes a tractor 12 including a main frame 14 supported on an undercarriage 16 including right and left track assemblies positioned on laterally opposite sides of the tractor for propulsion of the vehicle 10, the track assemblies being mirror images of each other with only the left track assembly being shown at 18. The left track assembly 18 includes a fore-and-aft extending track frame 20 carrying an idler 22 at its forward end and having a rear end positioned just ahead of a drive sprocket 23 rotatably mounted to the tractor main frame 14 in a position in fore-and-aft alignment with, the track frame 20. Looped about the idler 22 and drive sprocket 24 and supported by upper and lower track support rollers 25 carried by the track frame 20 is an endless track assembly 26, here shown simplified and in phantom. The undercarriage 16 may take any other suitable conventional form. Mounted on an upper rear region of the main frame 14 is an operators station 28 from which an operator can control the vehicle 10.

[0010] Referring now also to FIG. 2, there is shown a push frame 30 comprising fore-and-aft extending, right and left push-beams 32 and 34 respectively positioned laterally outwardly of, and having rear ends coupled to outer rear locations of, the right and left track assemblies by right and left pivot couplings 36 and 38, with only the connection of the left coupling with the left track assembly frame 20 being shown. The right and left pivot couplings 36 and 38 define a transverse pivot axis 40 about which the push-beams 32 and 34 may pivot vertically. The push frame 30 further includes a cross-beam assembly 42 including forwardly converging right and left beam sections having outer ends fixed to inner front regions of the push-beams 32 and 34 and having inner ends fixed together by a ball joint structure 44 allowing relative movement between them. The cross-beam assembly 42 aids in the stability of the push frame 30.

[0011] A transverse blade 50 is coupled so as to be supported by the push frame 30. Specifically, the push-beams 32 and 34 project forwardly beyond the cross-beam assembly 42 and have forward ends respectively defined by right and left pivot couplings 52 and 54, the latter being respectively received between right and left upright plates of right and left coupling brackets 56 and 58, respectively located at lower right and left regions at the backside of the blade 50. A coupling pin 60 secures the right pivot coupling 52 to the right coupling bracket 56 and a left coupling pin 62 secures the left pivot coupling 54 to the left coupling bracket 58, with the pins 60 and 62 defining a second transverse pivot axis 66 about which the blade 50 may be rocked, in a manner described below, to change its pitch angle relative to the ground.

[0012] Provided for effecting pitch and tilt angle changes of the blade 50 are right and left double-acting push-beam cylinders 68 and 70, respectively, having respective cylinder ends pivotally coupled to the push-beams 32 and 34 at right and left brackets 72 and 74 at upper edge locations spaced rearwardly from respective forward ends of the push-beams 32 and 34, and having respective rod ends pivotally coupled to attachment brackets 76 and 78 respectively located at upper right and left end locations at the back side of the blade 50. The push-beam cylinders 68 and 70 are individually controlled, in a manner described below, for pitching the blade 50 about the axis 66 and tilting the blade about a longitudinal axis 80 located in a vertical plane extending longitudinally halfway between the push-beams 32 and 34.

[0013] Right and left hydraulic lift cylinders 82 and 84 have their cylinder barrels respectively trunnion-mounted to upper, right and left forward regions at the opposite sides of the tractor 12, and have their respective rod ends coupled to right and left mounting brackets 86 and 88 at respective regions of the back side of the blade 50 respectively spaced inwardly of the right and left push-beam connection brackets 56 and 58, with a pair of pivot couplings 90, for example, or any other suitable coupler, being used for securing the lift cylinder rod ends to the brackets 86 and 88. The operator can raise and lower the blade 50 relative to the tractor 12 using the lift cylinders 82 and 84.

[0014] Referring now to Fig. 3, there is shown an electro-hydraulic control system 100 for controlling the operation of the push-beam cylinders 68 and 70, noting that while the lift cylinders 82 and 84 are illustrated, the operator lift input and lift control valve for controlling the cylinders 82 and 84 are omitted for the sake of brevity, with it to be understood that any conventional control arrangement for the selective extension and retraction of the cylinders 82 and 84 could be used.

[0015] The control system 100 includes first and second electro-magnetic direction control valves 102 and 104, respectively, with each control valve being coupled to a pump 106 by a branched supply line 108, and coupled to a sump 110 by a branched return line 112.shown here connected to the inlet of the pump 106, as well. The first direction control valve 102 is respectively coupled to the head and rod ends of the right push-beam cylinder 68 by first and second pressure/return lines 114 and 116. Similarly, the second direction control valve 104 is respectively coupled to the head and rod ends of the left push-beam cylinder 70 by third and fourth pressure/return lines 118 and 120.

[0016] As considered in Fig. 3, the upper and lower ends of the first direction control valve 102 respectively include right cylinder extend and contract solenoids 122 and 124. Similarly, the second direction control valve 104 includes upper and lower ends respectively provided with left cylinder extend and retract solenoids 126 and 128.

[0017] Provided for controlling operation of the push-beam cylinders 68 and 70 by way of the direction control valves 102 and 104 is an electronic controller 130, which preferably is a microprocessor-based controller adapted to sense a plurality of inputs and responsively produce output signals which are delivered to the direction control valves 102 and 104. Thus, the electronic controller 130 contains an operator command processor 132 coupled for receiving electrical operator inputs from operator tilt and pitch input devices 134 and 136, respectively, these devices being in the form of control levers, or the like, which operate a potentiometer or other suitable variable signal generating device that delivers an electrical signal at each different position of the tilt and input devices which is proportional to the movement of the lever in increasing distances from a neutral position. In addition to being coupled for receiving electrical input signals generated by the tilt and pitch input devices 134 and 136, the operator command processor 132 receives a current blade position signal from a position processor 138, which determines the blade position based upon generated feedback position signals received from position or stroke sensors 140 and 142 respectively associated with the push-beam cylinders 68 and 70; based upon a generated feedback position signal received from position or stroke sensors 144 and 146 respectively associated with the lift cylinders 82 and 84; and based upon information received from a table of geometric relationships 148 placed in the ROM of the controller 130, the table also providing information to the operator command processor 132.

[0018] Once the operator command processor 132 has arrived at a blade tilt and/or blade pitch position value corresponding to that commanded, a representative tilt and/or pitch value will be sent to a position limiting circuit 150 which determines from the signal received from the position processor whether or not one or the other of the cylinders 68 and 70 is approaching a position which might result in interference, or a desired preset position for holding or limiting the relative pitch and tilt angles of the blade. If such a stroke position is being approached, the position limiting circuit 150 sends an appropriate signal to the output conditioning circuit 152 which, in turn, acts to appropriately cut or reduce the command signal sent to one or the other or both of the control valves 102 and 104.

[0019] It is to be noted that the position of the lift cylinders 82 and 84 is monitored by the stroke sensors 144 and 146 so that, if the lift cylinders 82 and 84 are used to elevate or lower the blade 50, this fact is taken into account for the purpose of modifying the pitch of the blade 50 through operation of the cylinders 68 and 70 in a direction and magnitude for compensating for any change in pitch occurring due to the repositioning of the height of the blade 50 by the lift cylinders 82 and 84.

[0020] Thus, it will be appreciated that contrary to the prior art control systems, the control system 100 permits tilt and pitch input command signals to be simultaneously sent to the controller 130 and for "blended" output signals to be sent to the control valves 102 and 104 for simultaneously effecting pitch and tilt angle changes of the blade 50. This allows the control system 100 and/or the operator to operate with more simultaneous degrees of freedom than is possible with the prior art control systems, which lends to improved operator finesse and, consequently, increased machine productivity.

[0021] Having described the preferred embodiment, it will become apparent that various modifications can be made without departing from the scope of the invention as defined in the accompanying claims.

Claims

1. A work vehicle, comprising:

a blade (50);
a push frame (30) including fore-and-aft extending, right and left push beams (32, 34) coupled to opposite sides of said work vehicle (10), and said blade (50) being mounted to a front of said push frame (30);
an electric-hydraulic control system (100) configured to sense a pitch input and a tilt input and to generate a pitch signal in response to the pitch input and a tilt signal in response to the tilt input, the electric-hydraulic control system (100) comprising a hydraulic circuit, first and second position sensors (140, 142) and an electrical controller (130), wherein
the hydraulic circuit comprising hydraulic right and left push beam cylinders (68, 70) respectively having first ends coupled to right and left end regions (76, 78) of said blade (50) and second ends coupled to said right and left push beams (32, 34), the right and left push beam cylinders (68, 70) being operative for tilting the blade (50) relative to the push frame (30) about a fore-and-aft extending longitudinal axis (80) and pitching the blade (50) relative to the push frame (30) about a transversely extending pivot axis (66), electro-hydraulic first and second directional control valves (102, 104) being respectively fluid- coupled for controlling the flow of fluid to the right and left push beam cylinders (68, 70) from a source (106) of fluid pressure, and for controlling the flow of fluid from the right and left push beam cylinders (68, 70) to a sump (110);
the first and second position sensors (140, 142) respectively associated with the right and left push beam cylinders (68, 70) and being operative for sensing and generating first and second position signals respectively representative the strokes of the right and left push beam cylinders (68, 70); and
the electrical controller (130) coupled for receiving said first and second position signals from each of said first and second position sensors (140, 142), and coupled for sending a command signal to each of said first and second directional control valves (102, 104);
the controller (130) configured to:

receive the pitch signal, the tilt signal, the first position signal, and the second position signal,
determine a first valve position and a second valve position, each of the first and second valve commands dependent on the pitch and tilt inputs and the first and second position signals representing the position of the right and left push beam cylinders (68, 70), and
output a first control signal commanding the first valve (102) to the first valve position and a second control signal commanding the second valve (104) to the second valve position.

2. The work vehicle, as defined in claim 1, and further including right and left lift cylinders (82, 84) respectively coupled between said work vehicle (10) and right and left end regions of said blade (50); and right and left lift cylinder position sensors (144, 146) for sensing the position of, and generating respective right and left lift cylinder position signals representing the positions of the right and left lift cylinders (82, 84); said right and left lift cylinder position sensors (144, 146) being coupled to said controller (130); and said controller (130) having a memory containing a table of geometric relationships (148) and being responsive to the right and left lift cylinder position signals for generating a signal representative of the change in pitch occasioned by operation of the lift cylinders (82, 84); and said controller (130) being responsive to said signal representative of the change in pitch occasioned by operation of the lift cylinders (82, 84) to effect operation of said right and left push beam cylinders (68, 70) to compensate for the pitch change brought about by operation of the lift cylinders (82, 84).

3. The work vehicle as defined in claim 1, wherein the right and left push beams (32, 34) having front ends pivotally connected to lower rear locations (56, 58) of said blade (50) by first couplings (52, 54) defining the transverse pivot axis (66), and having rear ends pivotally connected to opposite sides of said work vehicle (10) by second couplings (36, 38) defining a second transverse pivot axis (40);
the electric-hydraulic control system (100) including a manually operated tilt and pitch input devices (134, 136) respectively operable for generating tilt and pitch input signals;
the electronic controller (130) coupled for receiving said tilt and pitch input signals from said manually operated tilt and pitch input devices (134, 136), wherein said tilt and pitch input devices (134, 136) being simultaneously operable, if desired, for effecting a blended tilt and pitch input command signal to be sent to said electronic controller (130) which operates in response to the blended tilt and pitch input command signal to send a blended output command signal to said first and second direction control valves (102, 104) for causing said right and left push-beam cylinders (68, 70) to be actuated for causing the tilt and pitch of the blade (50) to be simultaneously adjusted.

4. The work vehicle, as defined in claim 3, wherein said electronic controller (130) includes a memory containing a table (148) relating blade position to various stroke conditions of the right and left push-beam cylinders (68, 70); and right and left push-beam cylinder position sensors (140, 142) being respectively associated with said right and left push-beam cylinders (68, 70) and operative for providing right and left push-beam position signals to said electronic controller (130) which determines a current position of the blade (50) and compares it to the commanded position of the blade (50) determined from at least one of the pitch and tilt input signals.

5. The work vehicle, as defined in claim 4, and further including at least one lift cylinder (82, 84) coupled to the blade (50); and
a lift cylinder position sensor (144, 146) being associated with said at least one lift cylinder (82, 84) and operable for providing a lift cylinder position signal to said electronic controller (130), which determines, from said table of geometric relationships (148), any change necessary to be made in the pitch command signal in view of the pitch of the blade resulting from the position of the push-beams (32,34) about said second transverse pivot axis (40).

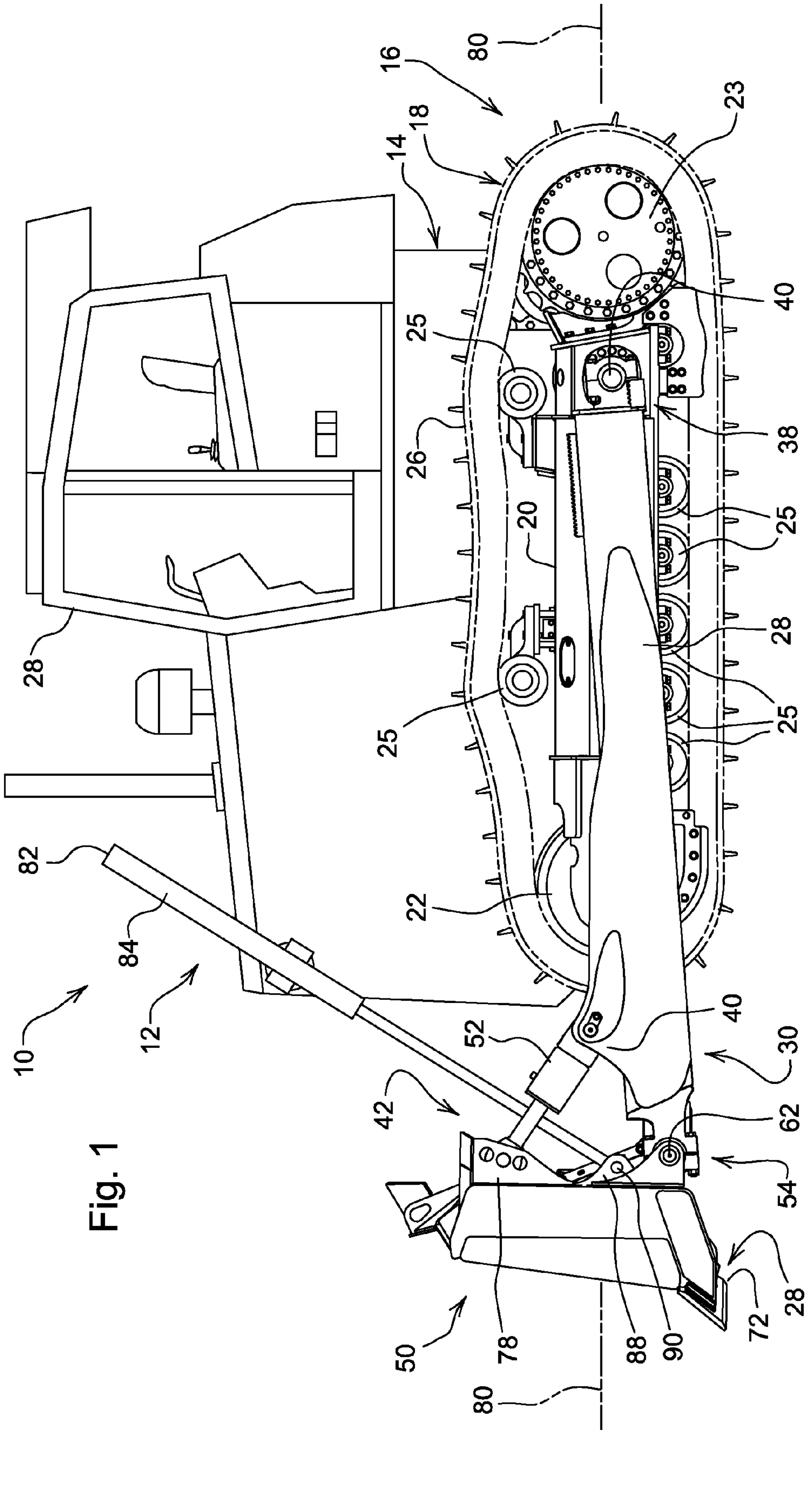

10
12
14
16
18
20
22
23
25
26
28
30
38
40
42
50
52
54
62
72
78
80
82
84
88
90

Fig. 1

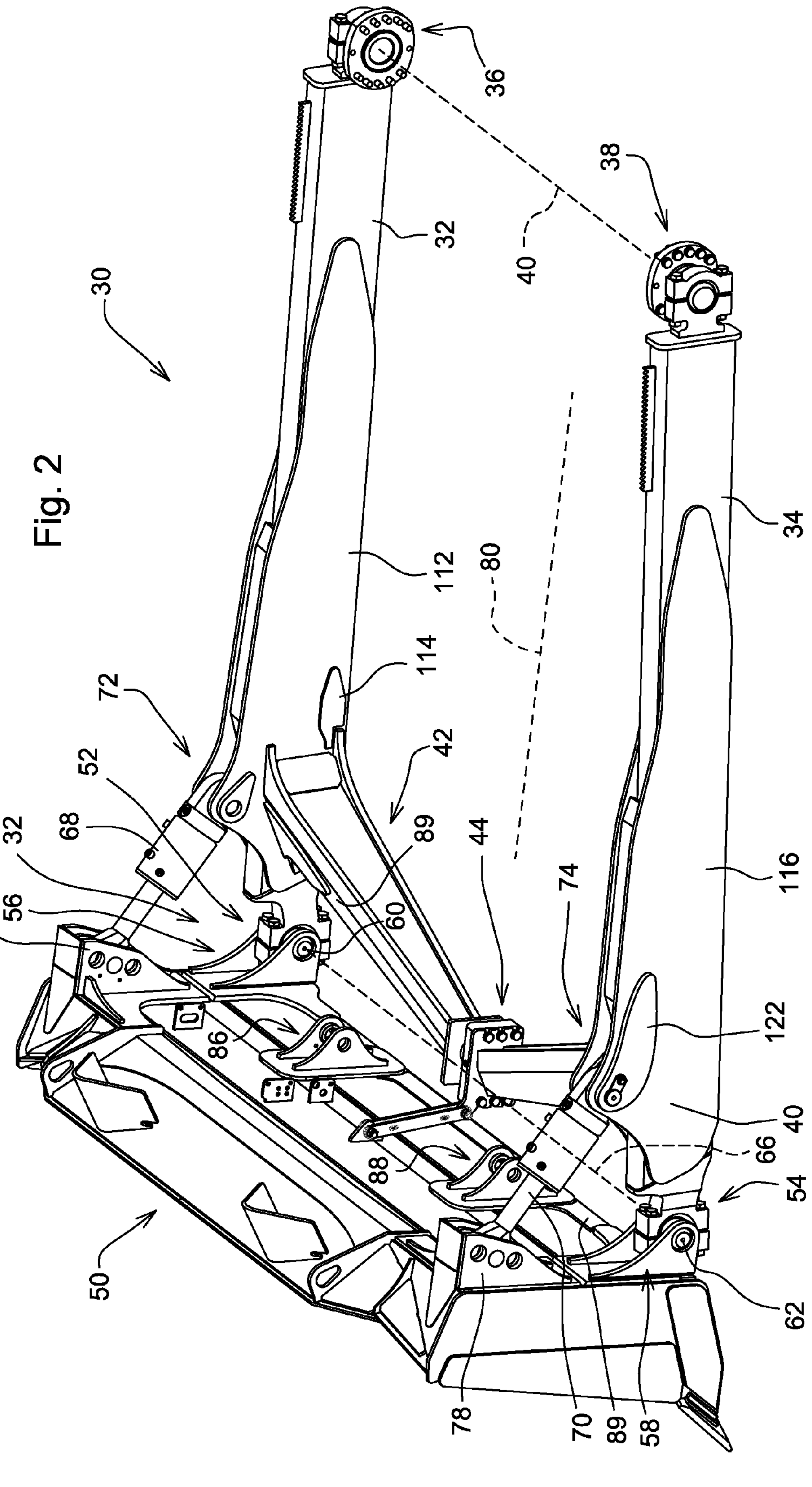

30
36
38
32
40
34
112
80
114
72
52
68
42
89
76
32
56
60
44
74
116
86
122
40
66
88
54
50
62
78
70
89
58

Fig. 2

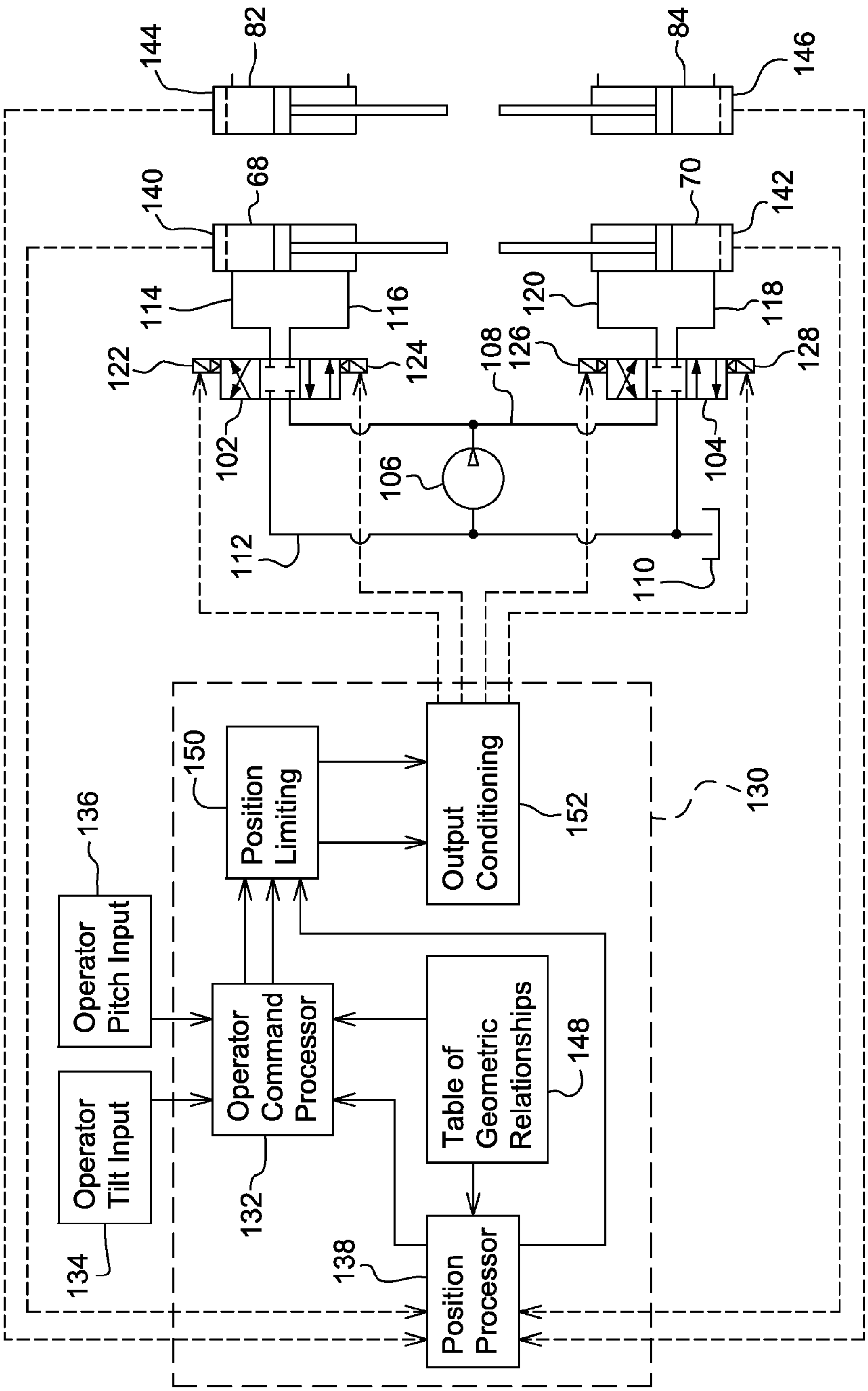

Operator Tilt Input
Operator Pitch Input
Operator Command Processor
Table of Geometric Relationships
Position Processor
Position Limiting
Output Conditioning
100
130
132
134
136
138
148
150
152
102
104
106
108
110
112
114
116
118
120
122
124
126
128
140
142
144
146
68
70
82
84

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 3184869 A **[0003]**
- US 5996703 A **[0003]**