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(72) Inventeur/Inventor:
KAYE, BRETT JAMES, NZ

(73) Propriétaire/Owner:
WARATAH NZ LIMITED, NZ

(74) Agent: BORDEN LADNER GERVAIS LLP

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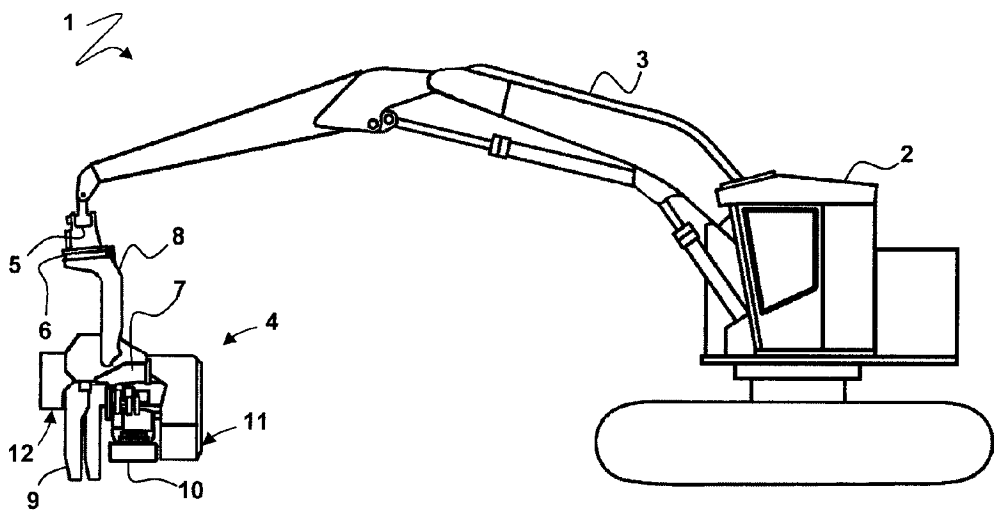


(57) Abrégé/Abstract:
A timber-working head and method of operation are provided. The head has a frame to which first and second arms are pivotally connected. Respective linear drive actuators pivot the respective arms relative to the frame to open and close them. At least one processor controls application of pressure by the linear drive actuators such that the arms grasp timber to be processed by the head. The position of the linear actuators is used to determine whether the the timber is offset from a feed axis of the frame beyond a predetermined distance, and the application of pressure by one of the linear actuators to reduce the offset to be within the predetermined distance.

ABSTRACT

A timber-working head and method of operation are provided. The head has a frame to which first and second arms are pivotally connected. Respective linear drive actuators pivot the respective arms relative to the frame to open and close them. At least one processor controls application of pressure by the linear drive actuators such that the arms grasp timber to be processed by the head. The position of the linear actuators is used to determine whether the the timber is offset from a feed axis of the frame beyond a predetermined distance, and the application of pressure by one of the linear actuators to reduce the offset to be within the predetermined distance.

A TIMBER-WORKING HEAD AND METHOD OF OPERATION

TECHNICAL FIELD

The present invention relates to a timber-working head, and more particularly to a system and method for controlling pivoting arms of a timber-working head.

BACKGROUND

It is well-known to mount a timber-working head, for example in the form of a harvesting head, to a forestry work machine to perform a number of functions in connection with timber. Such heads may be used to grapple and fell a standing tree and process the felled tree by delimbing, possibly debarking (depending on the configuration of the head), and cutting the stem of the tree into logs of predetermined length.

Processing the felled tree typically involves feeding the resulting stem along its length relative to the head using a feed mechanism. One well known system uses arm mounted hydraulic rotary drives having a feed wheel at the end of each arm. The arms may be driven by hydraulic cylinders to pivot relative to the frame of the head in order to grapple the stem with the feed wheels, which may then be driven in the desired direction. In order to ensure that the stem is firmly grasped in the desired centre position, a mechanical link between the arms is used so they open and close together.

However, the stems processed by the harvester head may be ill-formed, for example having sweep (i.e. variation in the axial linearity of the stem) or other contour irregularities (e.g. bulges, depressions, lack of circularity). In such cases the fixed relationship of the arms relative to each other means that one feed wheel may have a different degree of contact with the stem surface than the other, impacting on traction. This can cause hydraulic oil to bypass, leading to one wheel slipping and spinning - causing less than optimal feed performance and potentially damage to the stem by the slipping wheel ripping into the surface. There can also be further ramifications in terms of damage to the motors themselves as the result of this slipping and motor cavitation.

The mechanical link also adds weight and complexity to the harvester - particularly in the steel support frame and pins required for pivotal connection - which in turns adds to the cost of manufacture. These also create potential points of mechanical failure, particularly where ill-formed stems lead to an imbalance of forces being applied to the two arms - essentially attempting to rip them apart. As the operation of the feed arms is a crucial component of many, if not all, of the functions of a harvester head, time required to repair the link may reduce the productivity of the forestry work machine.

No admission is made that any reference cited in the application constitutes prior art. The discussion of the reference states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents forms parts of the common general knowledge in the art, in New Zealand or in any other country.

Throughout this specification, the word "comprise" or "include", or variations thereof such as " "comprises", "includes", "comprising", or "including" will be understood to imply the inclusion of a stated element, integer or step, or group of elements integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

SUMMARY

According to an embodiment of the present invention there is provided a timber-working head, including:

a frame;

a first arm and a second arm, the first and second arms pivotally connected to the frame, wherein pivotal movement of the first arm is mechanically independent to pivotal movement of the second arm; and

a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, wherein the linear actuators are configured to pivot the respective arms relative to the frame to open and close them.

According to another embodiment of the present invention there is provided a timber-working head, including:

a frame;

a first arm and a second arm, the first and second arms pivotally connected to the frame;

a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, wherein the linear actuators are configured to pivot the respective arms relative to the frame to open and close them; and

at least one processor configured to:

control application of pressure by the first and second linear drive actuators such that the arms grasp timber to be processed by the head;

determine whether the position of the linear actuators indicates that the timber is offset from a feed axis of the frame beyond a predetermined distance; and

control application of pressure by either the first linear actuator or the second linear actuator to reduce the offset to be within the predetermined distance.

According to another embodiment of the present invention there is provided a method of operating a timber-working head including a frame, a first arm and a second arm pivotally connected to the frame, and a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, the method including:

applying pressure by the first and second linear drive actuators such that the arms grasp timber to be processed by the head;

determining whether the position of the linear actuators indicates that the timber is offset from a feed axis of the frame beyond a predetermined distance; and

controlling pressure applied by either the first linear actuator or the second linear actuator to reduce the offset to be within the predetermined distance.

According to an exemplary embodiment of the invention there is provided an electronic control device for a timber-working head including a frame, a first arm and a second arm pivotally connected to the frame, and a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, the control device including:

at least one processor configured to:

control application of pressure by the first and second linear drive actuators such that the arms grasp timber to be processed by the head;

determine whether the position of the linear actuators indicates that the timber is offset from a feed axis of the frame beyond a predetermined distance; and

control application of pressure by either the first linear actuator or the second linear actuator to reduce the offset to be within the predetermined distance.

According to another exemplary embodiment there is provided an article of manufacture having computer storage medium storing computer readable program code executable by a computer to implement a method for operating a timber-working head including a frame, a first arm and a second arm pivotally connected to the frame, and a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, the code including:

computer readable program code applying pressure to the first and second linear drive actuators such that the arms grasp timber to be processed by the head;

computer readable program code determining whether the position of the linear actuators indicates that the timber is offset from a feed axis of the frame beyond a predetermined distance; and

computer readable program code controlling pressure applied to either the first linear actuator or the second linear actuator to reduce the offset to be within the predetermined distance.

In an exemplary embodiment the timber-working head may a harvester head, and may be referred to as such throughout the specification. Harvester heads typically have the capacity to grapple and fell a standing tree, delimb and/or debark a felled stem, and cut the stem into logs. However, a person skilled in the art should appreciate that the present invention may be used with other timber-working heads, for example a feller buncher, debarking and/or delimbing head, disc saw head, saw grapple, and so on – and that reference to the timber-working head being a harvester head is not intended to be limiting.

As such, in an exemplary embodiment the arms may be feed arms, each including a feed wheel configured to be brought in contact with timber. The feed wheels may each be connected to a rotary drive such that they may be used to feed the timber along a feed axis of the head. However, it should be appreciated that the present invention may be applied to other arms of the timber-working head, for example delimb arms.

In an exemplary embodiment, pivotal movement of the first arm may be mechanically independent to pivotal movement of the second arm. Reference to the pivotal movement of the arms being mechanically independent should be understood to mean the absence of a physical link causing one arm to pivot relative to the frame when corresponding pivotal movement of the other arm occurs. It may be said that the arms can pivot independent of one another, although it should be appreciated that control of each arm may be influenced by movement of the other.

In an exemplary embodiment the linear drive actuators may be hydraulically driven. Reference will herein be made throughout the specification to the linear actuator being a hydraulic cylinder, however is should be appreciated that other actuator types – for example electric or pneumatic – may be used in embodiments of the invention.

In an exemplary embodiment each of the first and second drive cylinders may be configured to output a signal indicative of the position of the cylinder. Reference to the position of the cylinder should be understood to mean the position of a point on the cylinder which may be used to determine the degree to which the cylinder is extended. For example, the cylinder may include a linear position sensor. Various technologies for sensing linear position are known in the art – for example operating using magnetostrictive principles, or Hall-Effect.

In an exemplary embodiment the timber-working head may include a controller configured to control operation of the first and second cylinders. In particular, it is envisaged that the controller may be configured to control pressure applied by the first and second linear actuators.

The controller may be configured to initially control pressure applied by the first and second linear actuators to be equal on receiving a command signal from an operator to close the arms. In doing so, it is envisaged that the arms may "float" – pressing against the surface of the timber, but being permitted to independently move inwardly or outwardly to maintain contact with the surface to account for irregularities which may be unequal between the sides of the timber.

The controller may be configured to control operation of the cylinders based on their respective positions. In an exemplary embodiment it is envisaged that the controller may be configured to control the pressure applied by one of the cylinders based on the position of the linear actuators indicating that a stem held between the arms is offset from a feed axis of the frame beyond a predetermined distance.

While it may be useful to allow independent movement of the arms to allow for irregularities in the profile of the timber, it may also be desirable to maintain the lateral position of the stem within certain limits relative to the feed axis of the timber-working head. In particular, it may be desirable for the stem to be held roughly centre in order to align it with delimbing blades, and maintain maximum traction by the feed wheels. Further, it may be desirable for the stem to be held such the saw may perform a cut at a substantially 90 degree angle. As the length measurement is taken from the shortest side of a cut log, achieving a square cut may assist in maximising the value of the log cut.

It should be appreciated that the predetermined distance may vary between different configurations of timber-working heads, particularly with regard to the dimensions of the heads themselves and the diameter of timber expected to be processed. Movement of the stem may generally limited by the harvester body itself. Control of the travel within this may account for maintaining a minimum gap between the harvester and the stem to reduce the likelihood of the stem grating against the side and potentially causing damage to the stem and/or harvester. Variation in the stem due to sweep or other contour irregularities may also be taken into consideration.

In an exemplary embodiment the controller may be that used to control other functions of the timber-working head. However, it should be appreciated that the controller may be one dedicated to performance of the present invention and in communication with a control module configured to control general operation of the head.

The various steps or acts in a method or process may be performed in the order shown, or may be performed in another order. Additionally, one or more process or method steps may be omitted or one or more process or method steps may be added to the methods and processes. An additional step, block, or action may be added in the beginning, end, or intervening existing elements of the methods and processes.

The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented by a programmed processor executing instructions stored in memory. The functions, acts or tasks are independent of the particular type of instructions set, storage media, processor or processing strategy and may be performed by software, hardware, integrated circuits, firm-ware, micro-code and the like, operating alone or in combination.

The memory may include computer-readable media. The term “computer-readable medium” may include a single medium or multiple media, such as a centralized or distributed database, and/or associated caches and servers that store one or more sets of instructions. The term “computer-readable medium” may also include any medium that is capable of storing, encoding or carrying a set of instructions for execution by a processor or that cause a computer system to perform any one or more of the methods or operations disclosed herein. The “computer-readable medium” may be non-transitory, and may be tangible.

It should be appreciated that in exemplary embodiments one or more dedicated hardware implementations, such as application specific integrated circuits, programmable logic arrays and other hardware devices, can be constructed to implement one or more of the methods described herein. One or more embodiments described herein may implement functions using two or more specific interconnected hardware modules or devices with related control and data signals that can be communicated between and through the modules, or as portions of an application-specific integrated circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention may be better understood with reference to the following description and accompanying drawings, which are given by way of example only:

FIG. 1 is a side view of an exemplary forestry work machine including an exemplary timber-working head according to one embodiment of the present invention;

FIG. 2 is an end perspective view of a prior art feed arm system;

FIG. 3 is an end perspective view of an exemplary feed arm system;

FIG. 4 is a block diagram of an exemplary control system for controlling operation of an exemplary timber-working head;

FIG. 5 is a front elevation view of an exemplary timber-working head, and

FIG. 6 is a flow diagram illustrating an exemplary method of controlling an exemplary timber-working head.

DETAILED DESCRIPTION

FIG. 1 illustrates an exemplary forestry work machine (generally indicated by arrow **1**) including a carrier **2** supporting an articulated boom **3**. An exemplary timber working implement in the form of a harvester head **4** is connected to an end of the boom **3**, using a dog-bone joint **5** connected to a rotator **6**, which is in turn connected to a frame **7** of the head **4** by hanger **8**. In operation, the head **4** may swivel relative to the end of the boom **3** about the rotator **6**, and pivotally move about its connection to the hanger **8** between a generally upright, harvesting position for felling a tree (not illustrated) and a generally prone, processing position (as illustrated) for processing the felled tree (e.g., delimbing, debarking, cutting to length).

The harvester head **4** includes a pair of grapple or delimbing arms **9** pivotally connected to the frame **7** and configured to grasp the stem of the tree. The head **4** also includes a pair of feed arms **10** pivotally connected to the frame **7** and including feed wheels configured to control the longitudinal position of the tree relative to the head **4**. The harvester head **4** also includes a main chain saw at the end marked by arrow **11**, and a topping chain saw at the end marked by arrow **12**.

The machine **1**, particularly harvester head **4**, may be controlled by an operator (not illustrated) using hand and foot controls as known in the art. A controller (such as that described with reference to FIG. 4) controls operation of the harvester head **4** in response to data or signals received from various components of the harvester head **4** and in conjunction with the operator input devices.

FIG. 2 illustrates a prior art feed arm system **200** for a harvester head (such as harvester head **4** illustrated in FIG. 1). The system **200** includes a left-hand (LH) feed arm **201** and a right-hand (RH) feed arm **202**. The feed arms **201**, **202** are pivotally connected to the frame (not illustrated) by pins **203** and **204** respectively, such that the arms **201**, **202** may be rotated to bring feed wheels **205** and **206** into contact with a tree stem **207**.

Movement of the arms **201**, **202** is driven by hydraulic cylinders **208** and **209** respectively. Each cylinder **208**, **209** is connected to the frame by pins **210** and **211** respectively, and the arms **201**, **202** by pins **212** and **213** respectively.

The arms **201**, **202** are mechanically connected by a timing link **214** between LH ear **215** and RH pin **216**. The arms **201**, **202** cannot rotate about pins **203**, **204** without affecting movement of the other arm due to the timing link **214**. The timing link **214** means that any movement by LH arm **201** towards or away from vertical centreline **217** will encourage the mirror movement by RH arm **202**. As such, where the stem **207** is irregular in profile, one feed wheel **205**, **206** will have greater contact with the stem **207** than the other. This unequal application of force may shift the stem away from the feed axis (not illustrated, but perpendicular to vertical centreline **217**) of the harvester head.

FIG. 3 illustrates an exemplary feed arm system **300** according to one aspect of the present invention. The system **300** includes a left-hand (LH) feed arm **301** and a right-hand (RH) feed arm **302**. The feed arms **301**, **302** are pivotally connected to the frame (not illustrated) by pins **303** and **304** respectively, such that the arms **301**, **302** may be rotated to bring feed wheels **305** and **306** into contact with a tree stem **307**.

Movement of the arms **301**, **302** is driven by LH and RH hydraulic cylinders **308** and **309** respectively. Each cylinder **308**, **309** is connected to the frame by pins **310** and **311** respectively, and the arms **301**, **302** by pins **312** and **313** respectively. Extension and retraction of the cylinders **308**, **309** through the control of hydraulic pressure supplied to the respective cylinders **308**, **309** pivots the arms **301**, **302** about pins **312**, **313**. The cylinders **308**, **309** are each configured to output a signal indicating the position of each cylinder in terms of its extension.

The pivotal movement of each of the arms **301**, **302** is mechanically independent to that of the other arm **301**, **302**. Unlike the prior art feed arm system **200**, there is no timing link connecting the arms **301**, **302** to prevent independent rotation about pins **303**, **304** without affecting movement of the other arm due to the timing link **214**.

FIG. 4 illustrates an exemplary control system **400** for feed arm system **300**. The control system includes a first position sensor **401** and a second position sensor **402** associated with hydraulic cylinders **308** and **309** respectively. These sensors **401**, **402** are configured to output a signal indicative of the position, or extension of the cylinders **308**, **309**. It should be appreciated that the sensors **401**, **402** may be integrated into the structure of the cylinders **308**, **309**, whether internally or externally.

The signals are communicated to a controller **403**. The controller **403** includes a data processor **404** which may access a look-up table, or apply an algorithm, to determine the respective positions of the cylinders **308**, **309** from the signals. The controller **403** is also in communication with a data storage device **405** and manages the storage, retrieval or access of reference data **406** stored thereon. A pressure adjustment module **407** of the controller **403** may respond to position data received from the cylinders **308**, **309** to control their operation, as will be described further below with reference to FIG. 6. It should be appreciated that reference to the controller **403** performing certain tasks may include those performed by the processor **404** and/or pressure adjustment module **407**.

A hydraulic control module **409** is in communication with the controller **403**, and is configured to control the delivery of hydraulic fluid to the cylinders **308**, **309**. It should be appreciated that the hydraulic control module **409** may include any suitable means known in the art for controlling hydraulic fluid flow, for example solenoids, relays, servo-motors in combination with some form of valve. The hydraulic control module **409** may be a centralised unit, or include components located at the cylinders **308**, **309** themselves. It should be appreciated that reference to the controller **403** controlling operation of the cylinders **308**, **309** may include operations performed by the hydraulic control module **409**, although explicit reference to this may not be made.

The controller **403** is also in communication with a user interface **408**. The user interface **408** may include a number of user input devices such as hand and foot controls and a touch screen as known in the art for controlling operation of a timber-working head including the feed arm system **300**. It should be appreciated that while the exemplary controller **403** is illustrated as a single device, this is not intended to be limiting and the functions described may be shared over multiple devices – for example, a first controller associated with the vehicle to which the head is connected, communicating with a second controller associated with the head over a communications bus.

Referring to FIG. 5, the feed arm system **300** is illustrated in the context of an exemplary timber-working head in the form of harvester head **500**, having a frame **501** to which the feed arm system **300** is connected. The pressure of cylinders (not illustrated) may be independently controlled to have the feed wheels **305**, **306** maintain contact with a stem (not illustrated) held between them, while maintaining a desired lateral position of the stem relative to feed axis **502** of the head **500**. Along the feed axis **502** the head **500** includes a drive wheel **503** for use in feeding the stem along the feed axis **502**, and a toothed measuring wheel (not illustrated) used to measure the length of the stem and its position relative to the head **500** (in particular main chainsaw **504** and topping saw **505**).

FIG. 6 illustrates an exemplary method **600** by which operation of harvester head **500**, and in particular feed arm system **300**, may be controlled.

In step **601**, the controller **403** receives a command from user interface **408** to activate the feed arm system **300** to cause a stem to be grasped by the feed arms **301**, **302**.

In step **602** the controller **403** causes equal hydraulic pressure to be applied to both cylinders **308**, **309**, in turn causing the feed arms **301**, **302** to pivot inwardly.

In step **603** the controller **403** receives signals from the position sensors **401**, **402** and processes these in combination with previously stored position data to determine whether either or both of the cylinders **308**, **309** are currently moving. If there is movement, the method proceeds to step **604**, otherwise the method continues with step **612**.

In step **604**, the controller **403** determines whether the position of the LH cylinder **301** is ahead of the position of the RH cylinder **302** by a distance greater than a predetermined value, for example 10 mm. It should be appreciated that this value may be dependent on a number of factors, for example the dimensions of various components of the head **500** including the saws **505** and **506**.

If the LH cylinder **301** is ahead of the RH cylinder **302** beyond the predetermined distance, this indicates that the stem being processed is off centre from the feed axis **502** to an undesired extent, and the method proceeds to step **605**. If not, the method continues with step **608**. In step **605**, the controller **403** determines whether the pressure setpoint of the RH cylinder **309** is at a maximum. If so, the setpoint of the LH cylinder **308** is reduced in step **606**, and the resulting reduced pressure differential with the RH cylinder **309** causes the RH feed arm **302** to act against the stem to bring it closer to the feed axis **502**. If the pressure setpoint of the RH cylinder **309** is not at maximum, the setpoint of the RH cylinder **309** is increased in step **607** to achieve the same effect. It should be appreciated that control loop feedback, such as PID control, may be used to ramp the accelerations or decelerations for each arm.

Once steps **606** or **607** have been performed, the method may return to step **603** – unless interrupted by a command received from the operator to release the stem.

In step **608**, a similar routine is followed if the RH cylinder **309** is ahead of the LH cylinder **308** is beyond the predetermined distance, and the method proceeds to step **609**. If not, the method continues with step **612**. In step **609**, the controller **403** determines whether the pressure setpoint of the LH cylinder **308** is at a maximum. If so, the setpoint of the RH cylinder **309** is reduced in step **610**, and the resulting reduced pressure differential with the LH cylinder **308** causes the LH feed arm **301** to act against the stem to bring it closer to the feed axis **502**. If the pressure setpoint of the LH cylinder **308** is not at maximum, the setpoint of the LH cylinder **308** is increased in step **611** to achieve the same effect. Once steps **610** or **611** have been performed, the method may return to step **603** – unless interrupted by a command received from the operator to release the stem.

If no movement is detected in step **603**, or if the RH cylinder **309** is not ahead of the LH cylinder **308** by the predetermined distance, the method continues in step **612** where the controller **403** determines whether the pressure setpoint of each cylinder **308**, **309** is equal. If they are, the method returns to step **603** – unless interrupted by a command received from the operator to release the stem.

If the setpoints are not the same, in step **613** the controller **403** determines whether the LH cylinder **308** setpoint is greater than the RH cylinder **309** setpoint. If it is the method proceeds to step **614**, where the LH cylinder **308** setpoint is adjusted to be the same as the RH cylinder **309** setpoint. Conversely, if the LH cylinder **308** setpoint is less than the RH cylinder **309** setpoint the method proceeds to step **615**, where the RH cylinder **309** setpoint is adjusted to be the same as the LH cylinder **308** setpoint. Once steps **614** or **615** have been performed, the method returns to step **603** – unless interrupted by a command received from the operator to release the stem.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof as defined in the appended claims.

CLAIMS:

1. A timber-working head, including:

a frame having a feed axis between a first side of the frame and a second side of the frame;

a first arm at the first side of the frame and a second arm at the second side of the frame, the first arm and the second arm being pivotally connected to the frame;

a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, wherein the first linear drive actuator and the second linear drive actuator are configured to pivot the first arm and the second arm relative to the frame to open and close the first arm and the second arm; and

at least one processor configured to:

control application of pressure by the first linear drive actuator and the second linear drive actuator such that the first arm and the second arm grasp a stem of a tree to be processed by the head;

determine whether a position of the first linear drive actuator and the second linear drive actuator indicates that the stem is offset from the feed axis of the frame closer to one of the first side of the frame and the second side of the frame beyond a predetermined distance; and

control application of pressure by either the first linear drive actuator or the second linear drive actuator to reduce the offset to be within the predetermined distance.

2. A timber-working head as claimed in claim 1, wherein the first linear drive actuator is configured to output a first signal indicative of the position of the first linear drive actuator to the processor, and the second linear drive actuator is configured to output a second signal indicative of the position of the second linear drive actuator to the processor.

3. A timber-working head as claimed in claim 1 or claim 2, wherein the processor is configured to initially control pressure applied by the first linear drive actuator and the second linear drive actuator to be equal.

4. A timber-working head as claimed in any one of claims 1 to 3, wherein the first arm and second arm each include a feed wheel.

5. A method of operating a timber-working head including a frame having a feed axis between a first side of the frame and a second side of the frame, a first arm at the first side of the frame and a

second arm at the second side of the frame, the first arm and the second arm being pivotally connected to the frame, and a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, the method including:

applying pressure by the first linear drive actuator and the second linear drive actuator such that the first arm and the second arm grasp a stem of a tree to be processed by the head;

determining whether a position of the first linear drive actuator and the second linear drive actuator indicates that the stem is offset from the feed axis of the frame closer to one of the first side of the frame and the second side of the frame beyond a predetermined distance; and

independently controlling pressure applied by either the first linear drive actuator or the second linear drive actuator to reduce the offset to be within the predetermined distance.

6. A method as claimed in claim 5, wherein equal pressure is initially applied by the first linear drive actuator and the second linear drive actuator.

7. An electronic control device for a timber-working head including a frame having a feed axis between a first side of the frame and a second side of the frame, a first arm at the first side of the frame and a second arm at the second side of the frame, the first arm and the second arm being pivotally connected to the frame, and a first linear drive actuator connected to the first arm, and a second linear drive actuator connected to the second arm, the control device including:

at least one processor configured to:

control application of pressure by the first linear drive actuator and the second linear drive actuator such that the first arm and the second arm grasp a stem of a tree to be processed by the head;

determine whether a position of the first linear drive actuator and the second linear drive actuator indicates that the stem is offset from the feed axis of the frame closer to one of the first side of the frame and the second side of the frame beyond a predetermined distance; and

control application of pressure by either the first linear drive actuator or the second linear drive actuator to reduce the offset to be within the predetermined distance.

8. An article of manufacture having computer storage medium storing computer readable program code executable by a computer to implement a method for operating a timber-working head including a frame having a feed axis between a first side of the frame and a second side of the frame, a first arm at the first side of the frame and a second arm at the second side of the frame, the first arm and the second arm being pivotally connected to the frame, and a first linear drive actuator

connected to the first arm, and a second linear drive actuator connected to the second arm, the code including:

computer readable program code applying pressure to the first linear drive actuator and the second linear drive actuator such that the first arm and the second arm grasp a stem of a tree to be processed by the head;

computer readable program code determining whether a position of the first linear drive actuator and the second linear drive actuator indicates that the stem is offset from the feed axis of the frame closer to one of the first side of the frame and the second side of the frame beyond a predetermined distance; and

computer readable program code controlling pressure applied to either the first linear drive actuator or the second linear drive actuator to reduce the offset to be within the predetermined distance.

FIG. 1

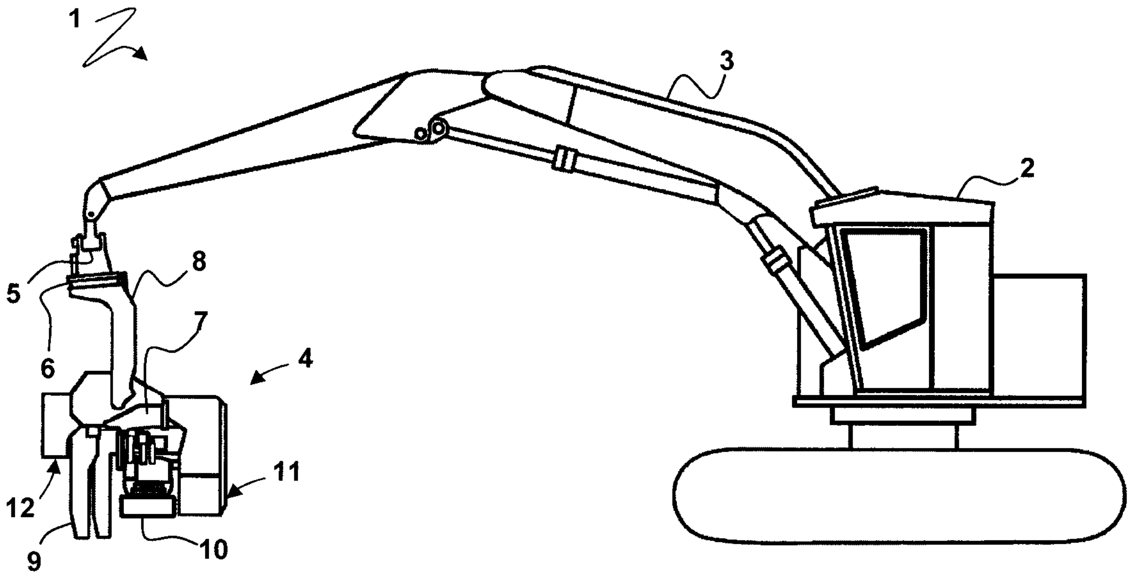
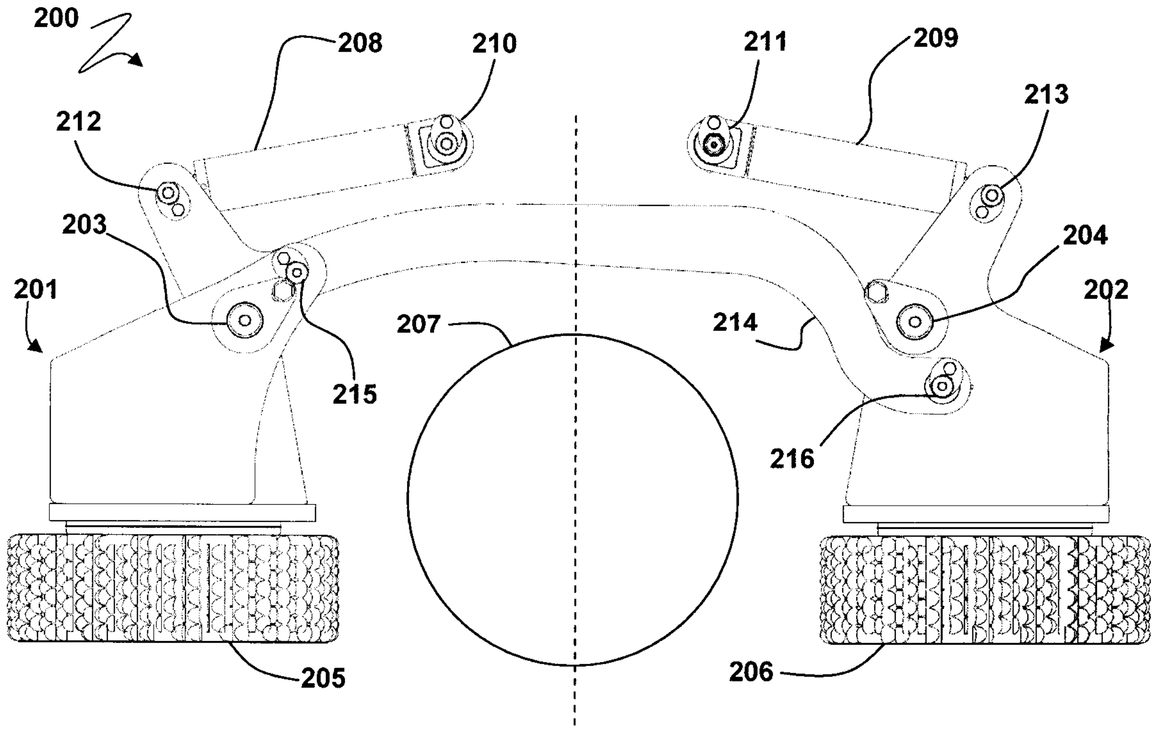


FIG. 2



PRIOR ART

FIG. 3

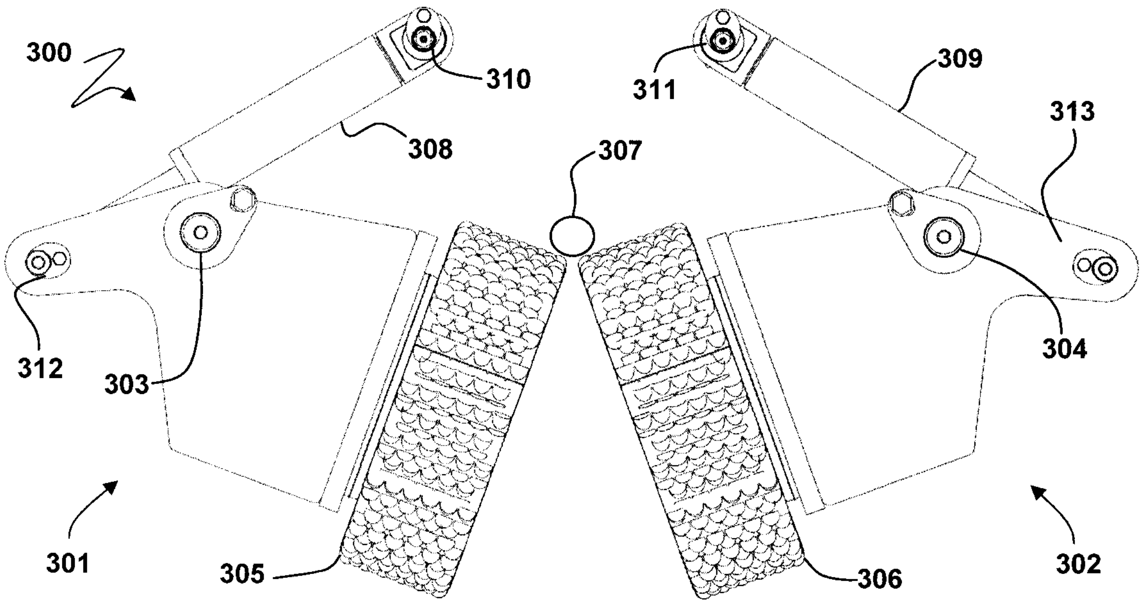

300
310
311
309
308
307
313
312
303
304
301
305
306
302

FIG. 4

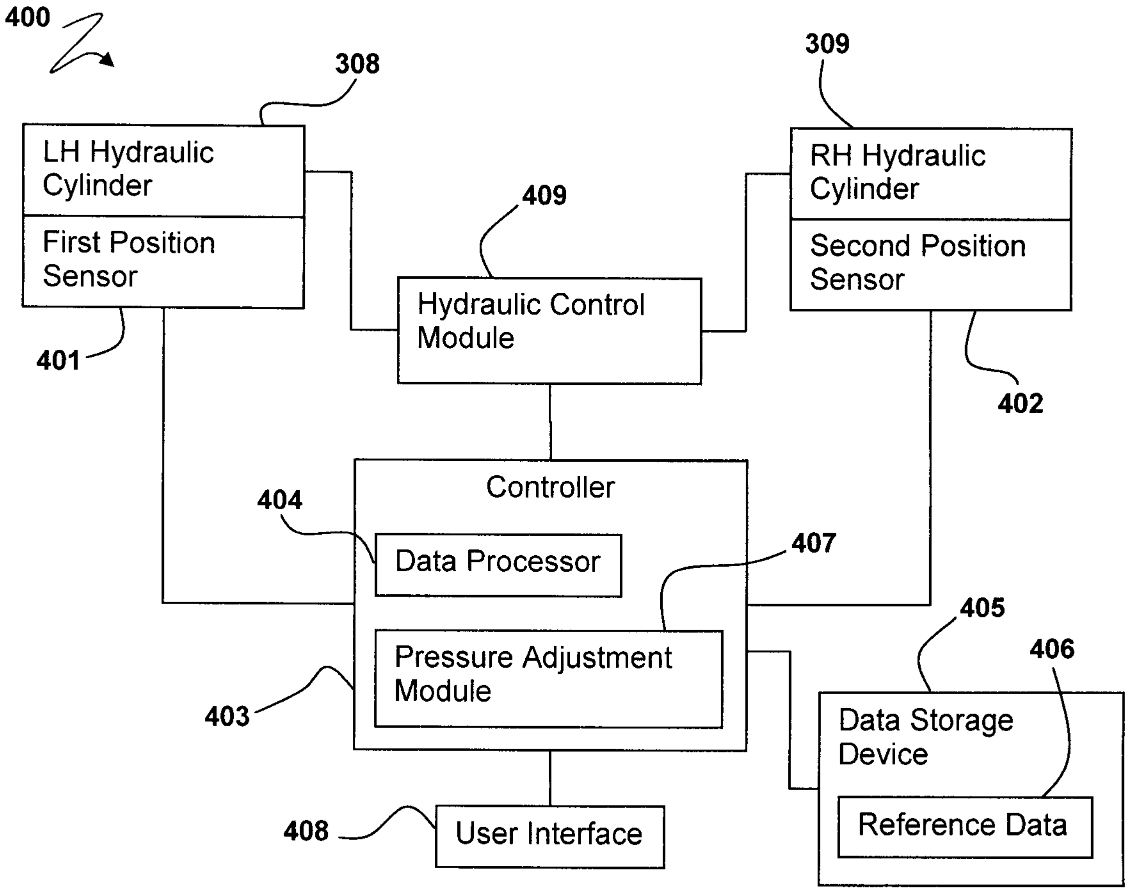
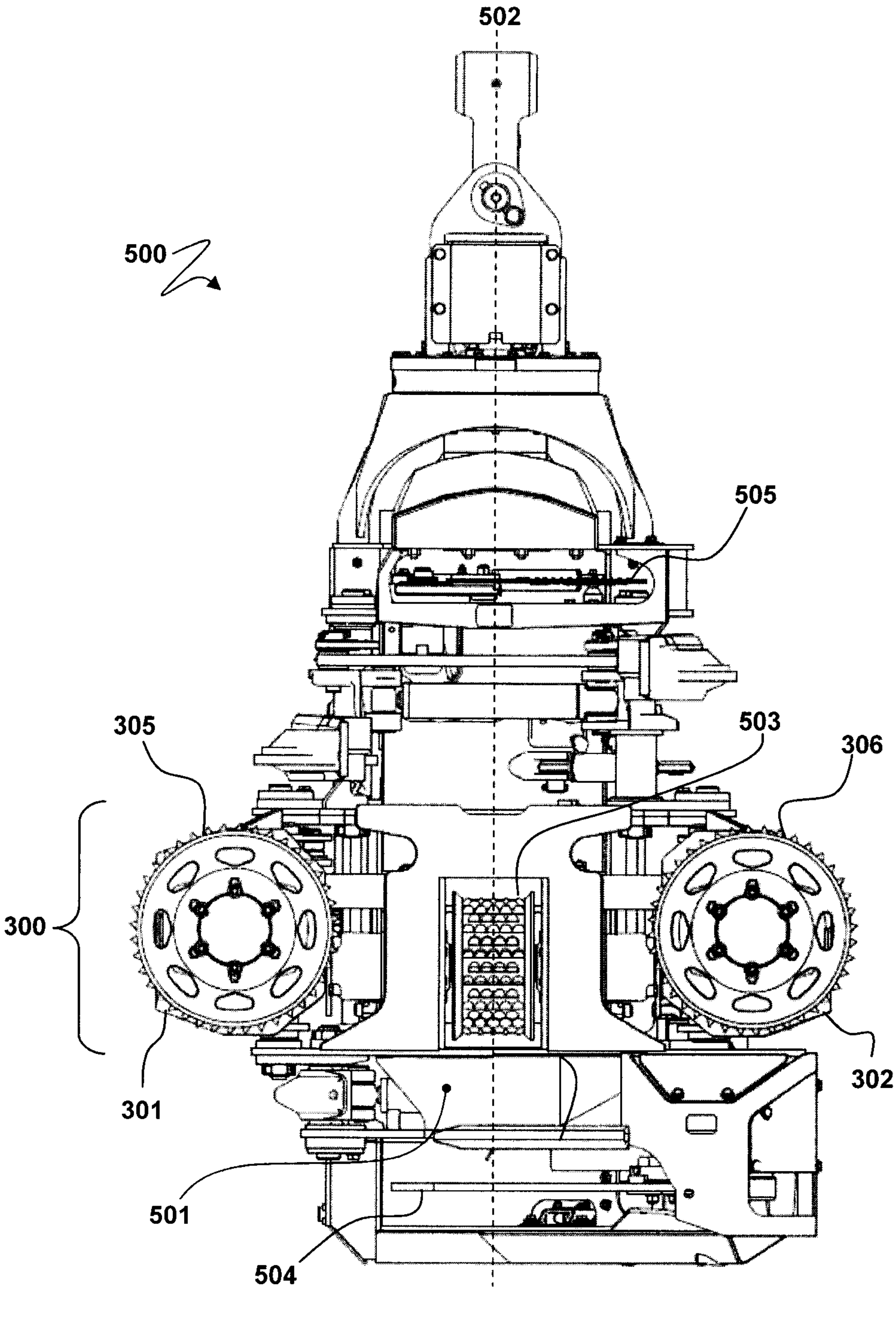

400
308
309
LH Hydraulic Cylinder
First Position Sensor
409
RH Hydraulic Cylinder
Second Position Sensor
Hydraulic Control Module
401
402
Controller
404
Data Processor
407
405
406
Pressure Adjustment Module
403
Data Storage Device
Reference Data
408
User Interface

FIG. 5



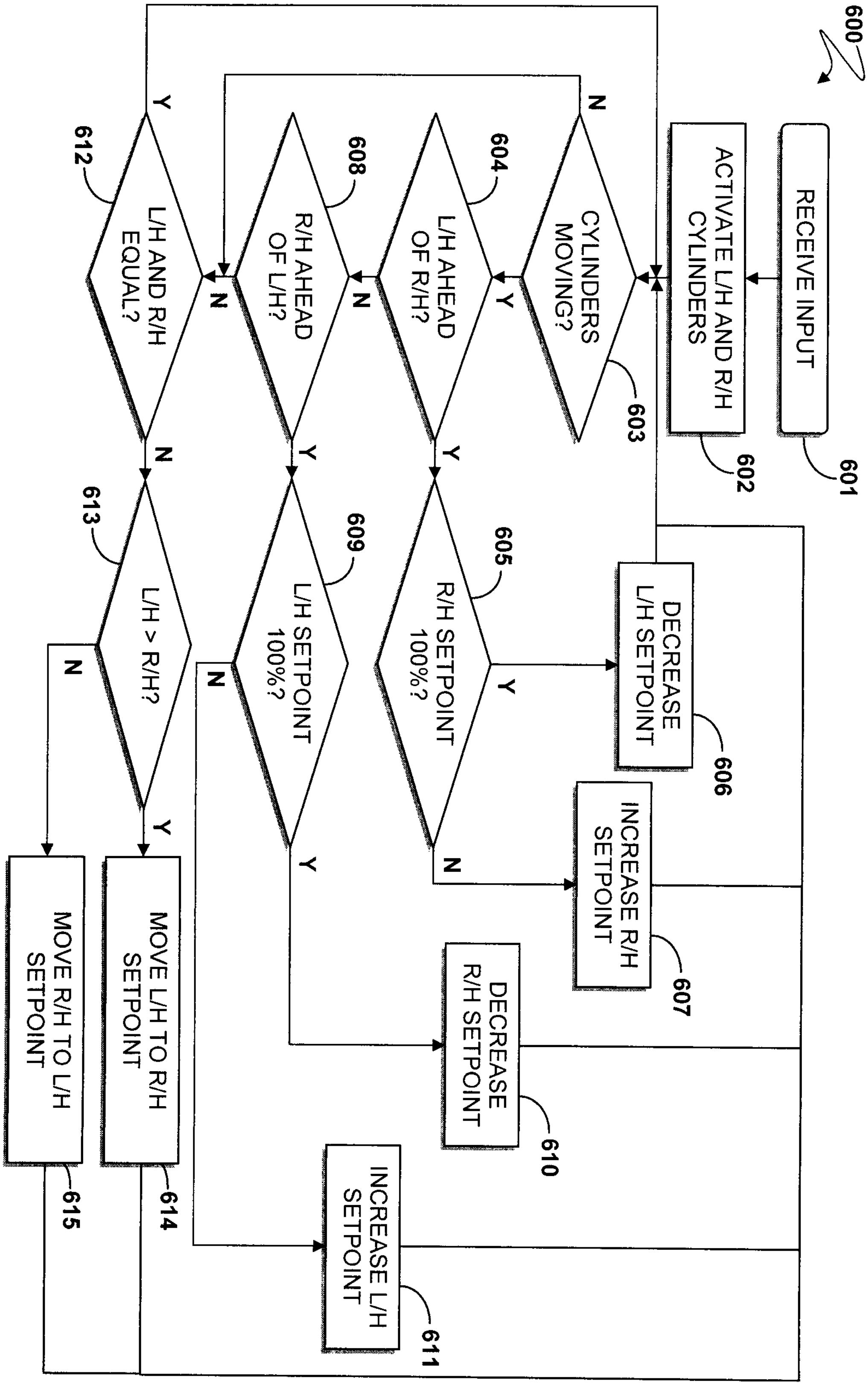
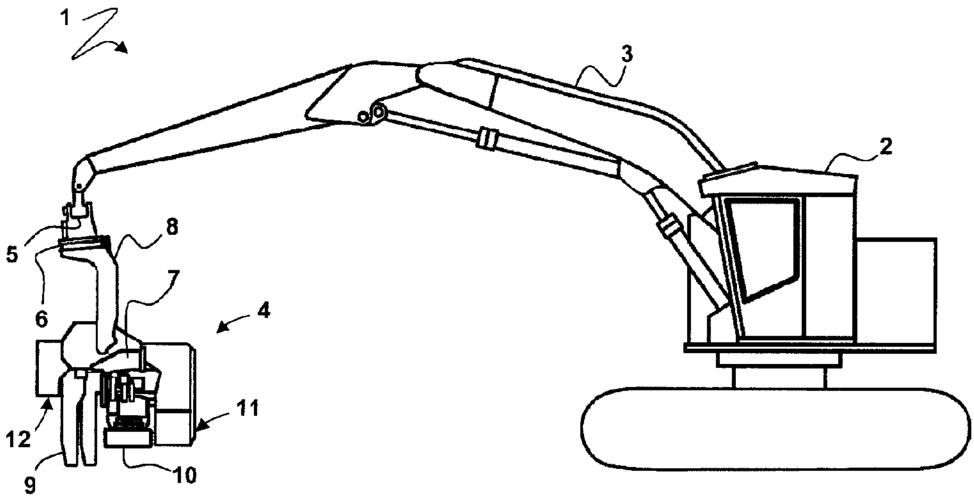

600
RECEIVE INPUT
601
ACTIVATE L/H AND R/H CYLINDERS
602
CYLINDERS MOVING?
603
N
Y
L/H AHEAD OF R/H?
604
N
Y
R/H SETPOINT 100%?
605
Y
N
DECREASE L/H SETPOINT
606
INCREASE R/H SETPOINT
607
R/H AHEAD OF L/H?
608
N
Y
L/H SETPOINT 100%?
609
Y
N
DECREASE R/H SETPOINT
610
INCREASE L/H SETPOINT
611
L/H AND R/H EQUAL?
612
Y
N
L/H > R/H?
613
Y
N
MOVE L/H TO R/H SETPOINT
614
MOVE R/H TO L/H SETPOINT
615

FIG. 6


1
2
3
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5
6
7
8
9
10
11
12