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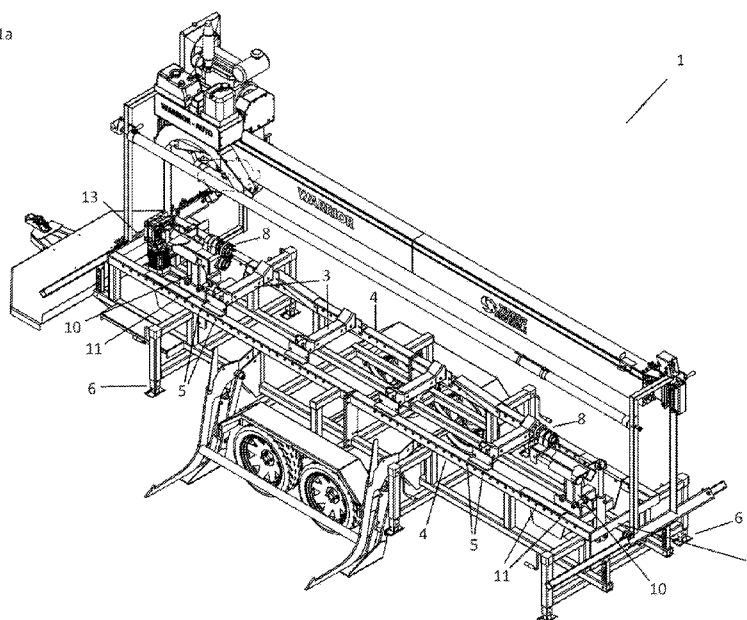
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(54) Title: MOBILE SAW MILL APPARATUS

Figure 1a



(57) Abstract: In one aspect the invention provides a mobile saw mill apparatus which includes a log deck configured to receive and locate a log to be milled. A log is secured by two rotatable mounting spikes, each being associated with opposite end of the log deck, and two lift assemblies each connecting a separate mounting spike to the log bed. These lift assemblies operation to move the log spikes towards and away from the log deck, and the log spikes can be rotated under the action at least one drive assembly which is operated by a programmable controller configured to issue control signals which control the degree to which a mounting spike and engaged log are rotated.



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MOBILE SAW MILL APPARATUS

Field of the Invention

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This invention relates to a mobile saw mill apparatus arranged to allow for automated rotation of a log during milling operations.

Background of the Invention

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Mobile saw mills have the potential to provide advantages in forestry environments, particularly when it may be difficult and costly to remove fallen trees to a remote saw mill installation. These types of mills can also be used to advantage where the desired end product lumbar is to be used in close proximity to the forest location.

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Most prior art mobile saw mills commonly mount a log on a static log deck and move a saw along the length of the log to cut lumber. This may be contrasted with static saw mill installations where the log is usually conveyed past a static saw.

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Mobile saw mills therefore require a log to be locked in place securely to a log deck, and this requirement places some restrictions on the form of cuts which can be made to the log. It is common for prior art mobile saw mills to only allow for through and through sawing of logs – where incremental cuts are made and actuated at the top, working down level by level to the bottom left over slab. The through and through method means the actual shape of the log will distort as the cuts are made. Every log has growth tension, some more than others. Ultimately meaning that the timber yielded from the log will not be of an accurate standard. Quite often the timber is significantly bowed. A way around this in part may be to re-skim the faces regularly before the dimensioned timber is removed, however this is only an attempt to prevent the problem.

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The need to fix the orientation of the log for a number of consecutive cuts dictates the overall characteristics and yield of lumber which can be obtained

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from a log. To the applicant's knowledge at present an operator of an existing mobile saw mill would need to manually adjust the orientation of a log between consecutive cuts of the saw to undertake saw milling operations other than those referenced above.

It would be of advantage to have improvements made to mobile saw mill technology which addressed the above limitations or at least provided the public with an alternative choice. In particular it would be of advantage to have an improved mobile saw mill apparatus which allowed for the accurate automated rotation and positioning of a log about its longitudinal axis during a milling operation. It would also be of advantage to have improvements over the prior art which allowed for the execution of a computer derived cut plan through computerised control of the degree of rotation applied to a log between each cut made to the log.

Disclosure of the Invention

According to one aspect of the present invention there is provided a mobile saw mill apparatus which includes

a log deck configured to receive and locate a log to be milled, and two rotatable mounting spikes, each being associated with opposite ends of the log deck and being configured to engage with an end of a log located by the log deck, and

two lift assemblies, each lift assembly being operable to adjust the relative position of at least one of the rotatable log spikes to a log received by the log deck, and

at least one drive assembly engaged with one or more rotatable mounting spike, said drive assembly or assemblies being operable to rotate a mounting spike and a log engaged with the mounting spike, and

a programmable controller connected to said at least one drive assembly and being configured to issue control signals to said drive assembly or assemblies which control the degree to which a mounting spike and engaged log are rotated.

According to a further aspect of the present invention there is provided a mobile saw mill apparatus substantially as described above which includes a saw blade movable along the length of the log deck wherein the saw blade is

configured to reciprocate along the length of the deck to make a plurality of cuts in a log engaged and held in a locked position by the rotatable mounting spikes.

- 5 According to yet another aspect of the present invention there is provided a mobile saw mill apparatus substantially as described above wherein the saw blade is formed by a rotatable disc blade.

10 According to a further aspect of the present invention there is provided a mobile saw mill apparatus substantially as described above wherein the saw blade is formed by a swing blade capable of adjusting the orientation of the plane of the blade relative to the longitudinal axis of a log engaged by the rotatable mounting spikes.

15 According to yet another aspect of the present invention there is provided a computer program product for milling a log using a mobile saw mill apparatus, the computer program product being stored on a non-transitory tangible computer readable medium and including instructions that when executed cause a programmable controller to:

- 20
- receive a minimum log diameter indication
 - receive an indication of the desired lumber characteristics to be produced by milling said log
 - determine a cut plan based on the received diameter indication and lumber characteristics
- 25
- issue at least one of a sequence of operational control signals to a drive assembly of a mobile saw mill apparatus to effect rotation of a log in accordance with the cut plan after each transit of a saw along substantially the length of the log deck of the mobile saw mill apparatus.

30 According to a further aspect of the present invention there is provided a computer program product substantially as described above wherein a cut plan is determined by dividing the effective volume of the log determined by the minimum log diameter information into a plurality of concentric rings

35 with the number of rings being dictated by the received lumber characteristics, and by dividing each ring into separate lumber components based on the received lumber characteristics.

The present invention is arranged to provide a mobile saw mill apparatus which incorporates a log deck. This log deck provides a support system to bear the weight of a log to be milled.

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In a preferred embodiment a log deck may be formed by a framework of beams which exhibit a self-centring characteristic. In such embodiments the log deck may define a central depression and utilise a gravity fed operation to allow a log to settle into this central depression.

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In a further preferred embodiment a central log centring depression may be formed in a log bed through the provision of at least one log centring support. Such a support may be deployed between two or more longitudinally orientated beams and can be sited substantially at right angles to these beams to traverse the width of the log deck. In various embodiments a log centring support may have a substantially 'U' or 'V' shaped form to provide the central depression used to centre centrally position logs loaded on to the log deck.

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In a further preferred embodiment a log centring support may have a movable connection to longitudinally orientated elements of the log deck, allowing this component to be positioned at various points along the length of the log deck. In various embodiments two or potentially more log centring supports may be provided in the construction of a log deck with this variable connection characteristic allowing the supports to be positioned appropriately within the deck.

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In a preferred embodiment a log deck may also incorporate two transverse end beams, each beam being supported by at least two height adjustable feet. These end beams can support loads applied to the intervening components of the log deck.

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In a preferred embodiment the invention may also co-operate with one or more centrally located levelling jacks. A levelling jack or jacks may be provided as a standalone separate component to the log deck and may be positioned underneath various regions of the log deck to support the weight of a log loaded onto the deck and accounting for sag correction. In a further

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preferred embodiment a levelling jack may be provided by a hydraulic jack assembly which can be raised to a desired height underneath the log deck to contact the underside of a log and assist in supporting the weight of the log.

- 5 The invention includes at least two rotatable mounting spikes deployed at opposite ends of the log deck. These spikes are configured to engage with a log by piercing the ends of the log.

10 In a preferred embodiment each rotatable mounting spike may be associated with a hydraulic cylinder drive which can be employed to force each spike into the end of a log, and also withdraw the spike from the remnants of the log after milling operations have concluded.

15 In a preferred embodiment the invention may include at least one log end measurement system. A log end measurement system may be deployed at one or potentially both ends of the log deck to provide an indication of the minimum diameter of a log supported by the deck. In a further preferred embodiment a log end measurement system may also be used to identify the centre of the log on the end of the log.

20 For example in one further preferred embodiment the invention may incorporate a single log end measurement system implemented by a laser rangefinder. These optical devices can be used to remotely identify the minimum or smallest width of a log. Those skilled in the art will however appreciate that other types of log end measurement systems may also be
25 utilised in conjunction with the present invention and reference to the provision of a single laser rangefinder at one end of the log deck should in no way be seen as limiting.

30 In a preferred embodiment the mobile saw mill apparatus may be provided with or in conjunction with a saw blade. This saw blade may be moved along the length of the log deck to complete milling operations, with the saw blade reciprocating back and forth along the deck to mill various lumber cuts from a log.

35 Those skilled in the art will appreciate that existing or conventional saw blades currently used with mobile saw mills may be employed in conjunction

with the present invention. However, in a preferred embodiment a rotatable disc blade may be provided in combination with the invention. In a further preferred embodiment a swing blade may be provided as a saw blade in conjunction with the invention. Swing blades are formed from a rotatable disc blade which has the capacity to pivot through a range of angles. For example, in some embodiments a swing blade may be provided with the invention which has the capacity to present the plane of the blade at a substantially horizontal angle to the longitudinal axis of a log, at a substantially vertical angle the same axis, or at a range of angles between these horizontal and vertical orientations.

In some embodiment the invention may include a saw blade with the plane of the blade orientated substantially perpendicular to the longitudinal axis of a log. In such embodiments the invention may also include a jig, where the jig controls the vertical position of the perpendicular saw blade as it travels along the log deck. In such embodiments the longitudinal travel rate of the perpendicular blade may be set to a consistent value while the blade follows the profile of the jig, allowing for a very complex shape to be spun true from the log.

In other embodiments the invention may include a belt sander and jig in combination with, or as an alternative to the saw blade referenced above. Similar drive systems as those used to rotate a saw blade may be employed to rotate the belt of the sander as it traverses the length of the log deck while the log is continuously rotated on the log deck. This arrangement allows for a smooth product finish against complex radial shapes when the log is spun at a certain set speed while the sanding apparatus is set to travel at a longitudinal rate following the jig.

Reference in general throughout this specification will also be made to a swing blade being provided in conjunction with the present invention, while those skilled in the art will appreciate that alternatives are also within the scope of same.

In a preferred embodiment the invention may also include a camera remote from a display system which can be viewed by an operator. This camera can record or transmit a view of the end of a log which is remote from the

operator. The view provided by this camera may be used by an operator to judge the relative positioning of an adjacent rotatable mounting spike and if the mounting spike is ready to move forward and pierce the centre of the log.

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In a further preferred embodiment an identifier of the log centre may be superimposed on the image presented to the operator by the display system. In such embodiments this information may act as a guide to the operator to ensure they correctly position the rotatable mounting spike and that this spike pierces the centre of the log.

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A mobile saw mill provided in accordance with the invention includes two lift assemblies, each lift assembly being operable to adjust the relative position of at least one of the rotatable log spikes to a log received by the log deck.

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In a preferred embodiment a mobile saw mill provided in accordance with the present invention may include two lift assemblies, each being connected to one of the inventions rotatable mounting spikes. These lift assemblies can be configured to move the connected mounting spike towards and away from the log deck, preferably moving the spike up and down relative to the log deck. The action of these lift assemblies will therefore facilitate lifting of a log pierced by the mounting spikes off the log deck, allowing free rotation of the mounting spikes and log during milling operations. The same lift assemblies can then be used to return any remnants of a log to the log deck after the completion of milling operations.

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However in some alternative embodiments the lift assemblies provided by the invention may not be connected to the rotatable mounting spikes, nor be used to move a spike towards and away from the log deck. In such embodiments a lift assembly can be used to adjust the relative position of a log spike to a log received by the log deck by lifting or lowering the log relative to the log deck and mounting spike connected to the log deck. In such embodiments each mounting spike be mounted to the log deck at a static height or position, with the log being manoeuvred by the lifting assemblies to locate each mounting spike adjacent to the centre of the log.

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Reference in general throughout this specification will however be made to a

lift assembly being connected to a rotatable mounting spike, and being used to adjust the relative position of the mounting spike to a log by moving the spike towards and away from the log deck. However those skilled in the art will appreciate that other implementations of the invention are envisioned, and reference to the above should in no way be seen as limiting.

In a preferred embodiment a lift assembly may incorporate or include a hydraulic lifting cylinder. Pressurised hydraulic fluid may be used to lift a log (or a mounting spike which is engaged with a log) and this fluid may be released from the hydraulic cylinder to lower the same log. Those skilled in the art will appreciate that hydraulic lifting cylinders may be easily configured to perform this role, and controlled either by a computerised control system or through a manual actuation signal provided by an operator of the invention.

The invention incorporates at least one drive assembly engaged with one or more mounting spikes. A drive assembly can be used to apply a torque or rotational force to one or more mounting spikes to rotate a log engaged by the spike spikes

In a preferred embodiment the invention may incorporate a single drive assembly only engaged with a single mounting spike deployed at one end of the log deck. The remaining mounting spike can be described as a follower spike and will therefore rotate freely when its opposite is rotated by the single drive assembly. Reference throughout this specification will also be made to the present invention incorporating a single drive assembly linked to a single mounting spike only. However those skilled in the art appreciate that other arrangements or configurations of the invention are envisioned – such as the provision of two drive assemblies or a drive assembly linked to both mounting spikes.

The drive assembly provided by the invention can allow for precise automated control and hold of the angle or degree of rotation applied to a log by rotation of a mounting spike. This precise control can allow the invention to execute a log cut plan which requires the precise rotation of a log by a set number of degrees for each pass of the saw blade along the length of the log deck. For example, a specific portion of a cut plan may

dictate that a log undergoes a 20 degree rotation for every pass of the saw blade, with the drive assembly facilitating the execution of these rotations at the end of cuts made by the saw blade.

- 5 In a preferred embodiment a drive assembly may be formed by an electric motor with an associated transmission system engaged with a mounting spike. Electric motors and their associated transmissions are well known in the art and may be readily configured to perform as a drive assembly. In a further preferred embodiment a self-braking electric motor with an integral
10 gearbox may be employed as a drive assembly which serves to hold the log steady while each incremental cut is performed.

A mobile saw mill provided by the invention also includes a programmable controller configured to transmit control signals to the drive assembly. This
15 programmable controller allows for precise automatic control of the degree of rotation applied to a log in a single actuation of the drive assembly for a single pass of the saw blade. Those skilled in the art will appreciate that a range of information technology systems may be employed to implement a programmable controller, such as for example, embedded automated PLC
20 components through to more sophisticated flexible computer systems. Various forms of programmable controller hardware may be employed by the invention, preferably which can be loaded with a set of executable instructions which facilitate the completion of milling operations.

- 25 In a preferred embodiment the programmable controller may also receive input signals from a log end measurement system. These signals may be used to determine a log cut plan in some embodiments, as discussed further below. Furthermore this information may also be used to generate a superimposed centre point graphic or image to be presented on an operator
30 observable display system screen which presents an image of the end of the log remote from the operator.

In preferred embodiments the invention may also include an operator interface station. The station can be used to receive commands from an
35 operator to control the behaviour of the apparatus provided. Those skilled in the art will appreciate that an operator interface station may include manual override controls which allow direct control of the various moving parts of

the invention. For example buttons and/or control levers may be provided to provide the operator with the ability to raise or lower a log to desired heights, rotate the log to a desired degree in either a clockwise or anti-clockwise direction, and/or rotate a log at a desired speed. Manual controls
5 may also be provided to actuate mounting spikes to pierce the ends of a log or to withdraw the mounting spikes from the remnants of a log after a milling operation.

In various embodiments an operator interface station can also be used to
10 interact with the programmable controller and any executable processes being run by this controller. An operator interface station may receive information from the operator which can be used to determine a cut plan, and may - for example - receive an indication from the operator that the saw blade has completed the current pass down the log deck and that the
15 next rotation of the log dictated by a cut plan should be executed.

The present invention also encompasses a computer program product for the above-referenced mobile saw mill apparatus, this program facilitating the determination of log cut plans and also the execution of these cut plans. It
20 should be appreciated by those skilled in the art that this program product may consist of a series of computer executable instructions stored in a non-transitory tangible computer readable medium.

When running this computer program may initially receive a minimum long
25 log diameter indication. As referenced above minimum log diameter information may be obtained automatically in some embodiments from a log end measurement system, or in other embodiments may be provided through information input into an operator interface station. This minimum log diameter identifies the smallest possible width or diameter of a log to be
30 milled.

The execution of this computer program can also solicit the provision of desired lumber characteristics to be produced by milling the log with the above identified minimum log diameter. These desired lumber characteristics
35 can incorporate the height and width of individual pieces of lumber to be produced by the milling operation.

In some further preferred embodiments this computer program may also solicit the provision of additional information from an operator. For example in a number of exemplary embodiments the following milling processes may be executed through the operator providing lumber characteristic
5 information as set out below:

- Tensioned logs – Flat sawn boards: The operator may choose to reduce the log in to planks with minimal crook or bow. Typically timber can bow out when dealing with a very tensioned log. In this situation it is best to remove timber with its widest face centred above and around the heart. It is easier to flatten a board than it is to straighten a sideways bow. In the industry this method is called flat sawing or back sawing. The board may spring up at each end relative to its flat face but does not spring sideways or toward its thinner face (defined as a crook board). In this situation the operator would advise the minimum diameter of the log, the widest dimension, the depth of dimension and the computer will advise the position of the first cuts and the number of rotations/angle of each consecutive cut. Once the top of the log is removed all around the log. The mill is then lowered to match the depth of the second cut advised earlier. The board is sourced at the centre of each open face and removed after each rotation until the next series of perimeter is input into the computer.
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- Stable quality logs – Quarter sawn: In this instance the operator requires a more structural stable timber from the log. The same parameters are entered; minimum diameter, width (now narrow) and depth (now deep). Each board will be removed with its narrowest face centred above and around the heart - effectively recreating the above-mentioned movements.
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- Simple conversion from round to square: In this instance the operator simply chooses to convert a round log into a square. The operator simply measures the first cut and the computer rotates 90 degrees for each cut.
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- Lathing a log: In this instance the operator simply requires a lathed

round log. A series of fine incremental cuts are performed all around the log – bringing the log to bear a relatively round result. The computer is then told to rotate the log at a set speed and the sawblade is brought to contact the tangent of the log. The saw mill is then set at a very slow feed rate will the log is spun true via rotation.

This computer program can also be utilised to determine a cut plan based on the received minimum diameter indication and desired lumber characteristics.

In a preferred embodiment the minimum radius of the log to be milled may be derived and divided into a series of concentrically orientated rings, each with a height approximately equal to the height of the desired lumber products. The circumference of each ring can then be divided by a number of cut identifiers spaced apart by distances approximately equal to the width of the desired lumber products while also accounting for kerf intersection and overlap. In this way a large volume of a log may be sawn into lumber products with the desired identified characteristics through sequentially cutting around each concentric ring defined by the cut plan.

Once a cut plan has been determined this computer program may be utilised to control the operation of the apparatus during execution of the cut plan. In such embodiments the software may receive an input – either via an automated system or from the operator – indicating that the associated saw blade is ready to complete a pass along the length of the log deck. The computer program can then command the appropriate degree of rotation to be applied to the log to produce the next cut dictated by the cut plan.

In further preferred embodiments the computer program may also provide informational or instructions to an operator of the invention through the display screen of the operator interface station. For example this information may indicate any changes required in the orientation or configuration of the saw blade to execute the current cut dictated by the cut plan.

The present invention may provide many potential advantages over the prior art.

In various embodiments the invention relates to the integration and co-

operation of:

- Log end centring, clamping and lifting.
- Computer rotation and positioning.
- 5 • User input software to optimise and compute patterns of sawing.
- Preferably, a single saw blade being position able along 3 movable axes in relation to the position of the rotatable log, where the single blade having the ability to rotate between 0-180 degree of rotation. This enables the single blade (reference to longitude movement along the log) the ability to cut both horizontal and vertical orientations while also having the ability to saw angles between.

In various preferred embodiments the use of a single swinging blade reveals an extensive combination of advantages regarding further de-stressing and sawing combinations while reducing the log to timber or shapes.

This combination of elements; log clamping and rotating, computer positioning and the swing-blade circular sawmill can provide a new and un-anticipated cooperation of sawing trees into higher quality products:

- a. The log external edge can now be removed revealing a pentagon face – de-stressing the log.
- b. Vertical cuts can then be made all around the log further de-stressing.
- c. Horizontal cuts will then be made progressively around the log releasing the stress and timber according to the preferred method of sawing; back sawn for extremely stressed logs, quarter sawn for high quality stress free logs.
- d. Multiple double width boards may be achieved through out the log.

Various embodiments of the invention may also provide the following:

- A very small circular 'swing-able' blade may be fitted as a method of double-cutting can be utilised producing double width boards all around the periphery of the log. A 6" depth swing blade may achieve 12" wide boards all around the log.
- Weather boards can be achieved by plunging in to the log, sawing longitude, plunging out, rotating then repeating the process. The ends of the log then can be chain sawed off to recover the wedges.

- Any size block of timber can be sourced from the centre of the log.
- One wide slab may be recovered from the centre of the log.
- Log home beams may be produced via cutting top and bottom faces flat. With regard to the top face the single blade may plunge in at the centre and remove a female square section. On the other face two cuts can be performed on either side leaving a male square at the centre.
- A horizontal positioned blade may be positioned at the tangent of the log. The log may be spun at a desired speed. The feed system of the circular blade may be actuated at a set speed. This allows the log to be spun true into a circular pole.
- Architectural Roman pillars may be made. By adding a perpendicular blade and jigging system, the log may be spun into quite complex and repeatable shapes. Adding a simple perpendicular sanding attachment these shapes and rounds may be smoothed off through the same process.
- The turning system can also secure log halves, quarters, and squares at any given end for further milling reduction.

Brief description of the drawings

Additional and further aspects of the present invention will be apparent to the reader from the following description of embodiments, given by way of example only, with reference to the accompanying drawings in which:

- Figures 1a, 1b shows an isometric view and side view of a mobile saw mill apparatus provided in accordance with one embodiment of the invention,
- Figure 2 shows a partial side view of one end of a mobile saw mill apparatus provided in a further embodiment,
- Figure 3 provides a schematic flowchart of executable instructions run by a computer program used to operate the mobile saw mill apparatus illustrate with respect to figure 1,
- Figure 4 shows a further embodiment of the invention with a front view illustrating the invention's log rotating system coupled with a swing blade assembly mounted around it,
- Figure 5 shows an isometric view of the embodiment of figure 4,

- Figure 6 shows an isometric view of parts of the invention shown in the embodiment illustrated by figures 4 and 5,
- Figure 7 shows the embodiment of the invention illustrated by figures 4-6 where a log ready to be sawn,
- 5 • Figure 8 shows the embodiment of the invention illustrated by figures 4-7 where the controller running computer software has identified the first cut starting point, Figure 9 shows the embodiment of the invention illustrated by figures 1-5 with the swing blade cutting head now lowered to the desired depth size of board
- 10 • Figure 10 shows the embodiment of figures 4-9 where the swing blade apparatus is sawing free the horizontal cuts.
- Figure 11 shows the embodiment of figures 4-10 where a consecutive radial drop of 2" after the minimum diameter is provided to the controller with width and depth of board factored,
- 15 • Figure 12 shows the embodiment of the invention illustrated by figures 4-11 which has been used to produce a surfaced pentagon,
- Figure 13 shows the embodiment of the invention illustrated by figures 4-11 which has been used to produce a finished square or rectangular cant,
- 20 • Figure 14 shows the embodiment of the invention illustrated by figures 1-11 and illustrates how a small log or the core of a larger log may be lathed into a true round pole,
- Figure 15 shows a further embodiment of the invention which includes a perpendicular saw blade mounted onto the swing blade apparatus
- 25 • Figure 16 shows the same perpendicular arrangement of the embodiment of figure 15 but fitted with a belt sander in place of the saw blade,
- Figure 17 shows a comparative example of cut plans which provide radial 'back sawn' boards, and
- 30 • Figure 18 shows how in some embodiments the invention may be used to produce lumber used to form log home wall structures.

Further aspects of the invention will become apparent from the following description of the invention which is given by way of example only of particular embodiments.

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Best modes for carrying out the invention

Figures 1a and 1b shows a perspective isometric view and side view of a mobile saw mill apparatus 1 as provided in accordance with one possible embodiment of the invention.

- 5 The apparatus includes a log deck 2 provided to bear the weight of a log to be milled. The log can be rolled by hand or mechanically lifted on to the deck.

10 The log deck 2 defines a central depression which is provided to locate logs in the centre of the deck, self-centring the log in relation to the circular longitude movement. This central depression is provided by a number of log centralising supports 3 which are connected at right angles to two main longitudinal beams 4 to define the deck. Each log centralising support 3 has a U-shaped configuration to provide the centralising depression of the log
15 deck, and the position of each of these supports along the length of the deck can be adjusted as desired using a set of removable connection pins 5.

Adjustable feet 6 are provided to elevate the log deck off the ground, with height adjustments being made to accommodate sawdust build up. However
20 in some alternative embodiments the log deck may be mounted using series of wheels and suspension resembling a trailer to provide a more portable character.

In the embodiment shown a centre levelling jack 7 is provided to
25 compensate for long length operation. Prior sawing and after rotation the centre support is jacked up to alleviate log sag. The amount of lift required can be estimated by measuring the circular saw mill beam position from each ends of the log and comparing the relationship at the centre of the system. Alternatively, a string or laser system will also provide for this
30 adjustment.

Two rotatable mounting spikes 8 are provided at each opposed end of the log deck to engage with the ends of a log to be milled. The end mounting spike engagement systems are movable with regards to the ends of the log
35 through the provision of a hydraulic cylinder 9 for each spike, these cylinders being used to plunge the spikes into and out of the ends of the log.

Two lift assemblies 10 are provided, each connecting a rotatable mounting spike 8 to the log deck by way of a series of removable pins 11. These removable pins provide a movable connection system for the lift assemblies, allowing them to be connected at different regions in the log deck to
5 accommodate different lengths of log. Each lift assembly 10 also includes a hydraulic cylinder 12 engage with the mounting spike and configured to move the mounting spike towards and away from the log deck to raise or lower the end of any log pierced by the mounting spike.

10 This arrangement therefore provides two hydraulic cylinders at either end of the log deck to respectably drive a mounting pin into the end of log, and to lift the end of the log once pierced by a mounting spike.

A drive assembly 13 is also provided, formed by an electric self-braking
15 motor with an integral gearbox and transmission system linked to one of the rotatable mounting spikes 8. The drive assembly operates to apply a torque to the rotatable mounting spike to in turn rotate a log by a specific angle, or at a specific rotational speed.

20 The apparatus also includes a programmable controller mounted within an operator interface station 14. The controller embedded within the operators interface station 14 is arranged to execute a software product and is connected to the drive assembly 13 to issue control signals to the drive
assembly to control the rotation of the mounting spike.

25 In some embodiments a camera is located at the opposite end of the log deck to the operator interface station 14 and to transmit images of the adjacent end of the log which can't be seen by an operator when using the interface station. These opposite log end images can be presented to the
30 operator by a display system screen integrated into the interface station 14 so the operator may see when a mounting spike is positioned adjacent to the centre of the log. A cross hair is provided on the display to align the log centre to the far end spike which makes contact into the log. This allows complete operation from a remote position.

35 In some embodiments a log end measurement system can also be provided adjacent to such a camera. In various embodiments this system can include

a laser range finder adapted to measure the minimum diameter of the log at the end of the log deck, with the login measurement system and arranged to transmit this information to the programmable controller embedded within the user interface station 14.

Four actuation levers (not shown) are positioned at the operator's station. Two of these levers actuate the system driving mounting spikes into the ends of the log. The other two lift the log up off the deck ready for rotation. The interface station also provides the following direct operator control features:

- a) Manual rotation in either direction via two control buttons.
- b) Push to rotate button.
- c) Speed of rotation setting.
- d) Push to rotate continuously for lathing operations.

Once a log is loaded on to the load deck the mounting spikes are positioned and driven into the centre of the log at either end of the log. The log is then lifted using the lift assemblies so that it clears the components of the log deck when rotated by the drive assembly.

Figure 2 shows a partial side view of one end of a mobile saw mill apparatus provided in a further embodiment. In this embodiment the apparatus provided by the invention has a similar configuration to that shown with respect to figure 1 but also includes a camera 15.

This camera is mounted adjacent to a rotatable mounting spike 8' located remotely from the operator interface station (not shown). The camera is positioned in this location to include the end of the log and mounting spike in its field of view as shown by the dotted line of sight rays shown in figure 2. The camera is configured to transmit these images of the end of a log supported by the spike and log deck to the display system of the operator interface station.

Figure 3 provides a schematic flow chart of instructions executed by a computer program configured to assist in the operation of the mobile saw mill apparatus discussed with respect to figure 1.

Stage A executes once the log is loaded on to the log deck, centred, and lifted using the mobile saw mill apparatus illustrate with respect to figure 1. Initially the log end measuring system communicates (A) the minimum diameter of the log to the programmable controller, although in other
5 embodiments this information may be manually measured, entered by a keyboard or similar user interface, and supplied to the controller by way of the operator interface station.

10 The controller then solicits at stage B desired lumber characteristics from the operator in the form of the width and depth of lumber boards to be produced by milling operations. For example in various embodiments these characteristics can include the width and depth of lumber cuts to be made, this information being keyed in by the operator.

15 Next the program provided determines a cut plan at stage B. The computer software run by the controller uses the minimum log width information to calculate the effective radius of the log and divides this area of the log into a number of concentric rings deployed around the centre of the log. The received lumber width information determines how many boards can be
20 obtained from each ring, while the depth information determines the number of rings which can be milled from the log. Once the usual volume of the log is divided into the set of concentric rings made up of a number of potential boards the cut plan is finalised to identify where cuts need to be made, and hence the angle of rotation to be applied to the log after each specific cut. In
25 various embodiments such cut plans can include or indicate the height of the first cut to be made and the rotational angle and number of turns to be completed in accordance with subsequent cuts.

30 Lastly the program run by the controller executes the cut plan at stage D by issuing a sequence of operational control signals to the drive assembly to affect rotation of the log by the specific amounts after each transit of the saw along the length of the log deck. Stage D can execute a further iterative sub-process which initially makes the first horizontal cut, then the log is rotated to its given angle and a second horizontal cut is made. This process
35 repeats for every rotation defined in the cut plan. The blade is then lowered to the original keyed depth, where the original keyed width board is

removed from each open face centred to the heart of the log. The sub-process then runs again until the entire cut plan has been executed.

Figure 4 shows a further embodiment of the invention with a front view illustrating the invention's log rotating system coupled with a swing blade saw mill milling apparatus mounted around it. It shows a log (a) staged and ready to roll into the system. The swing-blade sawing head (b) is mounted and ready to be positioned to make its cuts. The swing blade is configured to reciprocate along the length of the log deck shown to make a plurality of cuts in a log engaged by a set of rotatable mounting spikes. In the embodiment shown the sawblade as formed by a rotating disk swing blade. The swing blade can adjust its orientation to change the angle made by the plane of the blade to the longitudinal axis of a log.

A log in the shape of a pentagon (c) is shown after some cuts have been made. The control station and display system screen (d) for manipulation of the log is shown just to the right of the turning system. Blocks of timber (e) or the like have been added to prop up components to allow for alignment and work flow.

Figure 5 shows an isometric view of the embodiment of figure 4 including the log rotating system coupled with a swing blade saw mounted around it. The swing blade assembly utilises 3 axis of movement to diminish the mounted rotatable log (c). Horizontal axis (f), vertical axis (g) and longitudinal feed axis (h) manipulate the cutting head through log (c). The control station is located directly next to the operator position (i).

Figure 6 shows an isometric view of parts of the invention shown in the embodiment illustrated by figures 4 and 5 where by the swing blade cutting head has been plunged into the log and sawing a deep horizontal cut (l). At the end of its longitudinal movement it will be plunged out of the cut. The vertical cuts (j) will be rotated and the process repeated all around the log. The ends of the log (k) will then be docked revealing equal sized wedged boards.

Figure 7 shows the embodiment of the invention illustrated by figures 4-6 where a log (a) ready to be sawn. The far end sliding (pin-able) connection

point (m) is secured to the log. The near end sliding connection point (o) is also secured to the log. The main support deck is supporting (p) the log. Hydraulic cylinder (q) has lifted both ends off the deck. Hydraulic cylinder (r) has pressurised the spikes into the log ready for rotation.

5

Figure 8 shows the embodiment of the invention illustrated by figures 4-7 where the controller running computer software (d) has identified the first cut starting point optimised with regard, to the choice of board size. The swing blade sawmill (b) has now performed a series of horizontal and vertical cuts to remove the external bark region converting the log shape after rotation into a pentagon (number of rotations and angle of rotation advised by the computer). Each top face (s) is sawn flat then rotated all around the log. The front view shows the bottom log support (t) which allows for initial alignment of the log and adjustability to varying sizes of logs.

15

Figure 9 shows the embodiment of the invention illustrated by figures 4-8 with the swing blade cutting head now lowered to the desired depth size of board. In this example, the sawing head has been lowered 1" and a series of vertical cuts have been made into the top face. The controller will then rotate to each additional flat face and the process repeated. This vertical first cut process relaxes the log. The tension is displaced equally around the log between the cuts.

20

Figure 10 shows the embodiment of figures 1-6 where the swing blade (b) apparatus is sawing free the horizontal cuts. The single blade may break up the log stress ordinarily experienced with a full depth horizontal cut. However, the single blade allows the blade to cut it in to two smaller consecutive cuts, the first horizontal 3" cut (v) followed by the following 3" cut (w) to achieve the full 6" wide board. This progressively reduces the stress in the log and the cut. Typically offering a more accurate cut and less strain on the blade. Once the board is removed, the log is then rotated to every face repeating the process.

25

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Figure 11 shows the embodiment of figures 4-10 where a consecutive radial drop of 2" after the minimum diameter is provided to the controller with width and depth of board factored. The external pentagon is then reshaped

35

and the mill is dropped 2". Here we have the swing blade (b) apparatus having already edged the vertical cuts and now releasing a double width cut 12" (z). The back cut (y) is now being performed to achieve this. The given example shows a 6" depth circular blade fitted. This process is typically called 'double-cutting' where by the left (x) and right (y) of the horizontal positioned blade can be utilised. Now that the log is rotatable, multiple double-cuts are achievable all around the log, meaning a much smaller machine can create very wide boards throughout the log efficiently.

10 Figure 12 shows the embodiment of the invention illustrated by figures 4-11 which has been used to produce a surfaced pentagon (aa) ready to be utilised as a structural product.

15 Figure 13 shows the embodiment of the invention illustrated by figures 4-11 which has been used to produce a finished square or rectangular cant (bb) ready to be utilised as a structural product. Squares of almost any size can be made utilising a very small blade in such embodiments.

20 Figure 14 shows the embodiment of the invention illustrated by figures 4-11 and illustrates how a small log or the core of a larger log may be lathed into a true round pole (cc) using the swing blade (b) cutting head. In this configuration the log is set to rotate permanently via the controller and software (d). The circular blade is then moved so that the edge of the blade is skimming the log at the tangent (dd). The longitudinal feed rate of the cutting head is then set where by the log rotates while skimming into a true round pole.

30 Figure 15 shows a further embodiment of the invention which includes a perpendicular saw blade (hh) mounted onto the swing blade apparatus (b) (ee) illustrated with respect to figures 1-8. This perpendicular saw blade may be pushed or attached to the head saw. The longitudinal feed rate of the saw blade may be set to a consistent value while the end roller follows a jig (ii), allowing for a very complex shape to be spun true from the log (gg). Log rotation speed is set at a certain rate via the controller and the crosscut blade makes its way along the jig against a roller arm (ff), and log (gg).

Figure 16 shows the same perpendicular arrangement of the embodiment of figure 15 but fitted with a belt sander (jj) in place of the saw blade. This arrangement allows for a smooth product finish against complex radial shapes. The log is spun at a certain set speed while the sawing apparatus is set at a longitudinal rate following the same jig.

Figure 17 shows a comparative example of cut plans which provide radial 'back sawn' boards (kk) centred to the heart and incrementally tilted to a predetermined board width calculated by the software. The cut plan implemented in accordance with this embodiment of the invention is illustrated on the left side of the page, while the cut plan (mm) normally executed by a prior art mobile saw mill is shown on the right side of page.

The process implemented by the invention in this embodiment provides straight timber which tends to bow up and down on the flat edge rather than the thin edge (crook). The last board (nn) on its rotation around the centre is compromised in width as this board is also used for the entry cut. After each full rotation, the boards are removed. The swing blade used is lowered by 1" (kk) followed by (oo), (pp), (qq), (rr) and (ss). The last portion remaining is the core which can be utilised for further shaping or left as it is. Typically, stressed logs have an undesirable core. The core may still be used, as enough material surrounding the dead core can captivate it, creating a structurally adequate product (tt).

Figure 18 shows how in some embodiments the invention may be used to produce lumber used to form log home wall structures.

As can be seen from figure 18 a log may initially be sawn on the top face. The sawblade is then lowered a set amount, a cut is made to the left and then to the right leaving a male protruding section at its centre. The log would then be rotated 180 degrees, and a face removed. The vertical positioned blade can then be lowered to a depth equalling the other side's male feature. A series of vertical cuts actuated side by side reveal an equal width 'female' channel. These sections of log maybe recreated so that each section clips into each other creating a log home style wall structure.

It is to be understood that the present invention is not limited to the embodiments described herein and further and additional embodiments

within the spirit and scope of the invention will be apparent to the skilled reader from the examples illustrated with reference to the drawings. In particular, the invention may reside in any combination of features described herein, or may reside in alternative embodiments or combinations of these
5 features with known equivalents to given features. Modifications and variations of the example embodiments of the invention discussed above will be apparent to those skilled in the art and may be made without departure of the scope of the invention as defined in the appended claims.

What we claim is:

1. A mobile saw mill apparatus which includes
a log deck configured to receive and locate a log to be milled, and
5 two rotatable mounting spikes, each being associated with opposite ends
of the log deck and being configured to engage with an end of a log
located by the log deck, and
two lift assemblies, each lift assembly being operable to adjust the
relative position of at least one of the rotatable log spikes to a log
10 received by the log deck, and
at least one drive assembly engaged with one or more rotatable mounting
spike, said drive assembly or assemblies being operable to rotate a
mounting spike and a log engaged with the mounting spike, and
a programmable controller connected to said at least one drive assembly
15 and being configured to issue control signals to said drive assembly or
assemblies to control the degree to which a mounting spike and engaged
log are rotated.
2. A mobile saw mill apparatus as claimed in claim 1 which includes a saw
20 blade movable along the length of the log deck, said saw blade being
configured to reciprocate along the length of the deck to make a plurality
of cuts in a log engaged by the rotatable mounting spikes.
3. A mobile saw mill apparatus as claimed in claim 2 wherein the saw blade
25 is a rotatable disc blade.
4. A mobile saw mill apparatus as claimed in claim 3 wherein the saw blade
is swing blade capable of adjusting the orientation of the plane of the
blade relative to the longitudinal axis of a log engaged by the rotatable
30 mounting spikes.
5. A mobile saw mill apparatus as claimed in claim 1 wherein the log bed
defines a central depression arranged to receive and locate a log in the
centre of the log bed.

6. A mobile saw mill apparatus as claimed in claim 5 wherein the central depression is formed at least in part by a log centralizing support which has a movable connection to the log bed.
- 5 7. A mobile saw mill apparatus as claimed in claim 1 which includes a centre levelling jack.
8. A mobile saw mill apparatus as claimed in claim 1 which includes a log end measurement system configured to provide an indication of the
10 minimum diameter of a log supported by the log deck.
9. A mobile saw mill apparatus as claimed in claim 8 wherein the log end measurement system includes a laser range finder.
- 15 10. A mobile saw mill apparatus as claimed in claim 1 which includes an operator interface station incorporating a display system.
11. A mobile saw mill apparatus as claimed in claim 10 which includes a camera adjacent to a rotatable mounting spike located remotely from the
20 operator interface station, said camera being configured to transmit images of the end of a log supported by the log deck to the display system of the operator interface station.
12. A mobile saw mill apparatus as claimed in claim 1 wherein a lift assembly
25 includes a hydraulic cylinder engaged with a mounting spike configured to move the mounting spike towards and away from the log deck.
13. A mobile saw mill apparatus as claimed in claim 1 wherein each mounting spike is associated with a hydraulic cylinder configured to drive the
30 mounting spike in to the end of a log located by the log bed.
14. A mobile saw mill apparatus as claimed in claim 1 wherein each lift assembly has a movable connection to the log bed allowing connection of the lift assembly to different regions of the log bed.
35
15. A mobile saw mill apparatus as claimed in claim 1 wherein a drive assembly is formed by an electric motor and transmission system.

16. A mobile saw mill apparatus as claimed in claim 15 which includes a self-braking motor and gear box.

5 17. A mobile saw mill apparatus as claimed in claim 1 which includes a perpendicular saw blade and jig.

18. A mobile saw mill apparatus as claimed in claim 2 which includes a belt sander.

10

19. A computer program product for milling a log using a mobile saw mill apparatus, the computer program product being store on a non-transitory tangible computer readable medium and including instructions that when executed cause a programmable controller to:

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- receive of a minimum log diameter indication
- receive an indication of the desired lumber characteristics to be produced by milling
- determine a cut plan based on the received diameter indication and lumber characteristics
- issue at least one of a sequence of operational control signals to a drive assembly of a mobile saw mill apparatus to effect rotation of a log in accordance with the cut plan after each transit of a saw along substantially the length of the log deck of the mobile saw mill apparatus.

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20. A computer program product as claimed in claim 19 wherein a cut plan is determined by dividing the effective volume of the log determined by the minimum log diameter information into a plurality of concentric rings with the number of rings being dictated by the received lumber characteristics, and by dividing each ring into separate lumber components based on the received lumber characteristics.

30

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Figure 1a

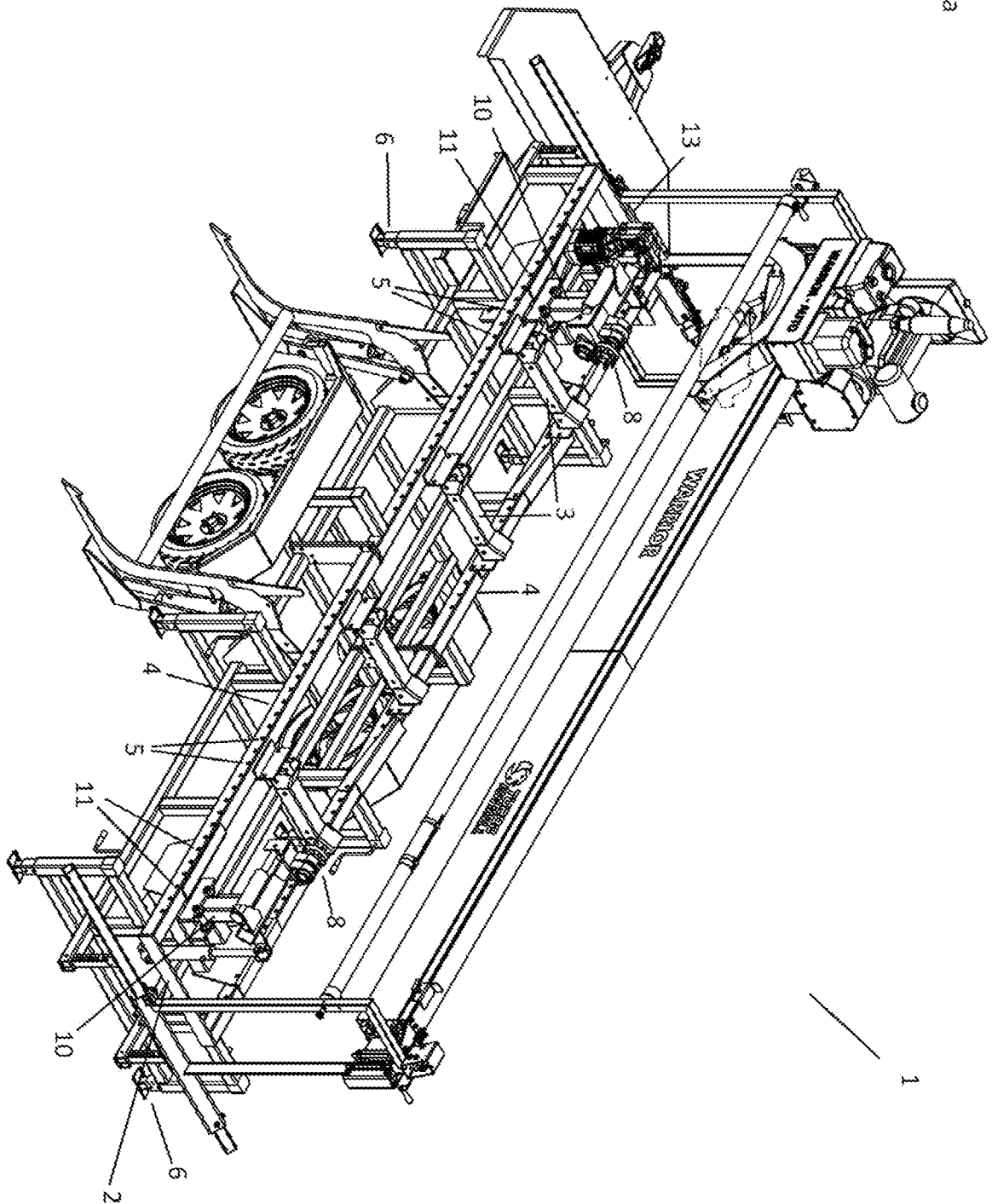


Figure 1b

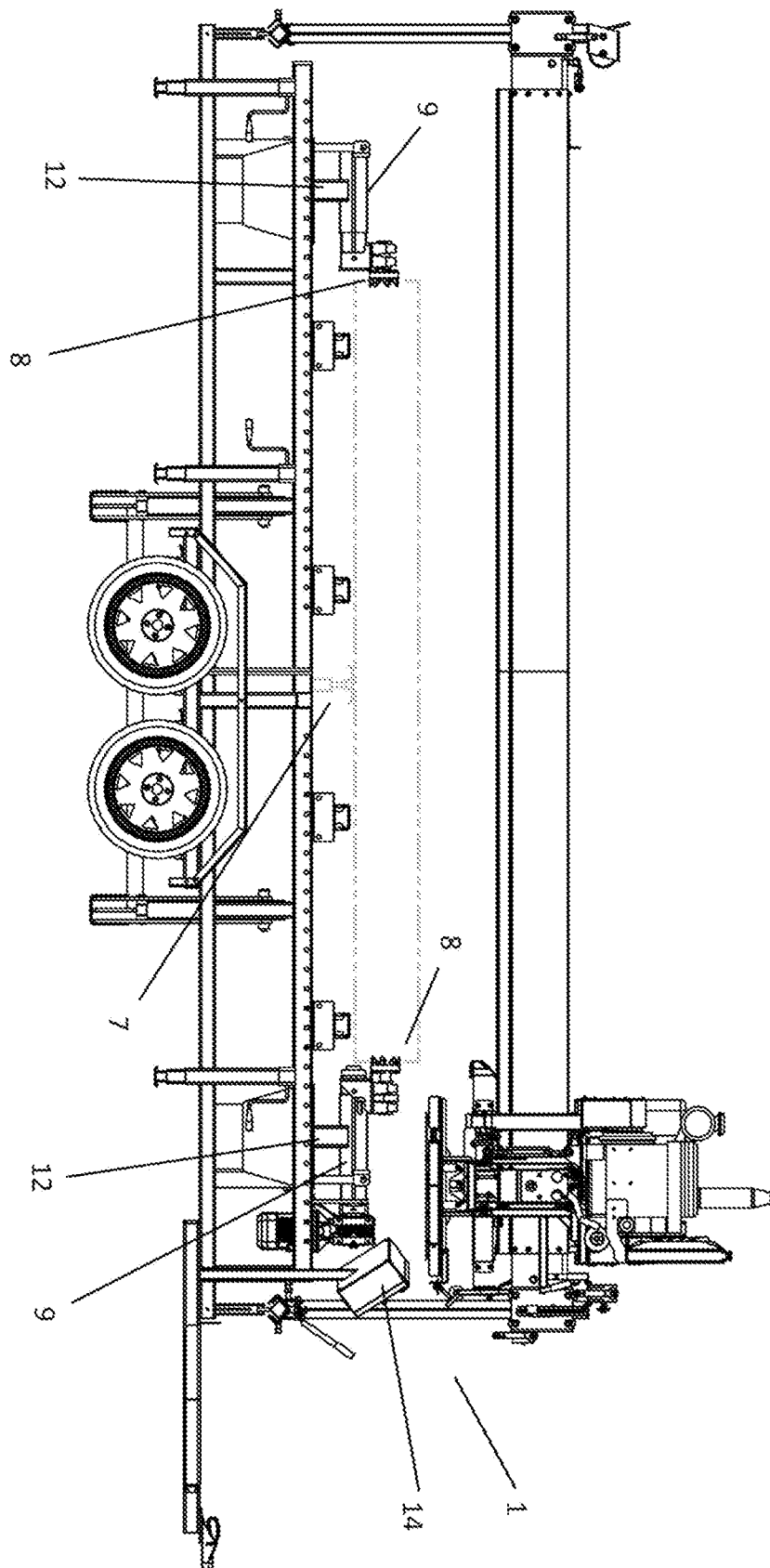


Figure 2

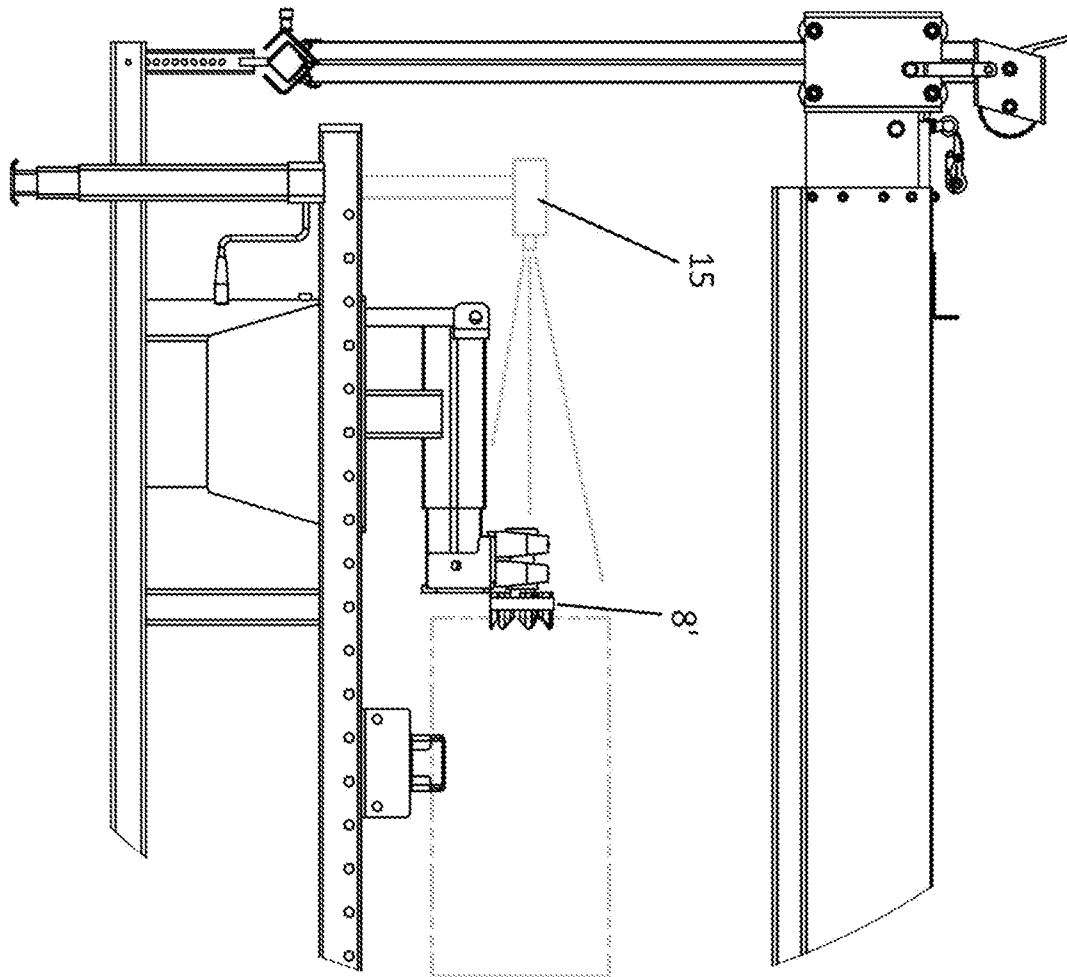
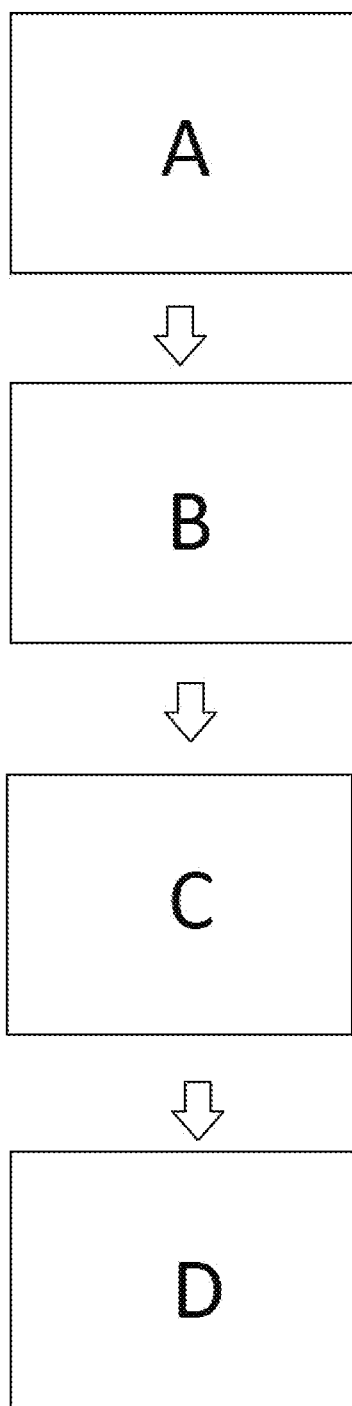


Figure 3



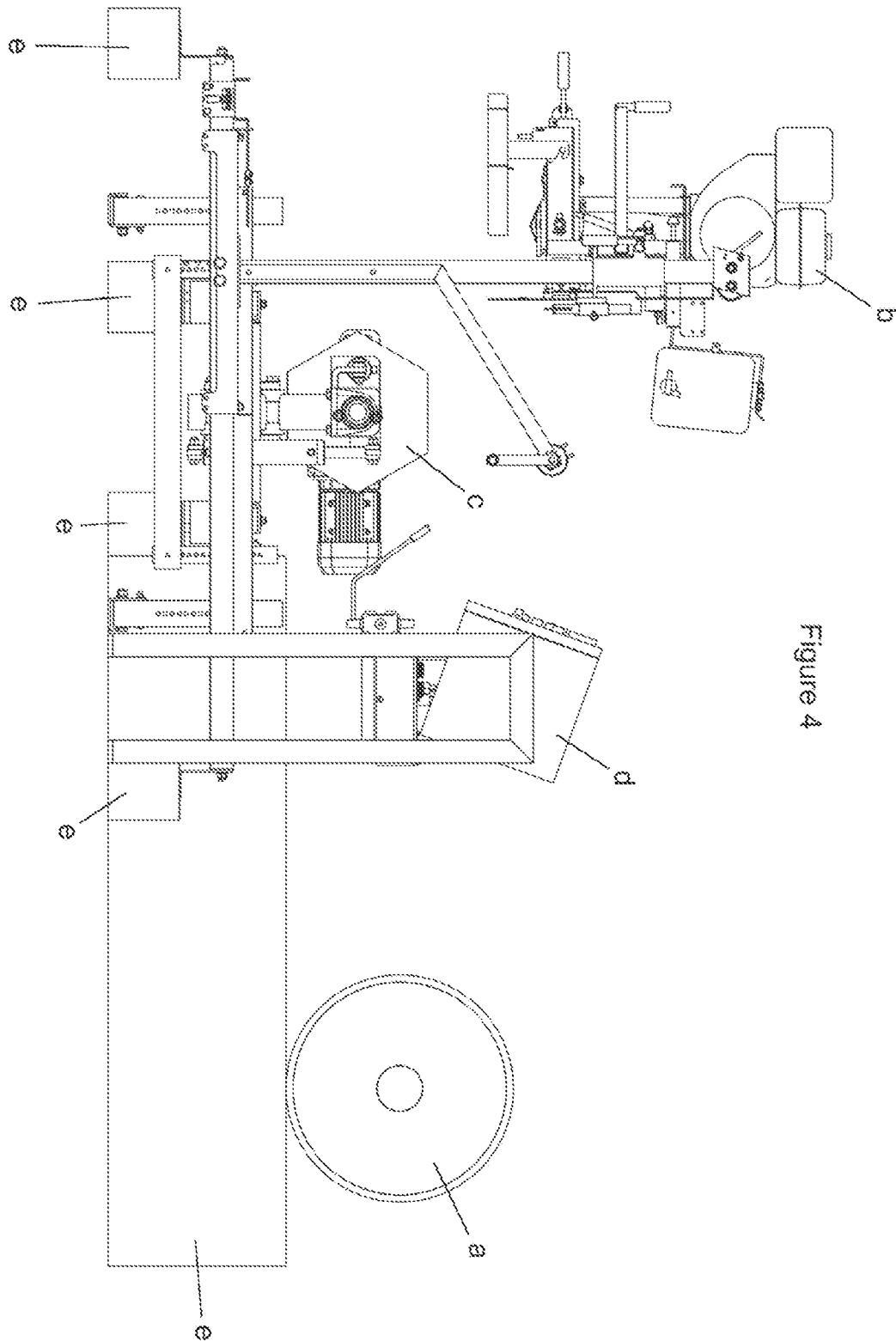


Figure 4

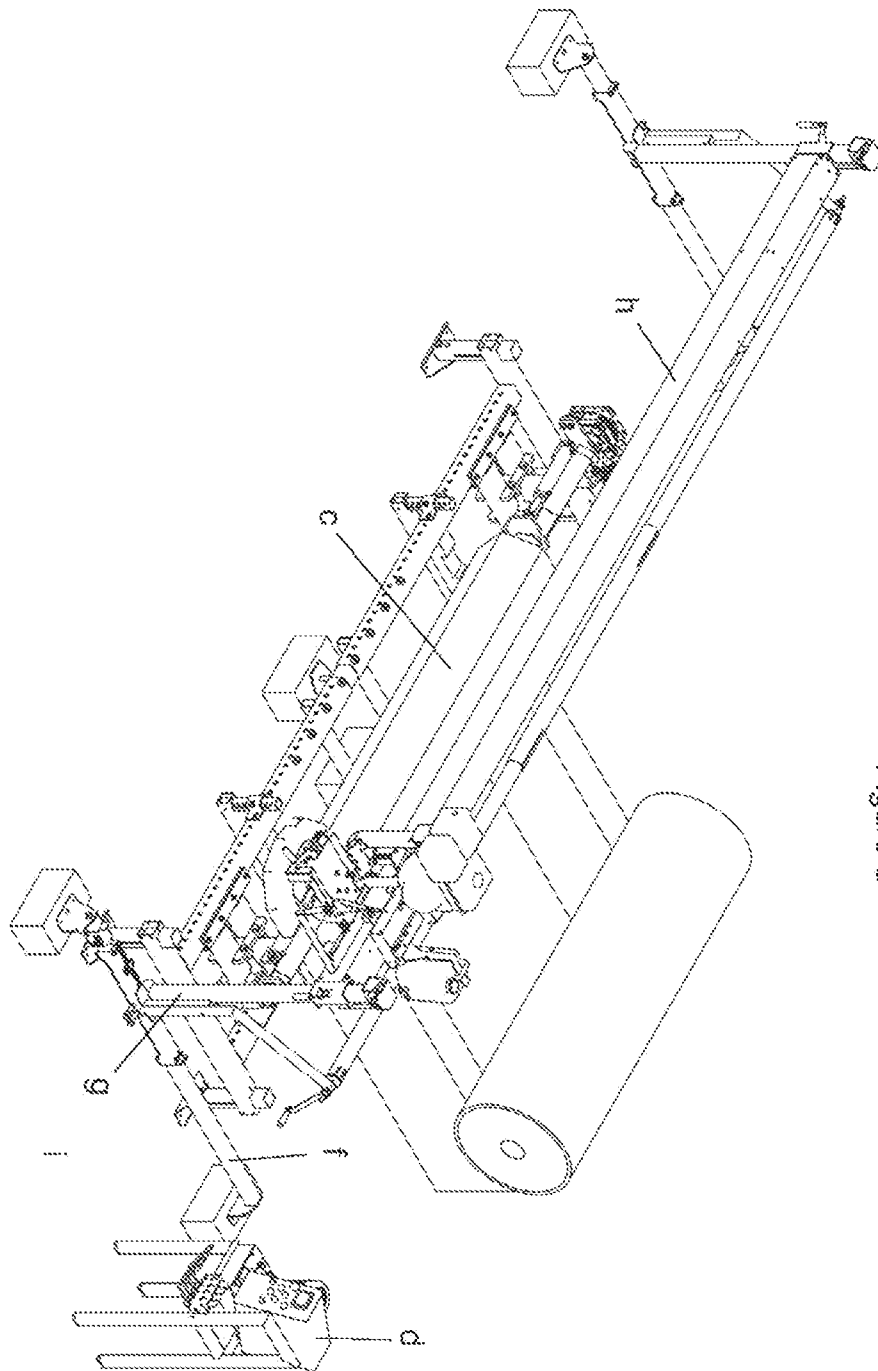
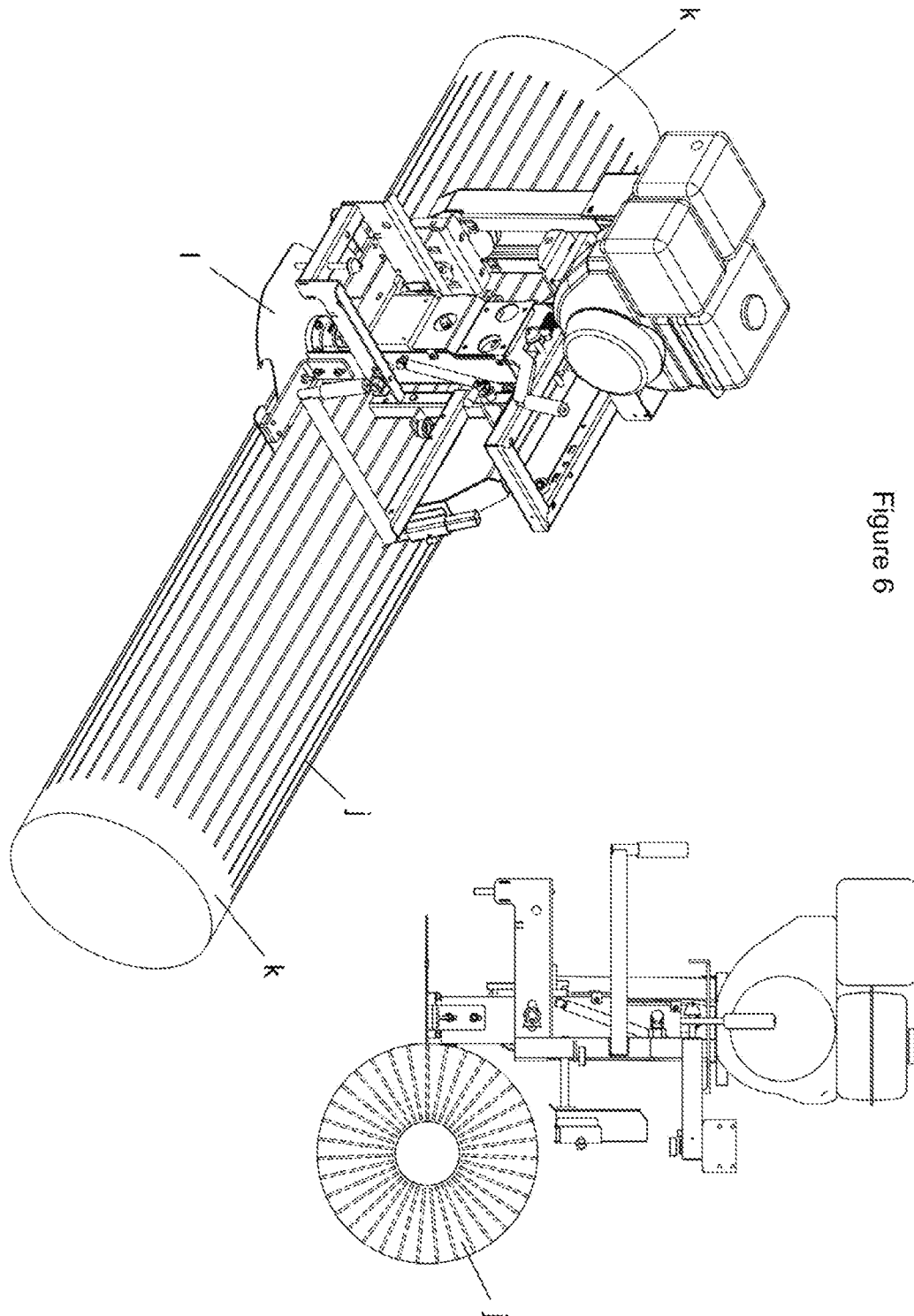


Figure 5



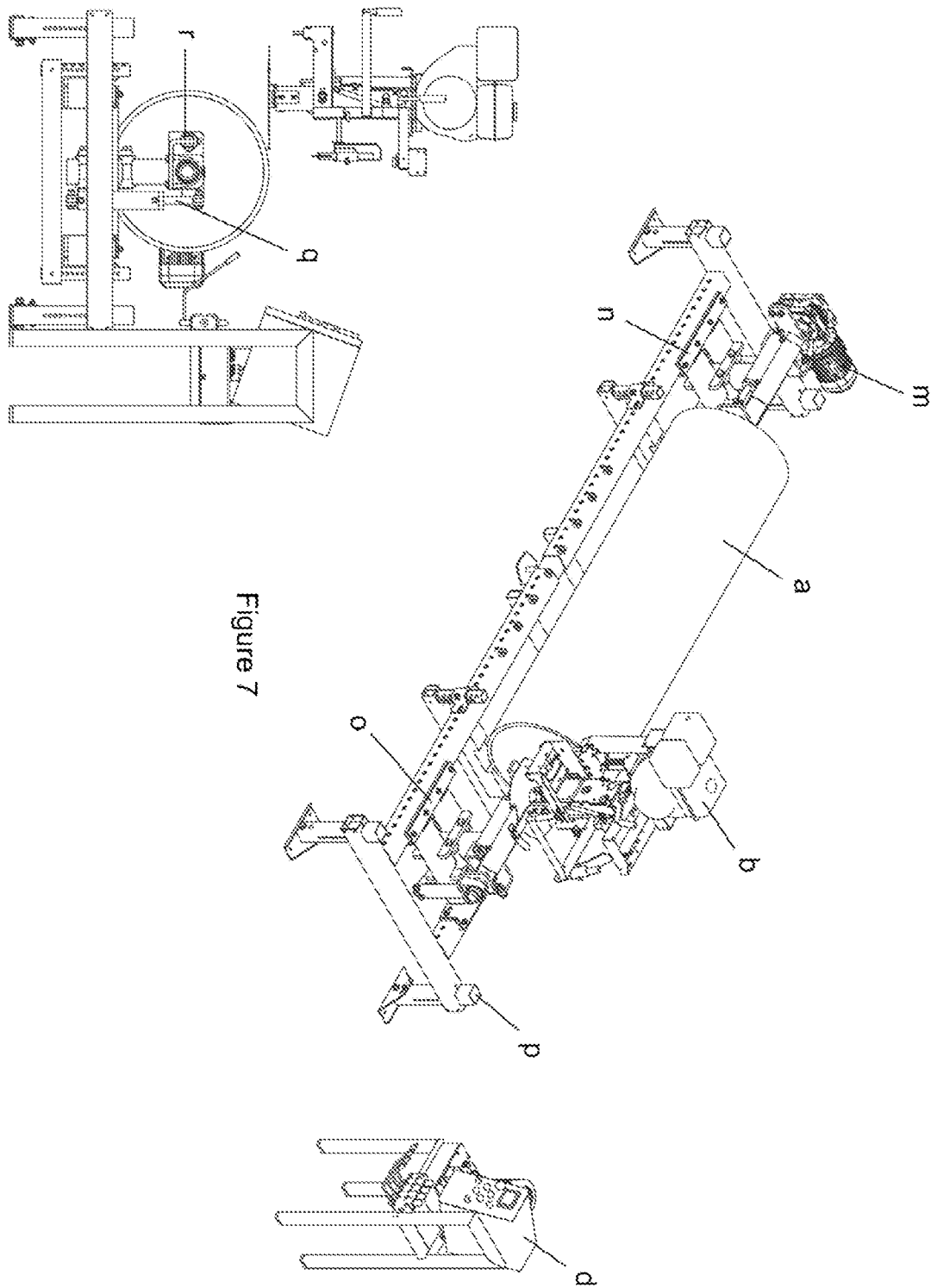


Figure 7

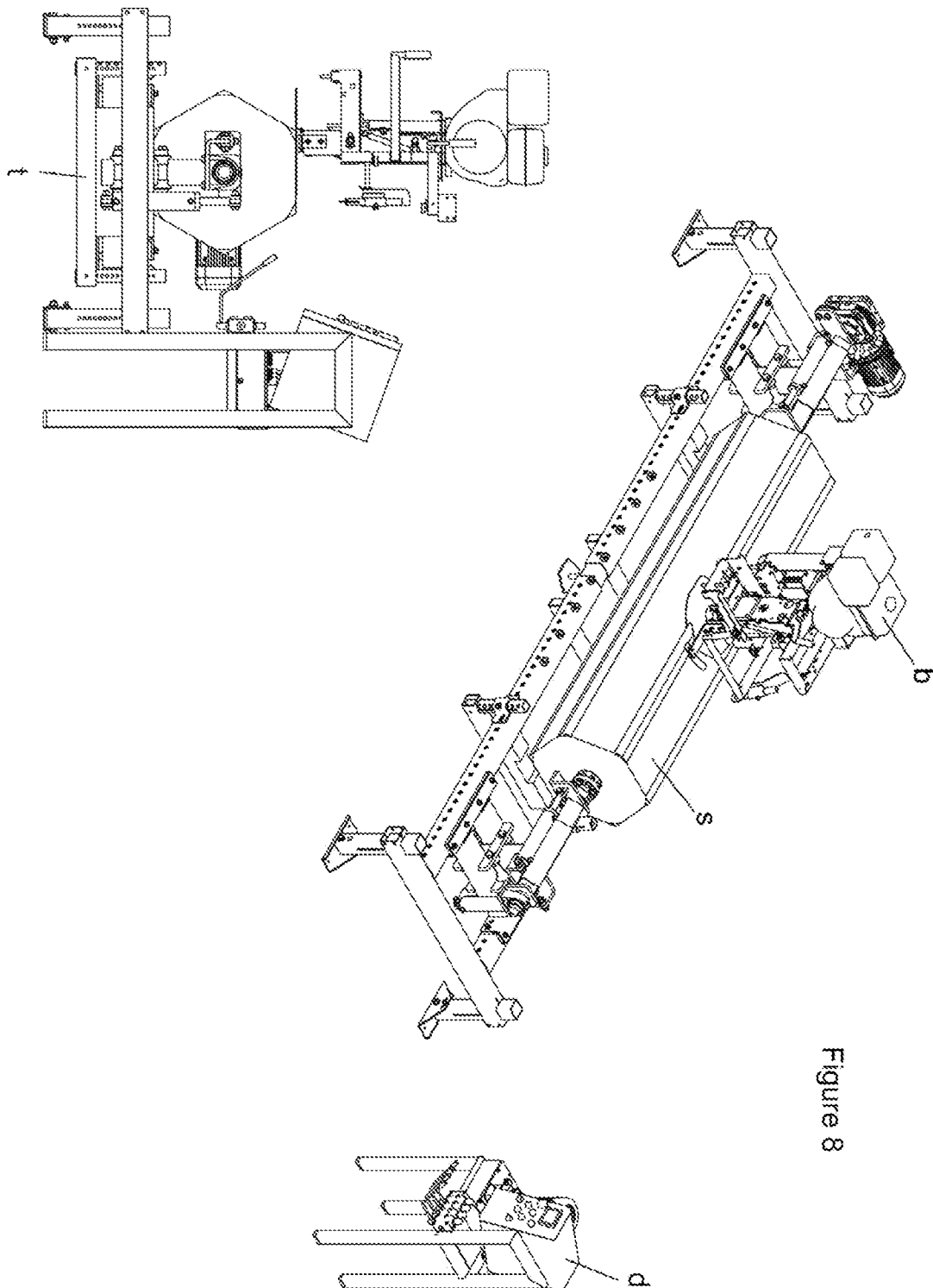


Figure 8

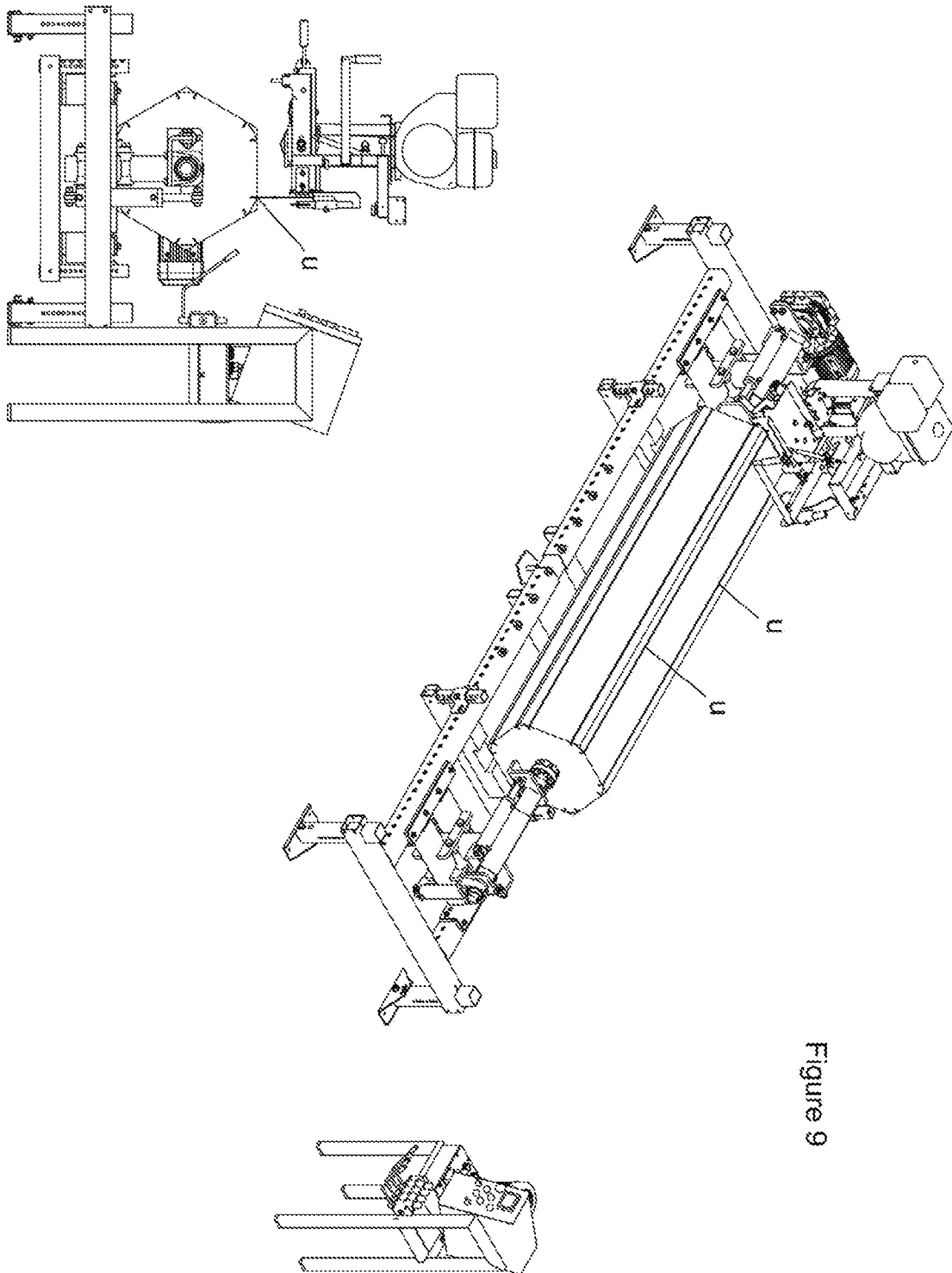


Figure 9

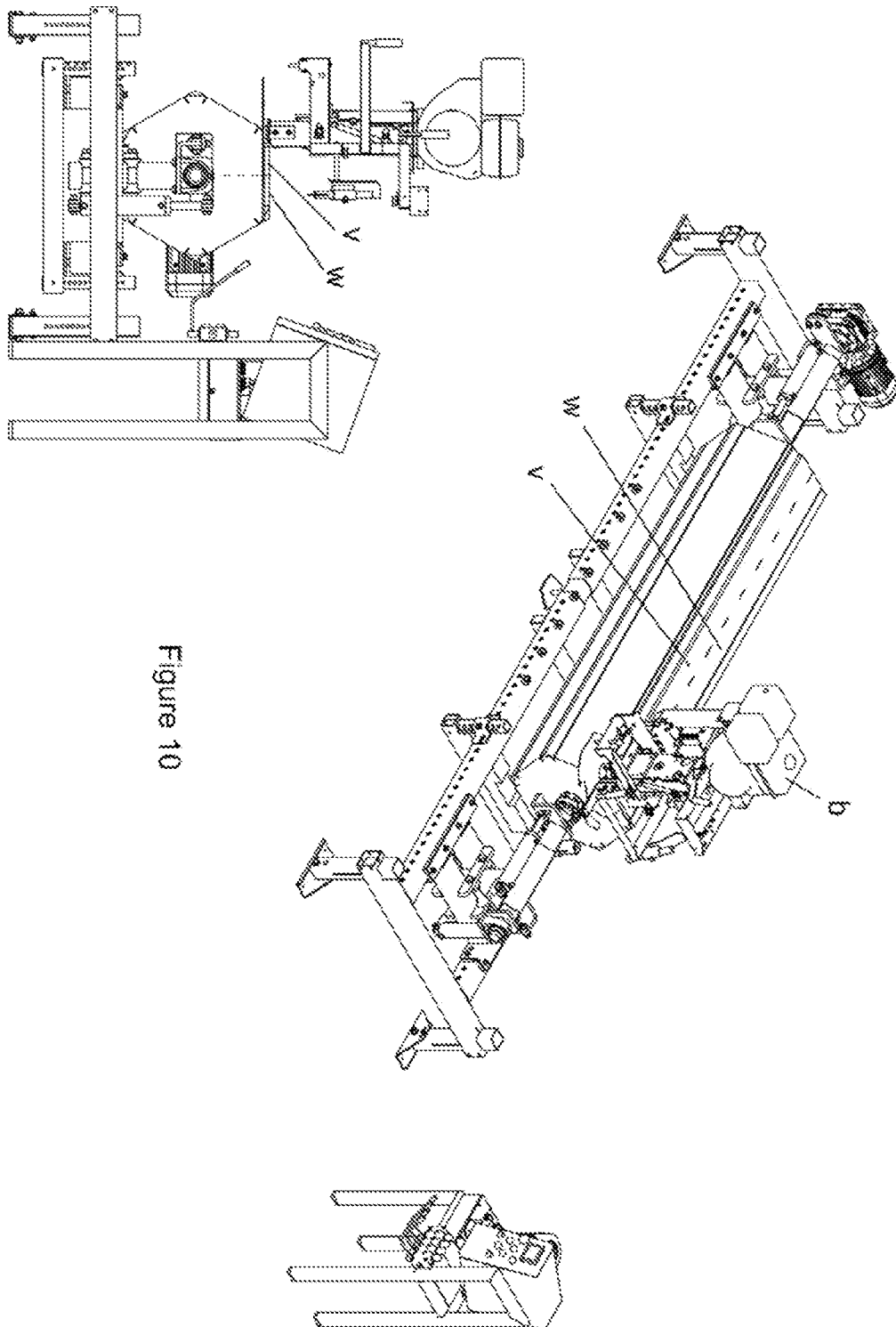
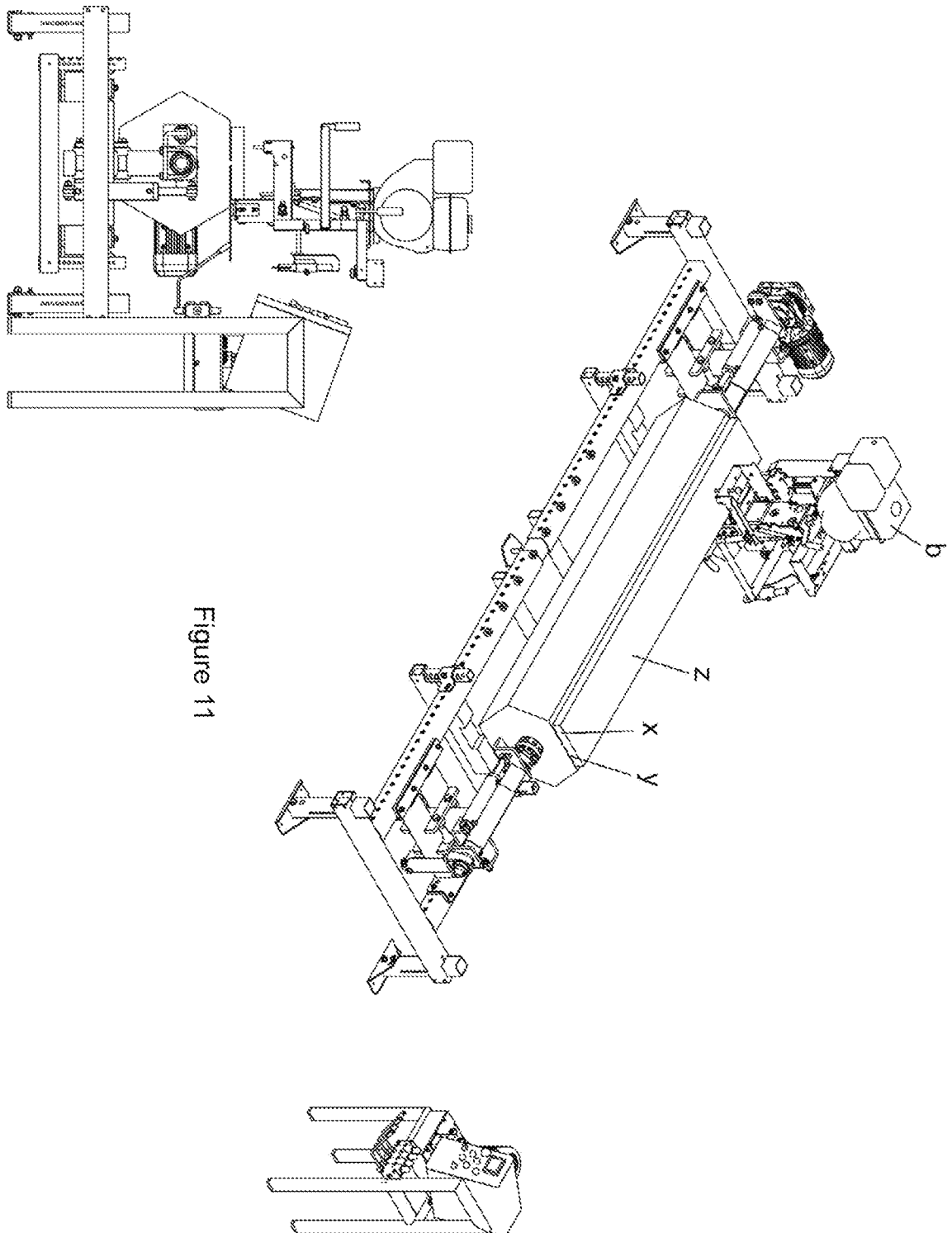
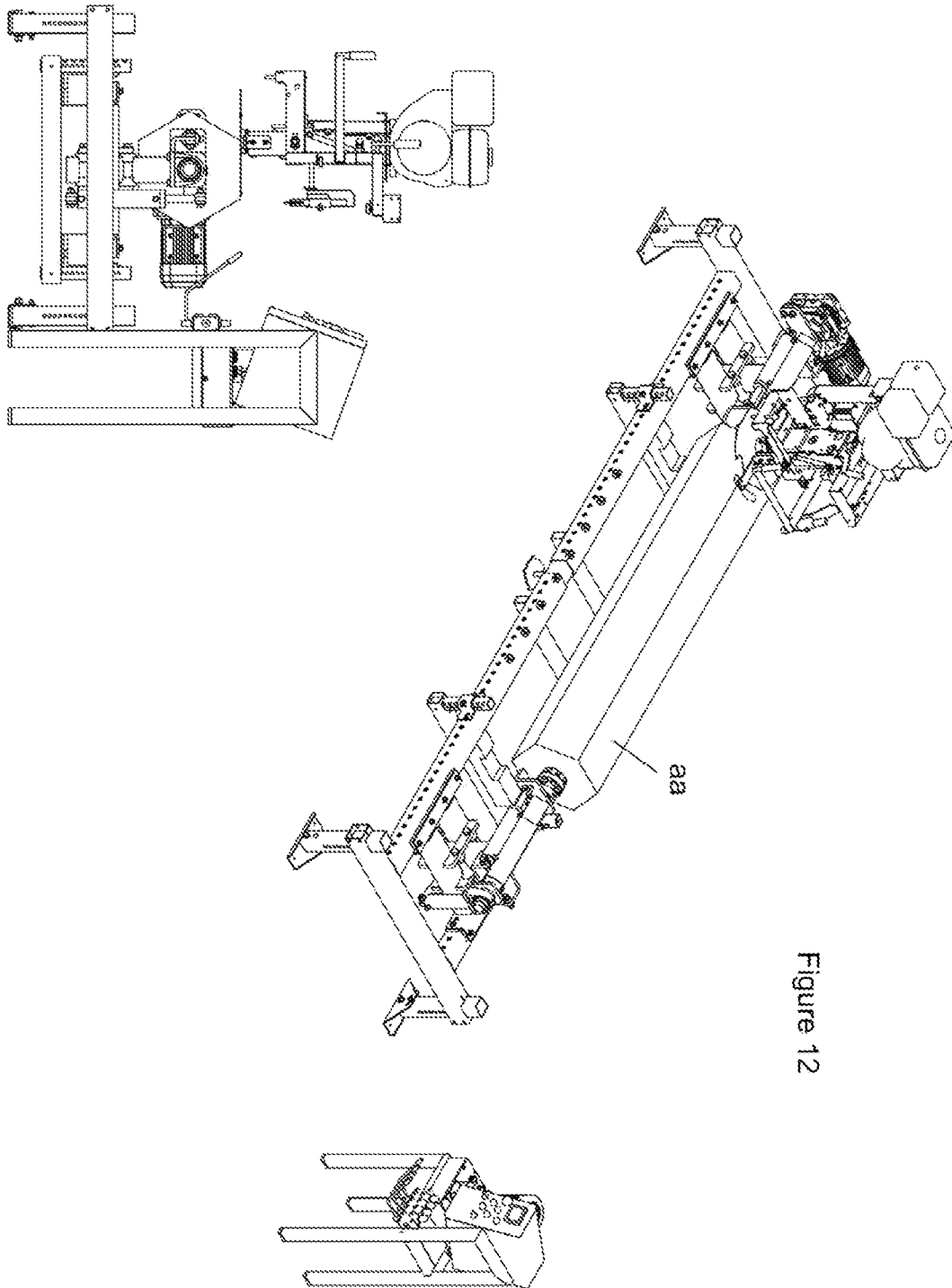
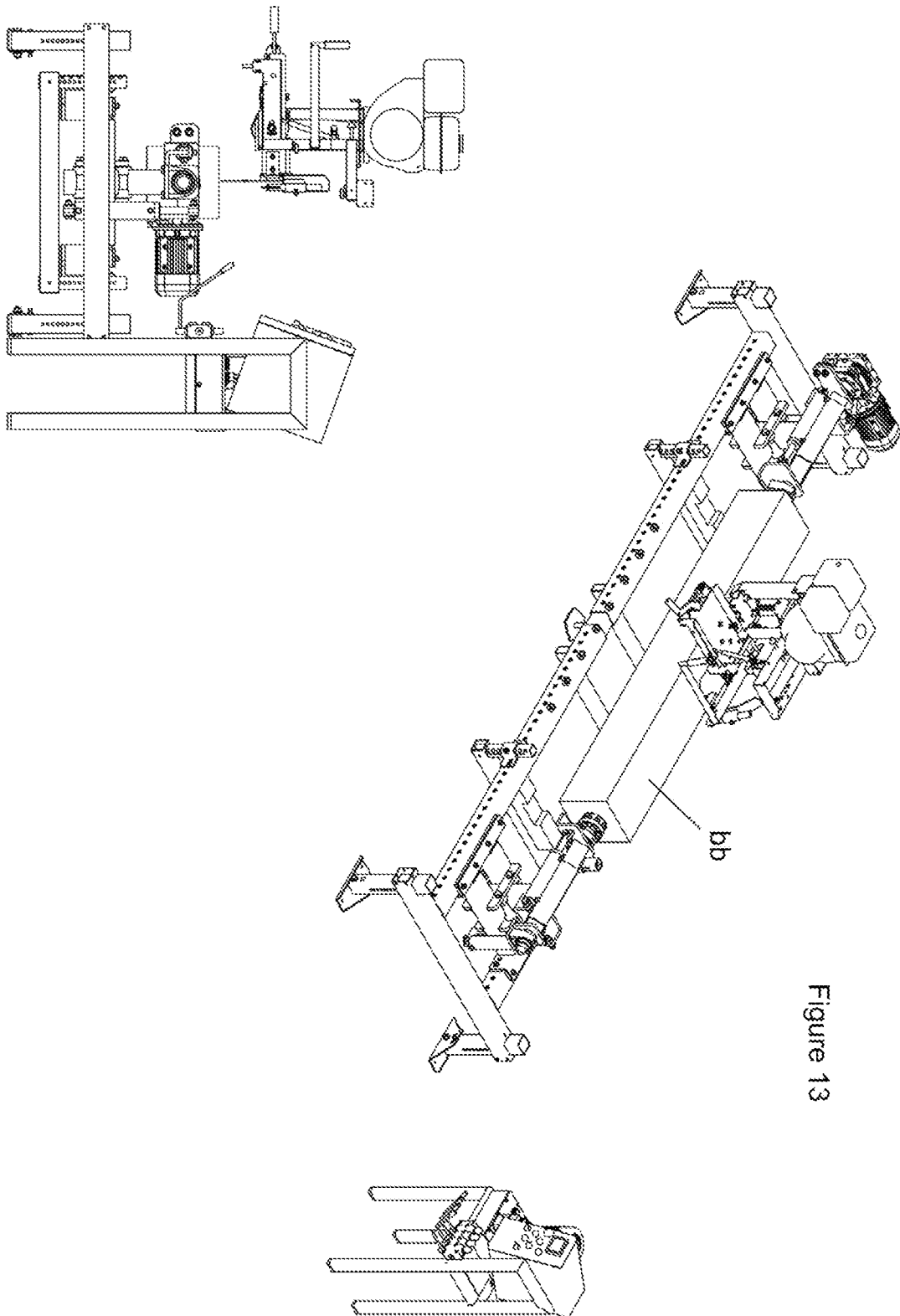


Figure 10







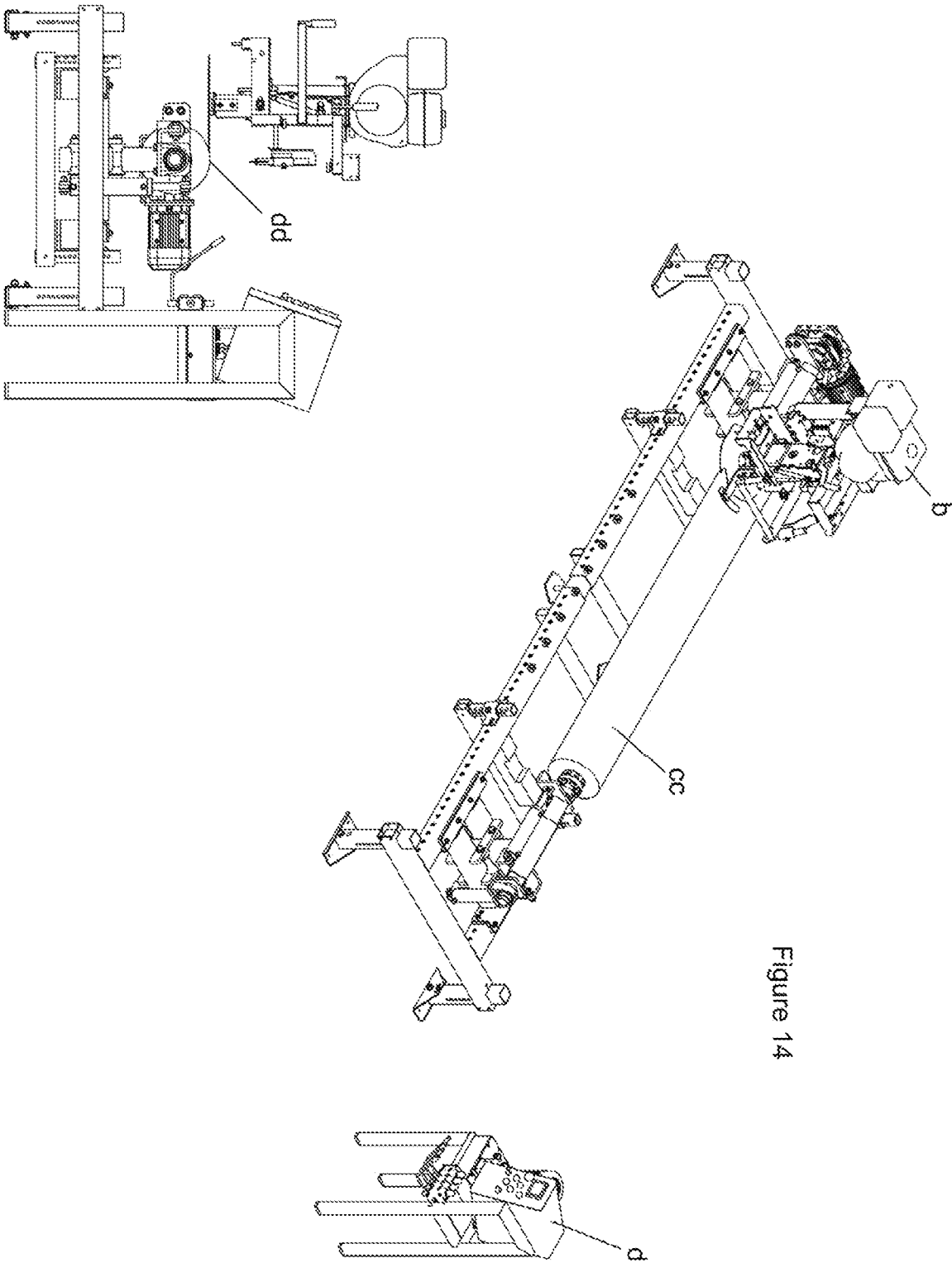


Figure 14

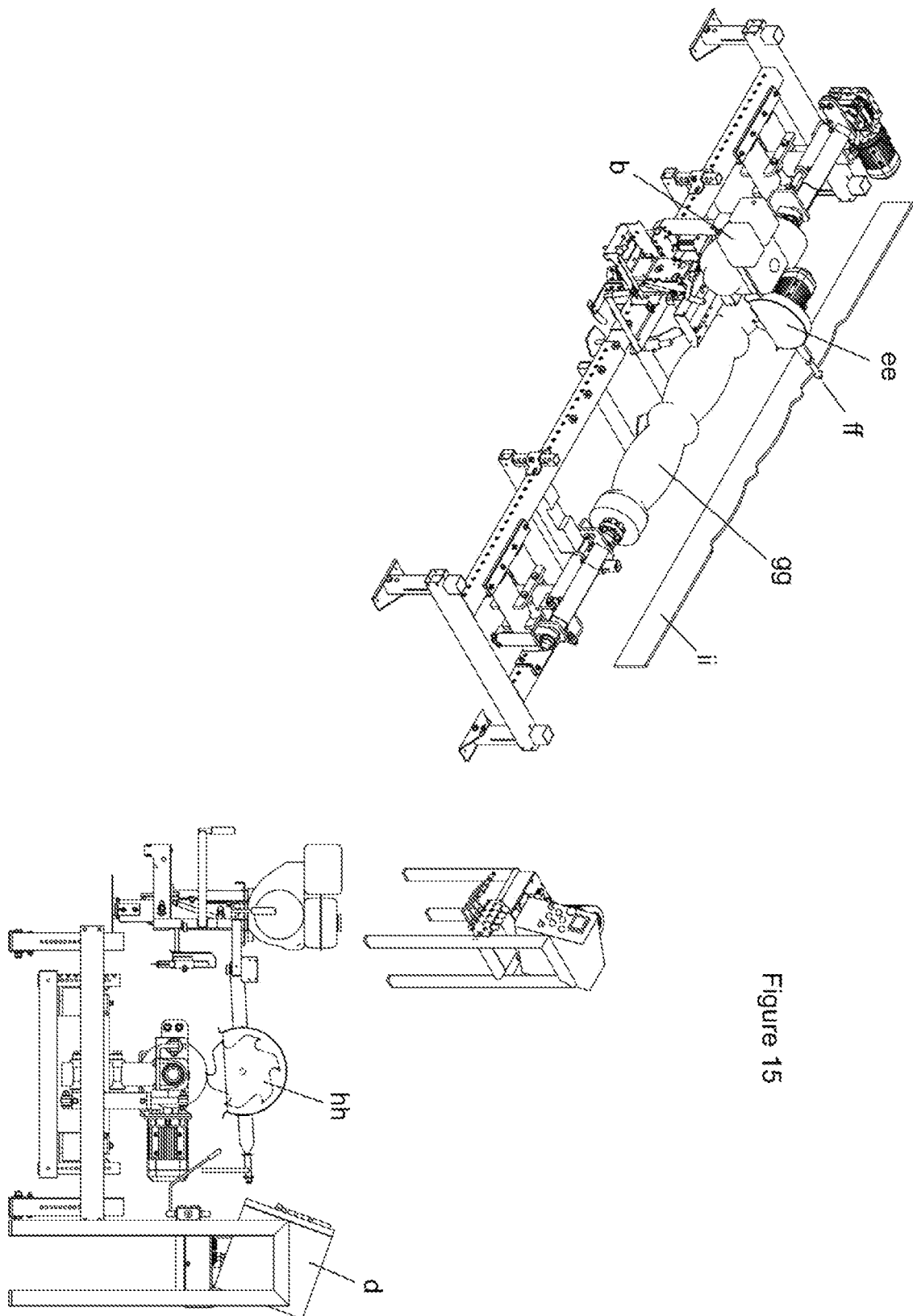


Figure 15

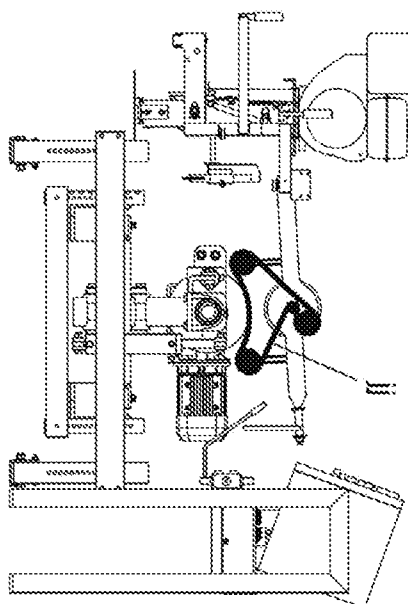
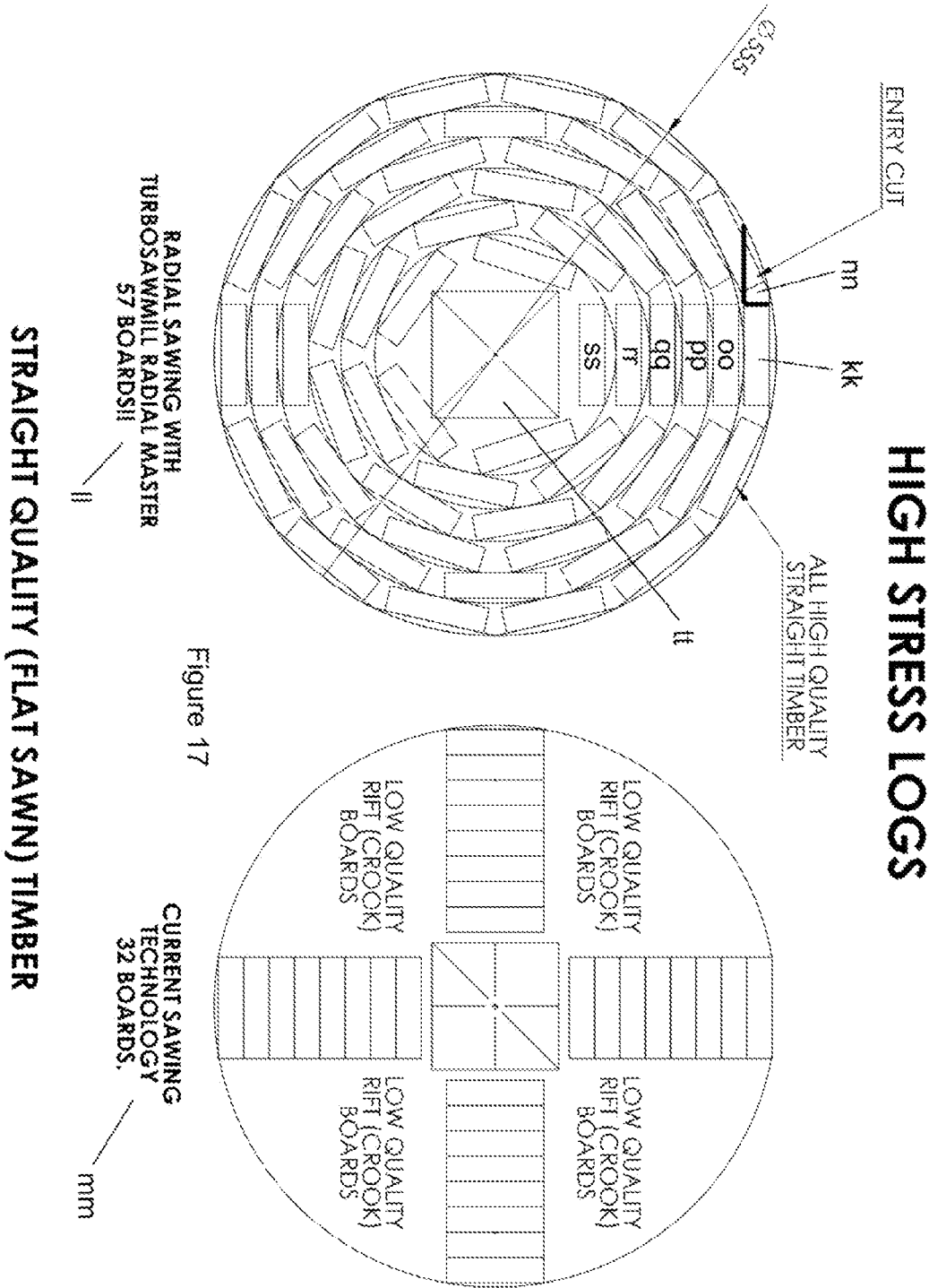
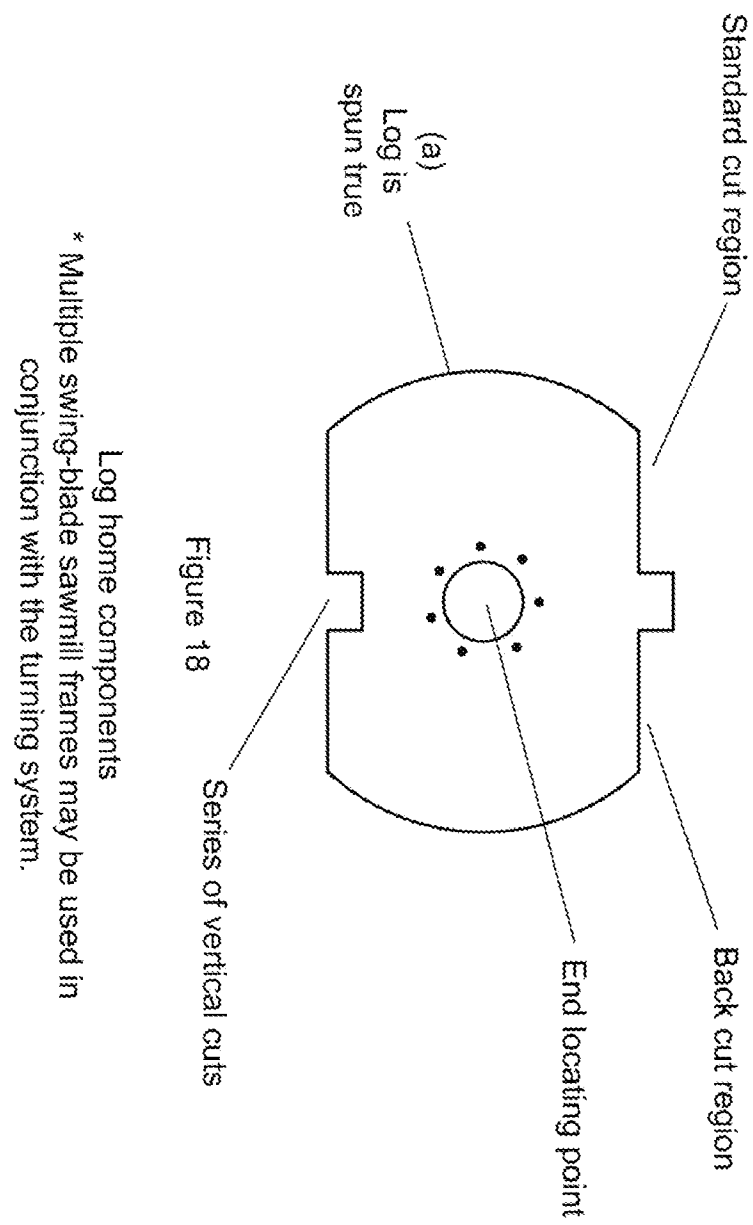


Figure 16





INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2018/050051**A. CLASSIFICATION OF SUBJECT MATTER****B27B 33/02(2006.01)i, B27B 29/06(2006.01)i, B27B 31/02(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B27B 33/02; B02C 25/00; B27C 9/00; B23B 3/36; B23B 3/00; B27B 7/04; B27L 7/00; B27B 15/08; B27B 17/02; B27B 29/06; B27B 31/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: mobile saw mill, log deck, mounting spike, lift assembly, drive assembly, controller, disc blade, swing blade, laser range finder, display, camera, minimum log diameter, lumber characteristic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5806401 A (RAJALA et al.) 15 September 1998 See column 5, line 38 - column 6, line 61, column 8, lines 10-54, column 9, lines 34-58, column 11, lines 3-7 and figures 1-5.	1-20
Y	US 4307641 A (SHAPLEIGH, ROBERT) 29 December 1981 See column 2, lines 7-47, column 3, line 10 - column 4, line 35 and figures 1, 5.	1-18
Y	US 4879659 A (BOWLIN et al.) 07 November 1989 See column 5, lines 7-56, column 7, lines 43-49 and figure 13.	8, 9, 11, 19, 20
Y	US 4895197 A (ANDERSEN, ERLING J.) 23 January 1990 See column 3, lines 4-11 and figure 1.	20
A	US 2002-0038587 A1 (RIOUX, YVES) 04 April 2002 See paragraphs [0032]-[0046] and figures 1-6.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09 August 2018 (09.08.2018)

Date of mailing of the international search report

13 August 2018 (13.08.2018)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/NZ2018/050051

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 4307641 A	29/12/1981	None	
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