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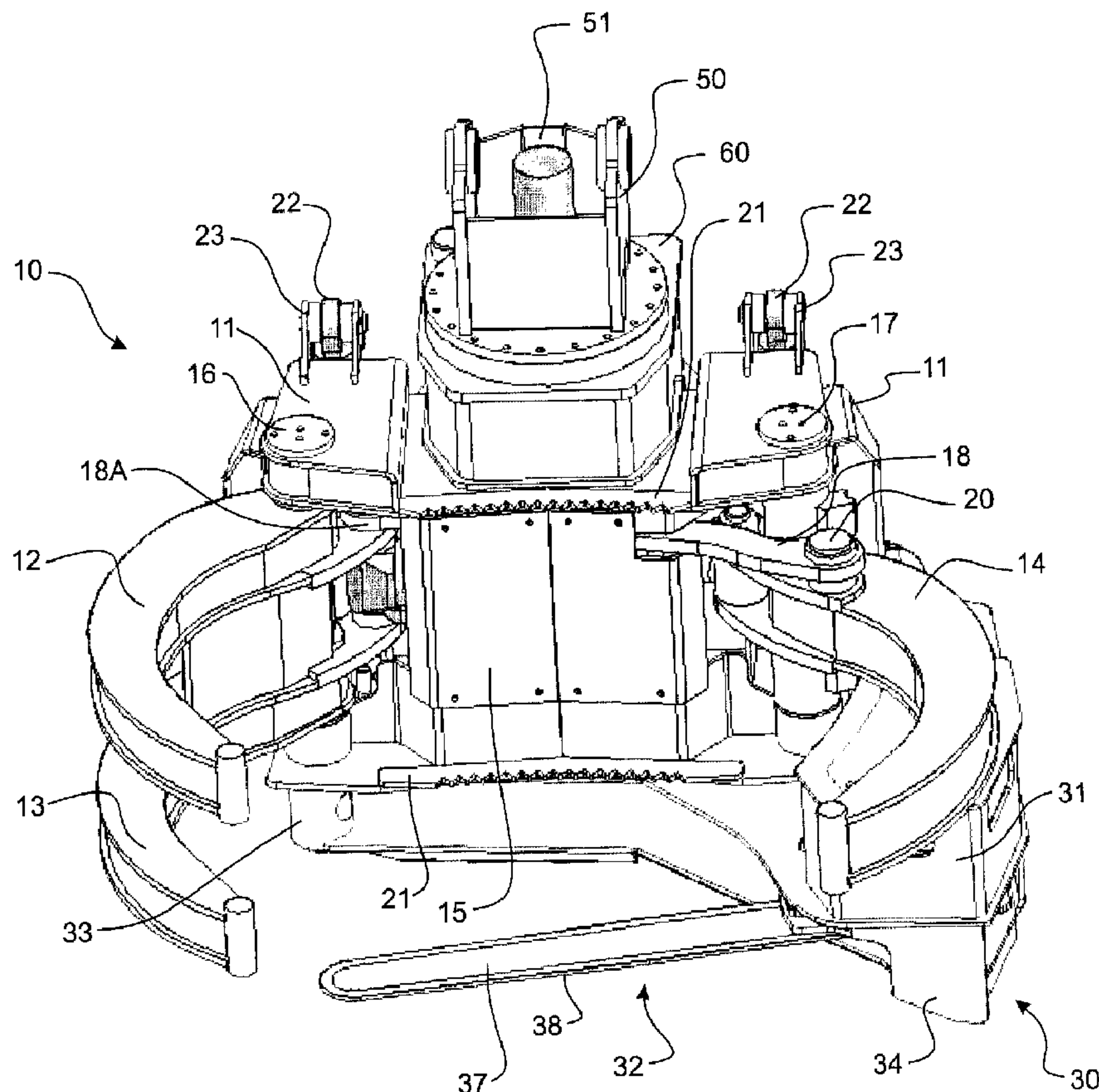
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(54) **Titre : ABATTAGE D'ARBRE ET TETE D'ACCROCHAGE**

(54) **Title: TREE FELLING AND GRAPPLING HEAD**



(57) **Abrégé/Abstract:**

A grapple and severing head for gripping and severing a tree stem, having a grapple assembly and a severing assembly 30. Grapple arms 12, 13, 14 are attached to a grapple body 11 and extend forward beyond a front face of the grapple body. A severing

(57) Abrégé(suite)/Abstract(continued):

assembly body 31 is attached to the grapple body and is moveable between a retracted position and an extended position. A severing device 32 is attached to the severing assembly body 31 and is moveable between a stowed position and a range of deployed positions. When the severing device 32 is in the stowed position and the severing assembly body 31 is in the retracted position, the severing device and the severing assembly body lie substantially behind the front face of the grapple body and/or behind the gripping face of at least one of the grapple arms.

ABSTRACT

A grappling and severing head for gripping and severing a tree stem, having a grapple assembly 10 and a severing assembly 30. Grapple arms 12, 13, 14 are attached to a grapple body 11 and extend forward beyond a front face of the grapple body. A severing assembly body 31 is attached to the grapple body and is moveable between a retracted position and an extended position. A severing device 32 is attached to the severing assembly body 31 and is moveable between a stowed position and a range of deployed positions. When the severing device 32 is in the stowed position and the severing assembly body 31 is in the retracted position, the severing device and the severing assembly body lie substantially behind the front face of the grapple body and/or behind the gripping face of at least one of the grapple arms.

TREE FELLING AND GRAPPLING HEAD

FIELD OF INVENTION

5 The present invention relates to a tree felling and grapple head and in particular to a tree felling and grapple head for attachment to a boom of vehicle used in forestry or logging operations. The head has grapple arms which can grip around the trunk of a tree, and a saw that can cut through the tree trunk being gripped by the grapple arms.

10 BACKGROUND

A tree felling head is attached to the boom of a vehicle and used in the forestry industry. Felling heads have been used for severing the tree stem from its stump and laying the severed stem on the ground for later extraction from the forest by other means. The cutting tools used
15 in felling heads may include circular saws, discs, guillotines and chainsaws. In the United States of America and Canada, circular saws and discs are more commonly used because tree size is relatively small. Chainsaw cutting mechanisms are typically used for tree felling operations in New Zealand where average tree sizes are significantly larger.

20 Felling heads are also used for grappling or shovelling operations in which felled stems are picked up off the ground and repositioned to facilitate more efficient or cost effective extraction to a site where the stems will ultimately be loaded onto transport, for example trucks or railway cars.

25 United States patent 5,390,715 describes an apparatus for cutting and pruning trees. A grapple and saw assembly 23 includes a grapple assembly 29 and a saw assembly 50. The saw assembly is attached to the output shaft 48a of a rotary hydraulic motor 48. The motor and the grapple assembly are attached to a frame 24. The saw assembly includes a chain saw hydraulic motor
30 51. A positioning mechanism permits the saw assembly to rotate through an arc of 360 degrees independently of movement of the grapple assembly.

United States patent 6,374,877 describes a bar saw feller buncher and method of felling trees. Harvesting arms 18, 20, 22 are pivotally attached to a frame 12 of a bar saw felling head 10. A bar saw 14, includes a saw bar and cutting chain is driven by a motor 16. A rotary or linear hydraulic actuator may rotate the bar saw through 90 degrees about the axis of the chain saw drive motor 16, or a different axis, to move the saw between a home position, in which the saw is housed in an open-sided box 40, and a cocked position.

United States patent 7,311,126 and corresponding New Zealand patent 532008 describe a grapple head assembly with a grapple 1 and a cut-off chain saw 30. A hydraulic saw drive motor 20 is mounted in a head portion 20 of the grapple. The saw bar 42 pivots about the saw drive sprocket 25, which is preferably coaxial with a pivot axis of a jaw 4 of the grapple.

The effectiveness of grappling or shovelling by prior art felling heads is limited due to the position of the saw box that houses the cutting mechanism.

In this specification where reference has been made to patent specifications, other external documents, or other sources of information, this is generally for the purpose of providing a context for discussing the features of the invention. Unless specifically stated otherwise, reference to such external documents or such sources of information is not to be construed as an admission that such documents or such sources of information, in any jurisdiction, are prior art or form part of the common general knowledge in the art.

SUMMARY OF INVENTION

At least one embodiment of the invention provides a tree felling and grappling head with a repositionable severing mechanism, or at least to provide the public with a useful choice.

In a first aspect, there is described a tree felling and grappling head for gripping and severing a tree stem, the tree felling and grappling head comprising: a grapple assembly comprising a grapple body and opposing grapple arms that define a grapple zone, the grapple arms being at

respective opposite sides of the grapple zone; a coupling head by which the tree felling and grapple head can be suspended from a supporting device; a saddle that is rotatably attached to the coupling head for rotation of the saddle, relative to the coupling head, about a saddle rotation axis; and a severing assembly comprising a severing assembly body and a severing device; wherein: the grapple body is tiltable relative to the saddle through at least 90 degrees about a grapple body tilt axis that is substantially perpendicular to the saddle rotation axis, between a tree felling configuration and a grapple configuration; the grapple arms are attached to the grapple body and extend forward beyond a front face of the grapple body when the grapple body is in the tree felling configuration; each of the grapple arms has a gripping face for contacting an object when gripped by the grapple arms; a rear portion of the grapple zone is adjacent the front face of the grapple body and a forward portion of the grapple zone is adjacent free ends of the grapple arms; the severing assembly body is pivotally attached to the grapple body at a severing assembly body pivot axis for pivoting relative to the grapple body, between a retracted position and an extended position; the severing device is pivotally attached to the severing assembly body for pivoting about a severing device pivot axis, relative to the severing assembly body, between a stowed position and a range of deployed positions; the severing assembly body pivot axis and the severing device pivot axis are respectively at the opposite sides of the grapple zone; and the severing device pivot axis is substantially parallel to the severing assembly body pivot axis; wherein when the severing device is in the stowed position and the severing assembly body is in the retracted position, the severing device and the severing assembly body lie substantially behind the front face of the grapple body, behind the gripping face of at least one of the grapple arms, or both substantially behind the front face of the grapple body and behind the gripping face of at least one of the grapple arms; and wherein when the grapple body is in the tree felling configuration and the severing assembly body is in the extended position, the severing device pivot axis is positioned forward of the front face of the grapple body toward the forward portion of the grapple zone so that the severing device can perform a cut in a direction away from the grapple body, with a final portion of the cut positioned at or adjacent the forward portion of the grapple zone.

Preferably, the grapple arms are pivotally attached to the grapple body at grapple arm pivot axes for pivoting, relative to the grapple body, between an open arm configuration and a closed arm configuration.

- 5 Preferably, the severing assembly body pivot axis and at least one grapple arm pivot axis are a common axis. In an alternative embodiment, the severing assembly body pivot axis is different from any of the grapple arm pivot axes.

- 10 Alternatively, the tree felling and grappling may comprise at least two grapple arms on one side of the grapple body and at least one opposed grapple arm on the other side of the grapple body, wherein the least two grapple arms are pivotally attached to the grapple body for pivotal rotation about a first grapple arm pivot axis and the at least one grapple arm is pivotally attached to the grapple body for pivotal rotation about a second grapple arm pivot axis, for moving the grapple arms between an open arm configuration and a closed arm configuration, and the severing assembly body is pivotally attached to the grapple body for pivotal rotation about the first grapple arm pivot axis.

Preferably, the saddle is rotatable, relative to the coupling head, through at least 360 degrees.

- 20 Preferably, the grapple arm pivot axes are substantially coplanar and the grapple body is tiltable, relative to the saddle, through at least 90 degrees, and preferably at least about 150 degrees, for moving the grapple arm pivot axes between a substantially horizontal orientation and a substantially vertical orientation, when the saddle rotation axis is substantially vertical.

- 25 The housing may house an actuator for moving the severing device between the stowed position and the range of deployed positions, and may house an actuator for moving the severing assembly body between the retracted position and the extended position.

- 30 Preferably, the severing device is a chain saw, and the chain saw comprises a bar which carries a cutting chain and is pivotally attached to the housing for movement of the chain saw between the stowed position and the range of deployed positions.

In a second aspect, there is described a method of using a tree felling and grapple head as described above, the method comprising: a. with the severing device in the stowed position, positioning the tree felling and grapple head, and closing the grapple arms to grip a portion of the stem of a standing tree with the grapple arms; b. with the severing assembly body in the
5 extended position, progressively extending the severing device through the range of severing positions to sever the stem below the gripped portion; c. retracting the severing device to the stowed position; d. allowing the weight of the severed stem to reorient the tree felling and grapple head and e. opening the grapple arms to release the severed stem.

10 Preferably, the method comprises the additional steps of: f. retracting the severing assembly body to the retracted position; and g. positioning the tree felling and grapple head, and closing the grapple arms to grab the stem of a felled tree with the grapple.

Preferably, the method comprises the further steps of: h. progressively extending the severing
15 device through the range of severing positions to sever the grabbed stem; and i. retracting the severing device to return the severing device to the stowed position.

Preferably, the method comprises the further steps of: j. relocating the grabbed stem: and k.
20 opening the grapple arms to release the grabbed stem.

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more said parts, elements or features.

25 To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures

and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

5 The term ‘comprising’ as used in this specification or in the accompanying claims means ‘consisting at least in part of’, that is to say when interpreting statements in this specification or in the accompanying claims which include that term, the features, prefaced by that term in each statement, all need to be present but other features can also be present.

10 The term “behind”, as used in this specification or in the accompanying claims to define a positional relationship of one feature with respect to another feature, is to be understood as meaning that one of the features is further back than the other feature, but is not necessarily directly in line behind the other feature.

15 As used herein, the term “and/or” means “and” or “or”, or both.

As used herein, “(s)” following a noun means the plural and/or singular forms of the noun.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Preferred embodiments and methods of utilising the invention will be further described by way of example only and without intending to be limiting, with reference to the accompanying figures in which:

25 Figure 1 shows a front perspective view of a grappling and severing head according to the invention, with a grapple body tilted to an upward position, grapple arms extended forwardly in a partially open configuration, a severing assembly body in an extended position, and a chain saw in a deployed position;

Figure 2 shows a side perspective view of the grappling and severing head of Figure 1, with the grapple body tilted to the upward position, the grapple arms extended forwardly in a partially open configuration, the severing assembly body in the extended position, and the chain saw in the deployed position;

Figure 3 shows a front perspective view of the grappling and severing head of Figures 1 and 2, with the grapple body tilted to the upward position, the grapple arms extended forwardly in a closed configuration, the severing assembly body in the extended position, and the chain saw in a stowed position;

Figure 4 shows a perspective view of the grappling and severing head of Figures 1 to 3, with the grapple body tilted to the upward position, the grapple arms extended forwardly in a partially open configuration, the severing assembly body in the extended position, and the chain saw in a deployed position;

Figure 5 shows a perspective view of the grappling and severing head of Figures 1 to 4, with the grapple body tilted to the upward position, the grapple arms extended forwardly in a partially open configuration, the severing assembly body in the extended position, and the chain saw in the stowed position;

Figure 6 shows a front view of the grappling and severing head of Figures 1 to 5, with the grapple body tilted to a downward position, the grapple arms extended downwardly in the open configuration, the severing assembly body in the extended position, and the chain saw in the stowed position;

Figure 7 shows a rear view of the grappling and severing head of Figures 1 to 6, with the grapple body tilted to the downward position, the grapple arms extended downwardly in the open configuration, the severing assembly body in the extended position, and the chain saw in the stowed position;

Figure 8 shows a sectioned bottom view of the grappling and severing head of Figures 1 to 7, as seen looking up from below the head and sectioned below the chain saw but above a lower wall of a chain saw housing of the severing assembly body, with the grapple body tilted to the upward position, the grapple arms extended forwardly in the open configuration, the
 5 severing assembly body in the extended position, and the chain saw in the stowed position;

Figure 9 shows a sectioned bottom view of the grappling and severing head of Figures 1 to 8, as seen looking up from below the head and sectioned below the chain saw but above the lower wall of the chain saw housing, with the grapple body tilted to the upward position, the
 10 grapple arms extending partially forward in the closed configuration, the severing assembly body in the extended position, and the chain saw in the stowed position;

Figure 10 shows a front view of the grappling and severing head of Figures 1 to 9, with the grapple body tilted to the downward position, the grapple arms extended downwardly in the
 15 open configuration, the severing assembly body in the retracted position, and the chain saw in the stowed position;

Figure 11 shows a rear view of the grappling and severing head of Figures 1 to 10, with the grapple body tilted to the downward position, the grapple arms extended downwardly in the
 20 open configuration, the severing assembly body in the retracted position, and the chain saw in the stowed position;

Figure 12 shows a sectioned bottom view of the grappling and severing head of Figures 1 to 11, as seen looking up from below the head and sectioned below the chain saw but above
 25 the lower wall of the chain saw housing, with the grapple body tilted to the upward position, the grapple arms extended forwardly in the open configuration, the severing assembly body in the retracted position, and the chain saw in the stowed position; and

Figure 13 shows a sectioned bottom view of the grappling and severing head of Figures
 30 1 to 12, as seen looking up from below the head and sectioned below the chain saw but above the lower wall of the chain saw housing, with the grapple body tilted to the upward position, the

grapple arms extended partially forward in the closed configuration, the severing assembly body in the retracted position, and the chain saw in the stowed position.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

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Referring to the figures it will be appreciated that the invention may be implemented in various forms and modes. The following description of embodiments of the invention is given by way of example only.

10 The figures show a grappling and severing head for use in forestry harvesting operations and particularly for gripping and severing a tree stem or trunk. The grappling and severing head comprises a grapple assembly 10 and a severing assembly 30.

The grapple assembly 10 comprises a grapple body 11 and three grapple arms 12, 13 and 14.
15 Each grapple arm extends forward beyond a bed plate 15 at a front face of the grapple body.

The severing assembly 30 comprises a severing assembly body 31 and a severing device, such as chain saw 32, which is attached to the severing assembly body.

20 The grapple arms 12, 13 and 14 are progressively reconfigurable between an open arm configuration shown in Figures 1, 2, 6 to 8 and 10 to 12, and a closed arm configuration shown in Figures 3, 7, 9 and 13. Partially-open arm configurations are shown in Figures 4 and 5.

The severing assembly body 31 is pivotally attached to the grapple body 11 at pivot 33, shown
25 in Figures 1, 4 and 5. The severing assembly body is pivotable, relative to the grapple body, about a severing assembly body pivot axis at pivot 33 for moving the severing assembly body 31 between an extended position, shown in Figures 1 to 9, and a retracted position, shown in Figures 10 to 13.

30 The severing assembly body 31 is positioned in its retracted position when the grapple and severing head is to be used in a shovelling or grappling mode in which the grapple and severing

head grips, and optionally severs, the stem of an already-felled tree. In this retracted grappling position, the severing assembly body 31 lies substantially behind the bed plate 15 at the front face of the grapple body 11.

5 The severing assembly body 31 is positioned in the extended position when the grapple and severing head is to be used in a felling mode in which the grapple and severing head grips and then severs the stem of a standing tree to fell the tree. In this extended felling position, at least a substantial portion of the severing assembly body 31 extends in front of the bed plate 15 at the front face of the grapple body 11.

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The severing assembly body 31 comprises a housing 34. The severing device, which is preferably a chain saw 32 as shown in the figures, is moveably attached to the housing for movement between a stowed position, shown in Figures 3 and 5 to 13, and a range of deployed positions, some of which are shown in Figures 1, 2 and 4. In the stowed position, the chain
15 saw 32 is stowed substantially inside the housing 34. In the deployed positions, a severing portion of the chain saw extends outside the housing for cutting and severing a stem held in the grapple.

The housing 34 houses a first hydraulic actuator or ram 35, partially shown in Figure 2, 4 and 5,
20 which is extended and retracted to move the chain saw 32 between the stowed position and the range of deployed positions. The housing also houses a second hydraulic actuator or ram 36, shown at least partially in Figures 2 and 4, 5, 8, 9, 12 and 13, which is extended and retracted to pivot the severing assembly body 31 and move it between its extended position, shown in Figures 1 to 9, and its retracted position, shown in Figures 10 to 13.

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The chain saw 32 has a bar 37 that carries an endless cutting chain 38 driven by hydraulic motor 39, via a chain drive sprocket 40 located at the proximal end of the bar, as best seen in Figures 6 to 9. The chain saw bar is pivotally attached to the housing 34 for pivoting about the axis of the chain drive sprocket 40, to pivot the chain saw between the stowed position and the range
30 of deployed positions.

The chain saw bar 37 pivot axis, at the axis of the chain drive sprocket 40, is spaced apart from, and substantially parallel to, the severing assembly pivot axis at pivot 33. In the embodiment shown in the figures, these two pivot axes are on opposite sides of the grapple zone between the opposing grapple arms. Extension and retraction of the severing assembly body 31 moves
5 the pivot axis of the chain saw bar respectively forward and rearward of the bed plate 15 at the front of the grapple body 11.

The chain saw motor 39 is housed, as are the actuators 35 and 36, inside the housing 34 to protect these components from impacts, for example with other machinery or with trees, logs
10 or the ground. Apertures are provided in the walls of the housing for inspection and servicing of components in the housing. The apertures are covered, in use, by cover plates which have been omitted from the figures to show the internal components.

Two of the grapple arms 12 and 13 are pivotally attached to the grapple body 11 for pivotal
15 rotation of these two grapple arms, relative to the grapple body, about a first grapple arm pivot axis at pivot 16. A third grapple arm 14 opposes the two grapple arms and is pivotally attached to the grapple body 11 for pivotal rotation of the third grapple arm, relative to the grapple body, about a second grapple arm pivot axis at pivot 17. The three grapple arms pivot about the respective pivots to move the grapple arms between the open arm configuration and the
20 closed arm configuration.

The grapple arm pivot axes are substantially coplanar and substantially parallel, and the severing assembly body pivot axis at pivot 33 and the pivot axis of the two grapple arms 12 and 13 at pivot 16 share a common axis provided by a single pivot pin.
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The two grapple arms 12 and 13 are a unitary construction and move together about their common pivot 16. One end of a link 18 is pivotally attached to the opposing third grapple arm 14 at a pivot pin 20 located in front of the pivot 17 about which the opposing third grapple arm 14 rotates. The other end 18A of the link 18 is pivotally attached to a rearward extension of the
30 two grapple arms 12 and 13, at a pivot 19 (seen in Figure 5). A hydraulic ram (not shown) is housed in the grapple body 11 and is pivotally attached to a rearward extension of the opposing

third grapple arm 14 to rotate that arm about its pivot 17. Rotation of the opposing third grapple arm 14 is coupled via linkage 18 to simultaneously rotate the two grapple arms 12 and 13 in an opposite direction about their common pivot 16, to move the three grapple arms between the open and closed arm configurations.

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The grappling and severing head also comprises a coupling head 50 by which the grappling and severing head can be suspended from a supporting device (not shown), such as the boom of a vehicle. The grappling and severing head may further comprise a saddle 60 that is rotatably attached to the coupling head 50 for unlimited rotation of the saddle through 360 degrees or more, relative to the coupling head, about a saddle rotation axis at a pivot pin 62 (an upper end of which may be seen in Figures 2, 4 and 5). A hydraulic motor 51, shown in Figures 1 and 3, is located in the coupling head 50, for rotating the saddle relative to the coupling head.

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The grapple body 11 is pivotally attached to the saddle 60 for tilting of the grapple body through at least 90 degrees, and preferably at least 165 degrees, relative to the saddle, about a grapple body tilt axis at saddle pivot 61. The grapple body tilt axis at saddle pivot 61 is substantially perpendicular to the saddle rotation axis at pivot pin 62.

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Two hydraulic rams 22 are connected between respective ram mounts 23 on the grapple body 11 and respective pivot pins 63 on the saddle 60, and are simultaneously extended or retracted to tilt the grapple body relative to the saddle. The rams 22 are extended to lift the grapple body to an initial felling position, with the grapple arms extending substantially horizontally, as shown in the figures, for gripping the stem of a standing tree about to be felled. After the stem has been severed, the rams 22 can be retracted to tilt and lower the grapple body to a grapple position to tilt and lower the severed stem to the ground. In the grapple position, shown in Figures 10 and 11, the grapple arms 12, 13 and 14 extend downward from the grapple body 11 which hangs below the saddle 60. With the grapple body in this grapple position, the grapple and severing head is useful for further processing of already-felled trees, as described below.

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When the saddle rotation axis is substantially vertical, the grapple body tilt axis is substantially horizontal, and the grapple arm pivot axes at the pivots 16, 17 can be moved, by tilting the

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grapple body 11 relative to the saddle 60 about saddle pivot 61, between a substantially vertical orientation, shown in Figures 1 to 5, 8, 9, 12 and 13, (useful when gripping upright stems or trunks of trees preparatory to felling) and a substantially horizontal orientation, shown in Figures 6, 7, 10 and 11, (useful when grappling felled stems or logs that are lying, or piled, on the ground).

Stationary blades 21 are fitted at opposite ends of the bed plate 15 of the grapple body 11. The blades are preferably provided with a serrated edge for improving the grip of the grapple on a stem, log or tree trunk held between the grapple arms. The serrated blade edges dig into the bark of a gripped stem to help prevent the stem from twisting or sliding in the grapple.

The grappling and severing head described above may be used to process forestry trees, and is particularly useful for tree felling operations, for shovel logging, for putting felled stems through delimbers or debarkers, for cutting logs to length, for repositioning or stacking felled trees and logs, and for loading logs onto transport such as railway cars or truck and trailer combinations. The term 'shovel logging' refers to the repeated repositioning of felled stems, to a position in readiness for removal from the forest, using an excavator-style machine with a boom and grapple head attachment.

In a typical method of using the grappling and severing head described above, the chain saw 32 is retracted to the stowed position in the housing 34 of the severing assembly 30, the severing assembly is extended to the felling position, and the grapple arms 12, 13 and 14 are opened to the open arm configuration, all as shown in the bottom view of Figure 8. The grapple and severing head is positioned with the open grapple arms around the stem or trunk of a standing tree, and the arms closed, as shown in the bottom view of Figure 9, to grip the stem or trunk by the grapple.

The chain saw 32 is then progressively extended outward from the housing 34 to pivot through the range of deployed severing positions for cutting through the stem below the gripping grapple arms 12, 13 and 14. With the severing assembly body 31 extended to the felling position, the chain saw 32 can be progressively extended through the range of deployed

severing positions to cut through the tree stem. The cut is completed by cutting the last outermost part of the tree stem at the furthestmost point from the bed plate 15 of the grapple body. When completing the cut, the pivoting bar of the chain saw is aligned approximately parallel to the bed plate 15 at the front face of the grapple body 11.

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When the severing assembly body 31 is in the fully extended position, the pivoting bar of the chain saw 32 can be aligned approximately parallel to the bed plate 15 at the front face of the grapple body 11 when the saw is about to completely sever a larger diameter tree stem. When the cut is about to be completed, it is advantageous for the remaining uncut segment of the tree stem to be furthestmost from the bedplate and for the chord of the remaining uncut segment to be at least approximately parallel to the bed plate.

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After severing the stem, the grapple may initially maintain the stem upright. The chain saw is retracted to its stowed position in the housing 34 of the severing assembly 30, and the grapple body and grapple arms partially assist the direction of the falling stem. The two hydraulic rams 22 controlling the tilt of the grapple body 11, and the hydraulic motor 51 controlling rotation of the saddle 60, are put in a float mode to allow the weight of the severed stem to tilt and rotate the grapple body as the stem falls to the ground. The operator of the vehicle boom, from which the grapple and severing head is suspended, can also move the boom to help control the falling tree. The hydraulic ram housed in the grapple body 11 is operated to open the grapple arms 12, 13 and 14 and release the grip of the grapple on the stem.

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When the severing assembly 30 is retracted to the grappling position, the chain saw pivot at the drive sprocket 40 is substantially in line with the bed plate 15, and the severing assembly is substantially clear of the grapple arms 12, 13 and 14 which are then free to grab one or more felled logs or stems. By stowing the chain saw 32 in the housing 34 and retracting the severing assembly substantially behind the bed plate 15 at the front face of the grapple body, the severing assembly and chain saw are relatively protected from damage and do not intrude substantially into the grappling zone. In this configuration, the grapple and severing head can be used to pick up felled stems, for example when shovel logging, sorting or stacking logs in readiness for loading, or when loading logs onto transport, or when the grapple and severing

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head is used in conjunction with a static delimber, without substantial interference from the severing assembly.

5 When the severing assembly is retracted to the grapple position, the chain saw can be progressively extended through the range of severing positions to cut through the log or stem held by the grapple arms, for example for cutting felled logs to pre-determined lengths preparatory to loading onto transport.

10 It is to be understood that all operations of the grapple and severing head can be performed simultaneously and without regard to the operational position or configuration of any component part of the grapple and severing head. For example, the grapple arms 12, 13 and 14 can be positioned at either the open arm configuration or the closed arm configuration, or anywhere between those two configurations, and the chain saw 32 can be driven and extended and retracted, when the severing assembly 30 is positioned in either the felling or grapple
15 modes or in any intermediate position between those two modes. Furthermore, these operations can be performed for any tilt position of the grapple body 11 relative to the saddle 60, or any rotational position of the saddle 60 relative to the coupling head 50.

20 In one preferred embodiment of the invention, the maximum stem or log diameter that can be cut is 1 metre in the felling configuration and 0.7 metre in the grapple configuration.

Specific embodiments of the invention have been described above by way of example only, and modifications and improvements as would be obvious to those skilled in the art may be made to the invention without departing from the scope of the invention as defined by the following
25 claims.

In one such modification, the chain saw of the severing device is substituted by a circular saw, disc or guillotine. The use of a circular saw or disc may be useful where typical tree sizes are relatively smaller, for example in the United States of America or Canada, than in New Zealand
30 where chain saw cutting mechanisms are found to be more suitable for the significantly larger tree sizes.

In another modification, the severing assembly body 31 is moved linearly instead of pivoting as described above, to move between a retracted position and an extended position. Similarly, the chain saw 32 or other severing device could be moved linearly, relative to the severing assembly
5 body 31, instead of pivoting.

It is to be understood that although three grapple arms are shown in the embodiment described above, any suitable number of grapple arms may be employed. At least one arm is moveable to open and close the grapple.
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It is also to be understood that when the severing assembly body is in the retracted position and the severing device is in the stowed position, the severing assembly body and the severing device lie substantially behind, i.e. further back than, the front face of the grapple body or lie substantially behind the gripping face of at least one of the grapple arms, even when the grapple
15 arms are in an open-arm configuration, so that the severing assembly body and the severing device are clear of the grappling zone, i.e. are clear of a stem or tree or log being grappled by the grappling and severing head. When the severing assembly body is in the retracted position and the severing device is in the stowed position, a portion or all of either one or both of the severing assembly body and the severing device may be positioned to one side of the grapple
20 assembly, i.e. behind the gripping face of one of the grapple arms, and/or a portion or all of either one or both may be positioned behind the front face of the grapple body. In these positions, the severing assembly body and the severing device are relatively protected from inadvertent impacts and do not get in the way of the grapple arms when they are being used in the grappling or shovelling modes.

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**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A tree felling and grapple head for gripping and severing a tree stem, the tree felling
5 and grapple head comprising:
 - a grapple assembly comprising a grapple body and opposing grapple arms that
define a grapple zone, the grapple arms being at respective opposite sides of the
grapple zone;
 - a coupling head by which the tree felling and grapple head can be suspended
10 from a supporting device;
 - a saddle that is rotatably attached to the coupling head for rotation of the
saddle, relative to the coupling head, about a saddle rotation axis; and
 - a severing assembly comprising a severing assembly body and a severing
device;
 - 15 wherein:
 - the grapple body is tiltable relative to the saddle through at least 90 degrees
about a grapple body tilt axis that is substantially perpendicular to the saddle rotation
axis, between a tree felling configuration and a grapple configuration;
 - the grapple arms are attached to the grapple body and extend forward beyond
20 a front face of the grapple body when the grapple body is in the tree felling
configuration;
 - each of the grapple arms has a gripping face for contacting an object when
gripped by the grapple arms;
 - a rear portion of the grapple zone is adjacent the front face of the grapple
25 body and a forward portion of the grapple zone is adjacent free ends of the grapple
arms;
 - the severing assembly body is pivotally attached to the grapple body at a
severing assembly body pivot axis for pivoting relative to the grapple body, between a
retracted position and an extended position;
 - 30 the severing device is pivotally attached to the severing assembly body for
pivoting about a severing device pivot axis, relative to the severing assembly body,
between a stowed position and a range of deployed positions;

the severing assembly body pivot axis and the severing device pivot axis are respectively at the opposite sides of the grapple zone; and

the severing device pivot axis is substantially parallel to the severing assembly body pivot axis;

5 wherein when the severing device is in the stowed position and the severing assembly body is in the retracted position, the severing device and the severing assembly body lie substantially behind the front face of the grapple body, behind the gripping face of at least one of the grapple arms, or both substantially behind the front face of the grapple body and behind the gripping face of at least one of the
10 grapple arms; and

 wherein when the grapple body is in the tree felling configuration and the severing assembly body is in the extended position, the severing device pivot axis is positioned forward of the front face of the grapple body toward the forward portion of the grapple zone so that the severing device can perform a cut in a direction away
15 from the grapple body, with a final portion of the cut positioned at or adjacent the forward portion of the grapple zone.

2. The tree felling and grappling head as claimed in claim 1, wherein:

 the grapple arms are pivotally attached to the grapple body at grapple arm
20 pivot axes for pivoting, relative to the grapple body, between an open arm configuration and a closed arm configuration.

3. The tree felling and grappling head as claimed in claim 2, wherein the severing assembly body pivot axis and at least one grapple arm pivot axis are a common axis.

25

4. The tree felling and grappling head as claimed in claim 2, wherein the severing assembly body pivot axis is different from any of the grapple arm pivot axes.

5. The tree felling and grappling head as claimed in claim 1, comprising at least two
30 grapple arms on one side of the grapple body and at least one opposed grapple arm on the other side of the grapple body, wherein said at least two grapple arms are pivotally attached to the grapple body for pivotal rotation about a first grapple arm pivot axis and said at least one opposed grapple arm is pivotally attached to the grapple body for

pivotal rotation about a second grapple arm pivot axis, for moving the grapple arms between an open arm configuration and a closed arm configuration, and the severing assembly body is pivotally attached to the grapple body for pivotal rotation about the first grapple arm pivot axis.

5

6. The tree felling and grapping head as claimed in any one of claims 1 to 5, wherein the saddle is rotatable, relative to the coupling head, through at least 360 degrees.

7. The tree felling and grapping head as claimed in claim 6, when dependent on any one of claims 2 to 5, wherein the grapple arm pivot axes are substantially coplanar and the grapple body is tiltable, relative to the saddle, through at least 90 degrees for moving the grapple arm pivot axes between a substantially horizontal orientation and a substantially vertical orientation, when the saddle rotation axis is substantially vertical.

8. The tree felling and grapping head as claimed in claim 7, wherein the grapple body is tiltable, relative to the saddle, through at least about 150 degrees.

9. The tree felling and grapping head as claimed in any one of claims 1 to 8, wherein the severing assembly body comprises a housing, the stowed position of the severing device is substantially inside the housing, and, when the severing device is in the range of deployed positions, a severing portion of the severing device extends outside the housing.

10. The tree felling and grapping head as claimed in claim 9, wherein the housing houses an actuator for moving the severing device between the stowed position and the range of deployed positions.

11. The tree felling and grapping head as claimed in claim 9 or 10, wherein the housing houses an actuator for moving the severing assembly body between the retracted position and the extended position.

12. The tree felling and grapping head as claimed in any one of claims 9 to 11, wherein the severing device is a chain saw, and the chain saw comprises a bar which carries a cutting

chain and is pivotally attached to the housing for movement of the chain saw between the stowed position and the range of deployed positions.

13. The tree felling and grapple head as claimed in claim 12, wherein in one of the
5 deployed positions of the severing device when the severing assembly body is in the extended position, the bar of the chain saw is approximately parallel to the front face of the grapple body.
14. A method of using a tree felling and grapple head as claimed in any one of the
10 preceding claims, the method comprising:
- a. with the severing device in the stowed position, positioning the tree felling and grapple head, and closing the grapple arms to grip a portion of the stem of a standing tree with the grapple arms;
 - b. with the severing assembly body in the extended position, progressively
15 extending the severing device through the range of severing positions to sever the stem below the gripped portion;
 - c. retracting the severing device to the stowed position;
 - d. allowing the weight of the severed stem to reorient the tree felling and grapple head and
20 e. opening the grapple arms to release the severed stem.
15. The method of using a tree felling and grapple head as claimed in claim 14, comprising the further steps of:
- f. retracting the severing assembly body to the retracted position; and
25 g. positioning the tree felling and grapple head, and closing the grapple arms to grab the stem of a felled tree with the grapple.
16. The method of using a tree felling and grapple head as claimed in claim 15, comprising the further steps of:
- h. progressively extending the severing device through the range of severing positions to sever the grabbed stem; and
30 i. retracting the severing device to return the severing device to the stowed position.

17. The method of using a tree felling and grappling head as claimed in claim 15 or 16, comprising the further steps of:
- j. relocating the grabbed stem; and
 - k. opening the grapple arms to release the grabbed stem.

5

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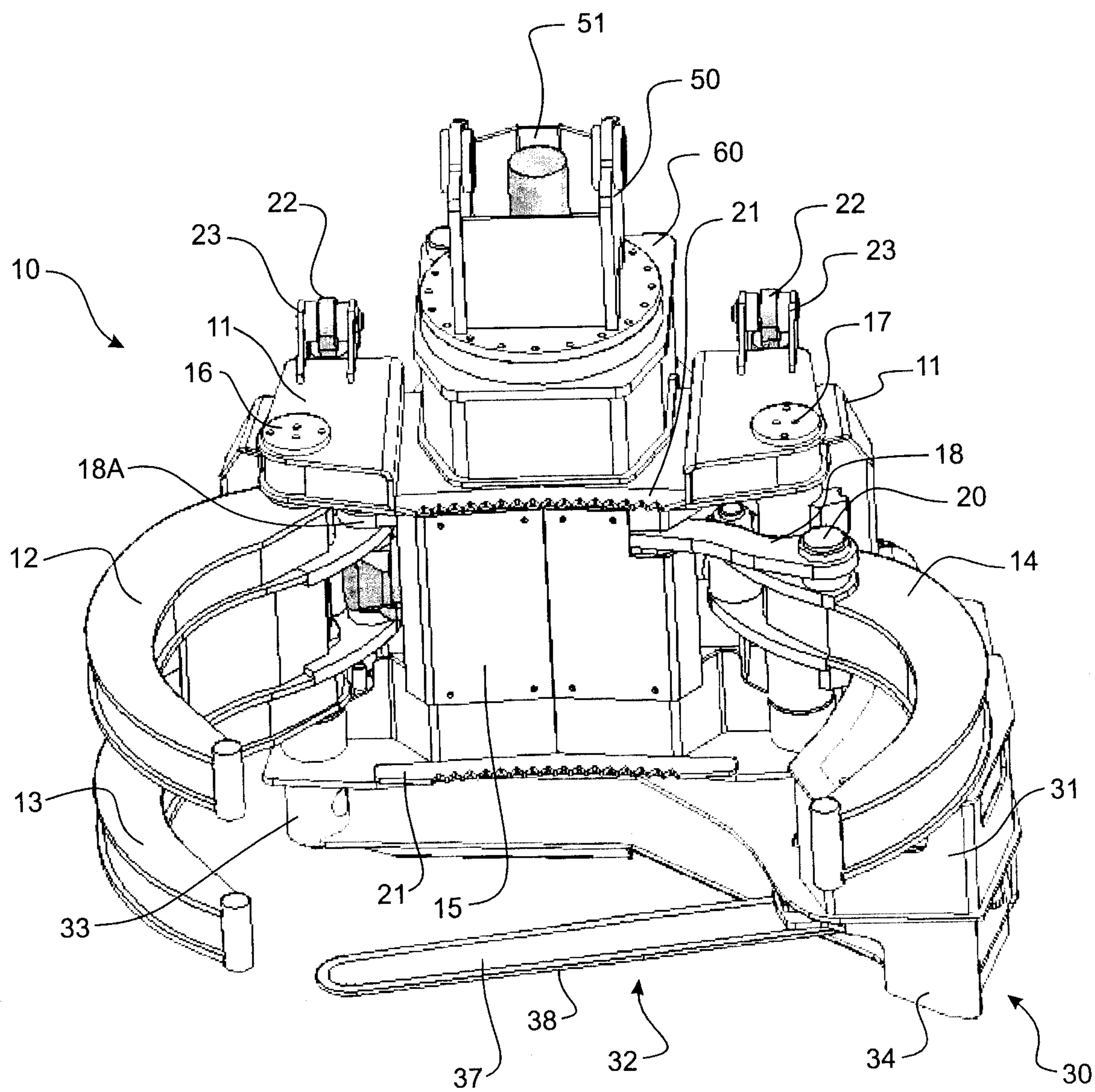


FIGURE 1

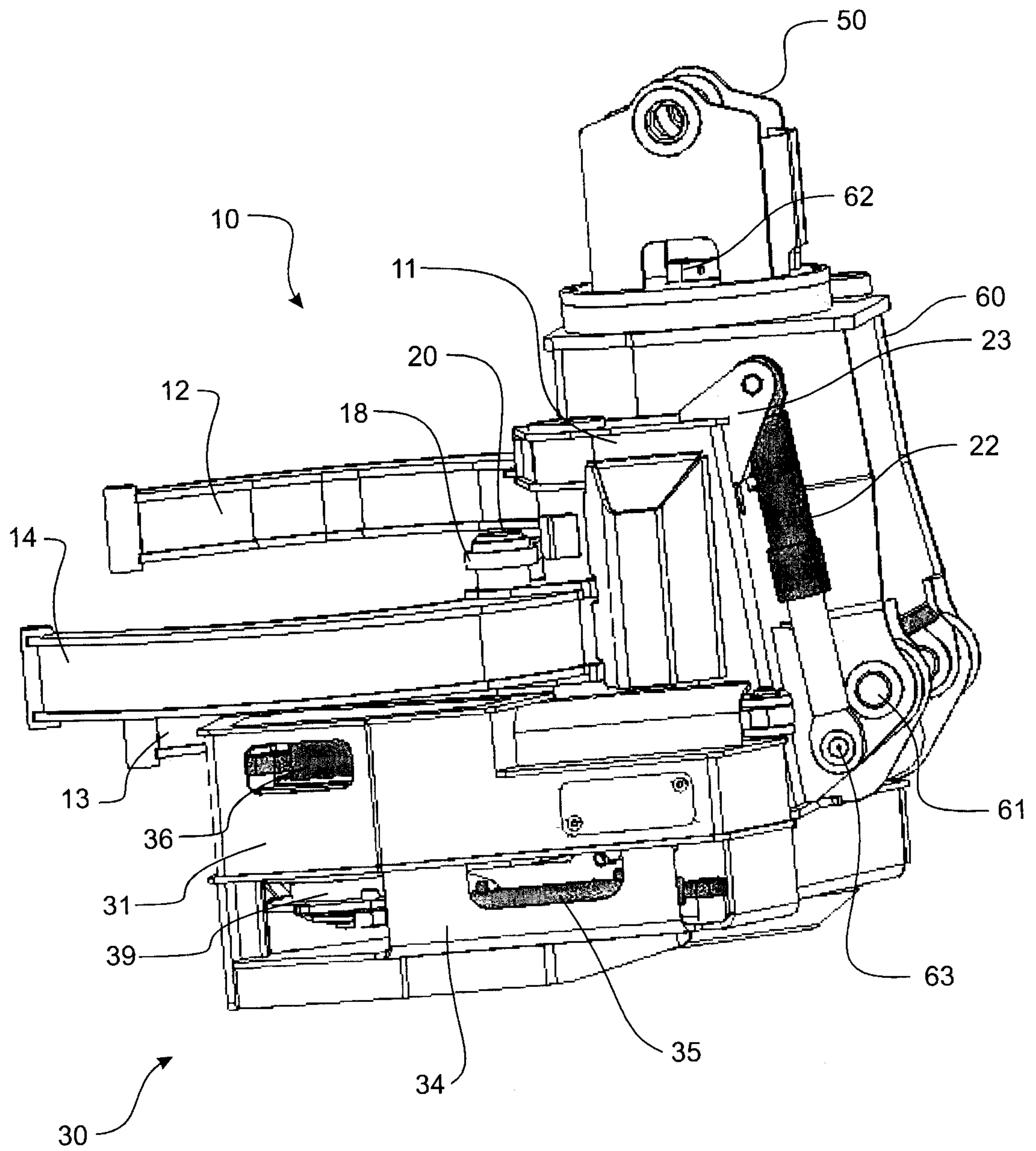
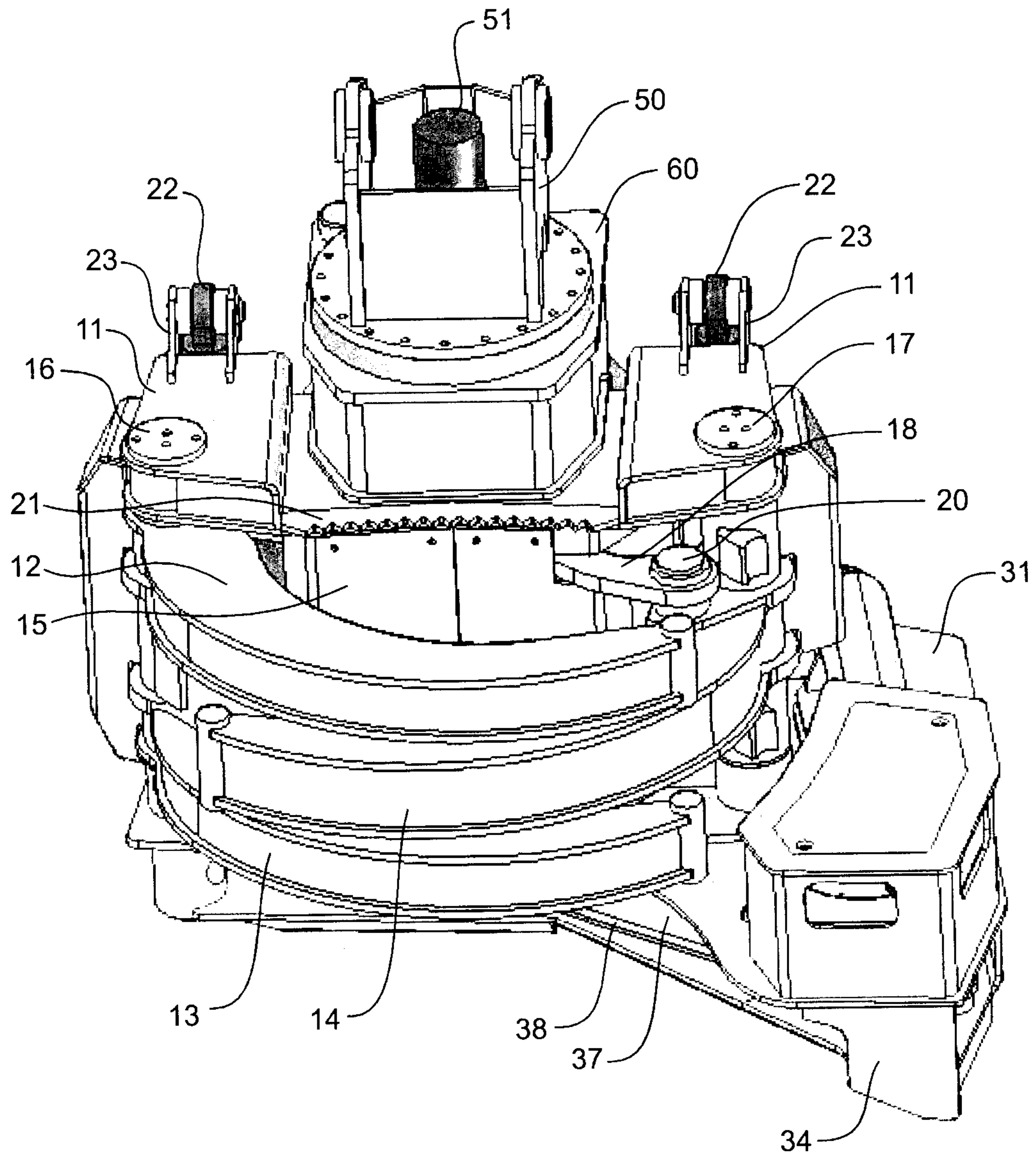
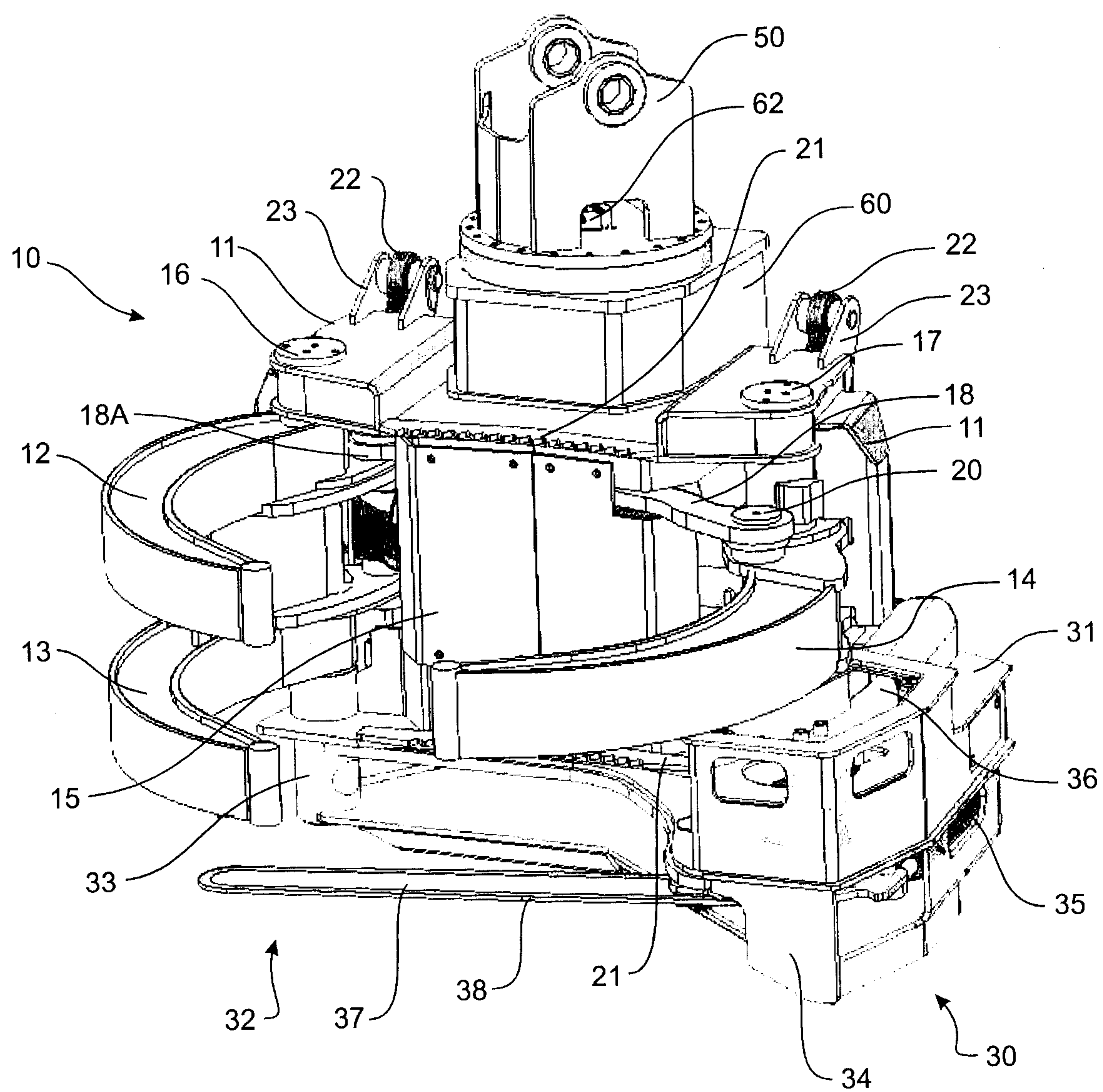


FIGURE 2

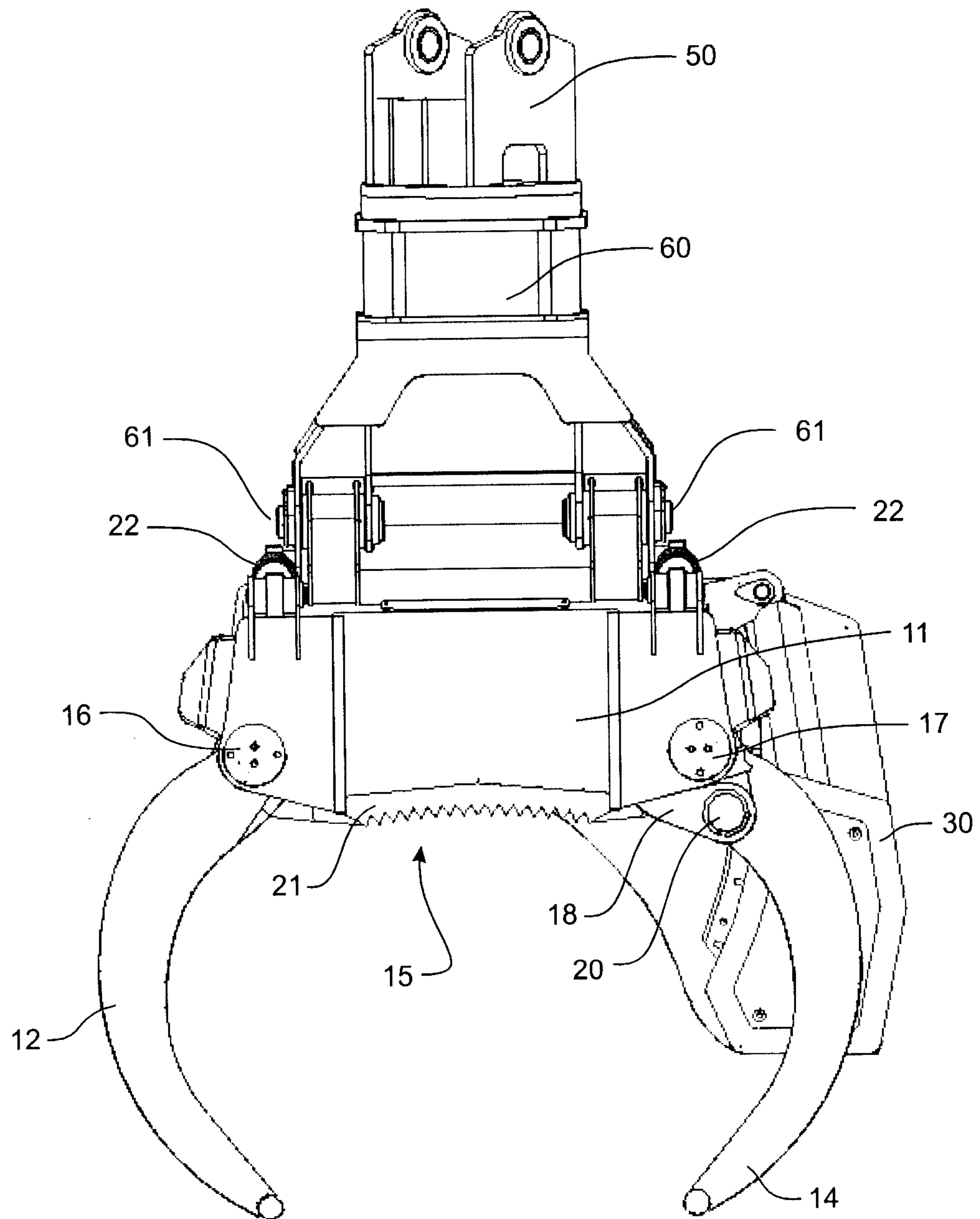
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**FIGURE 3**

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**FIGURE 4**

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**FIGURE 6**

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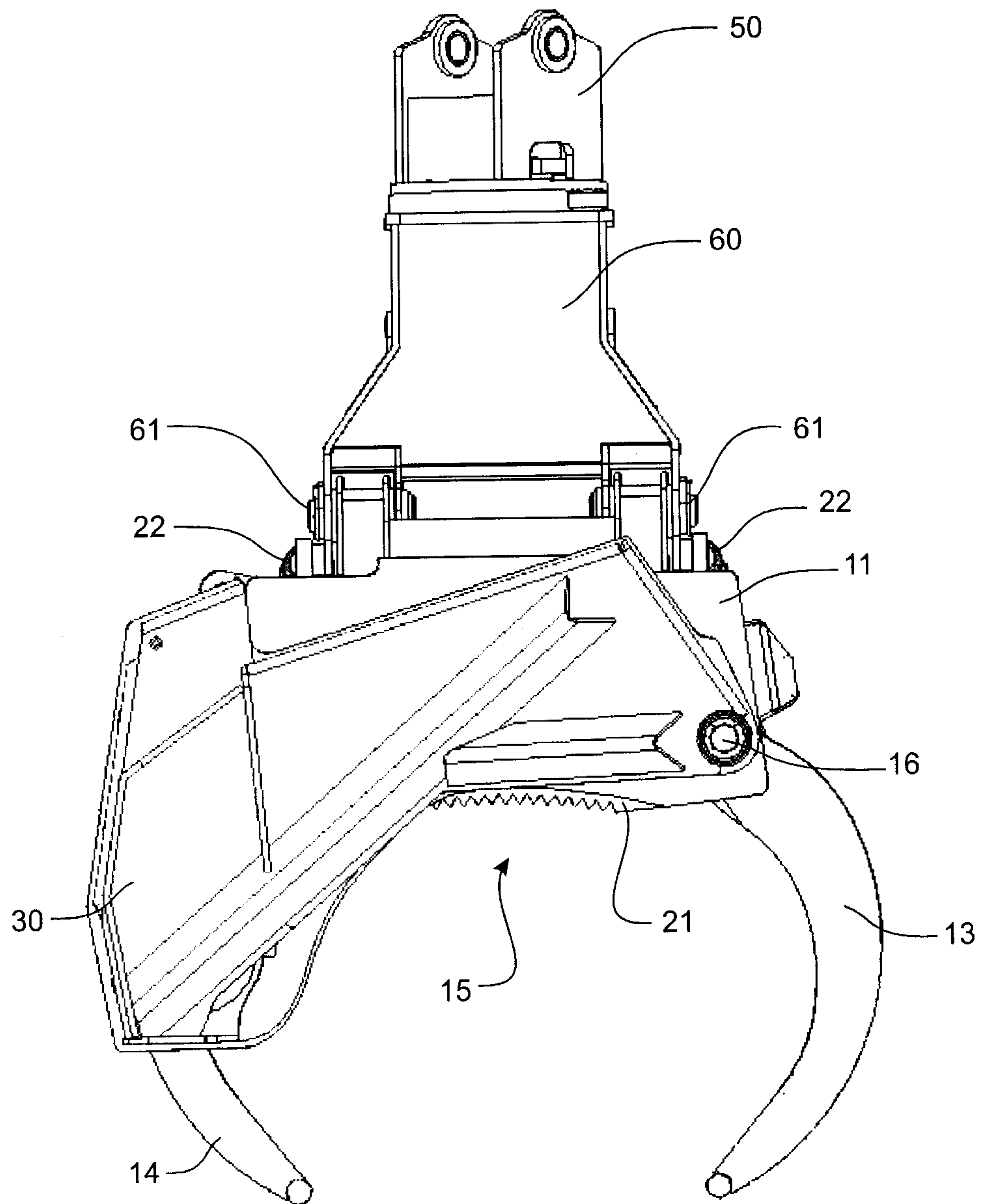


FIGURE 7

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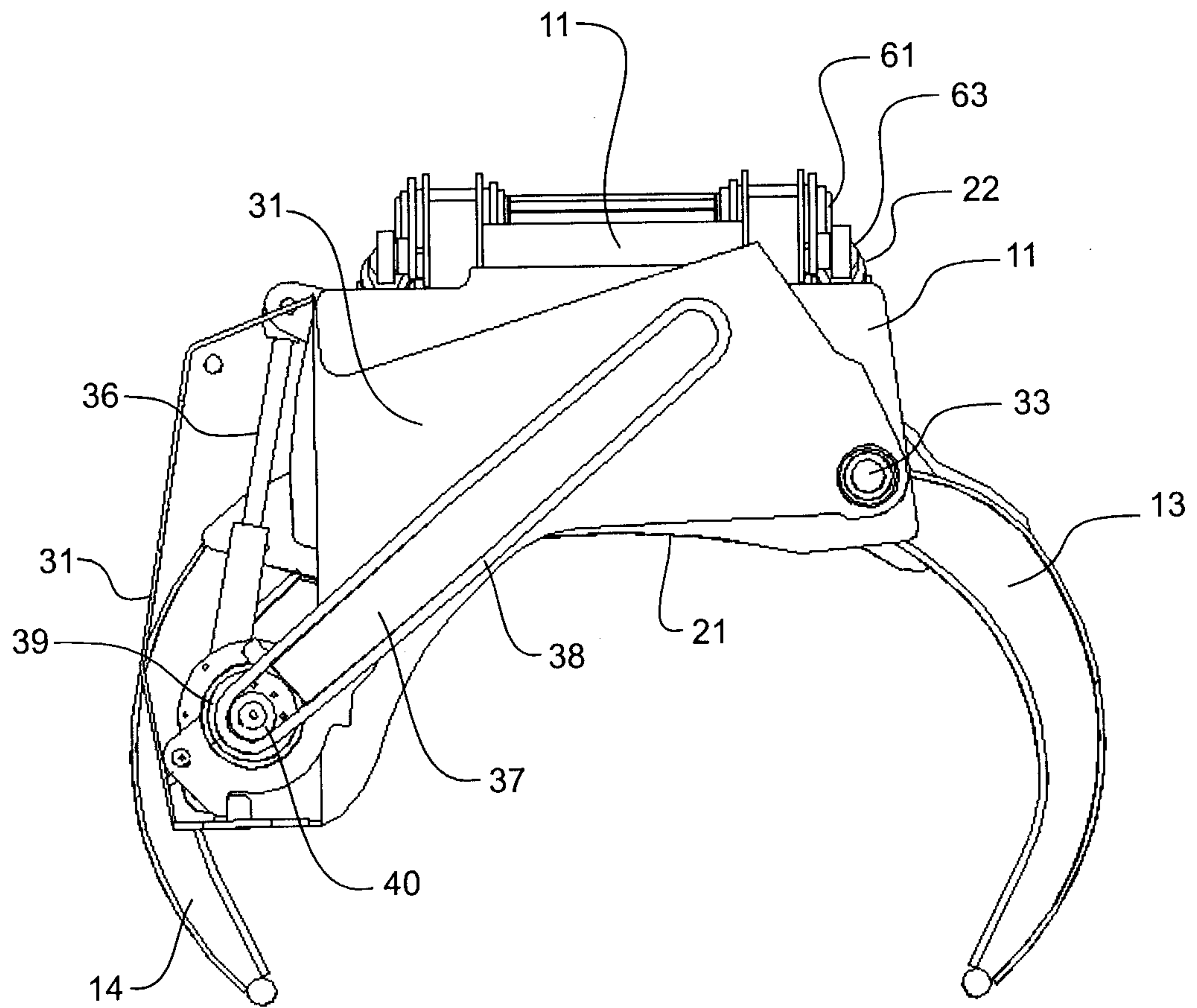
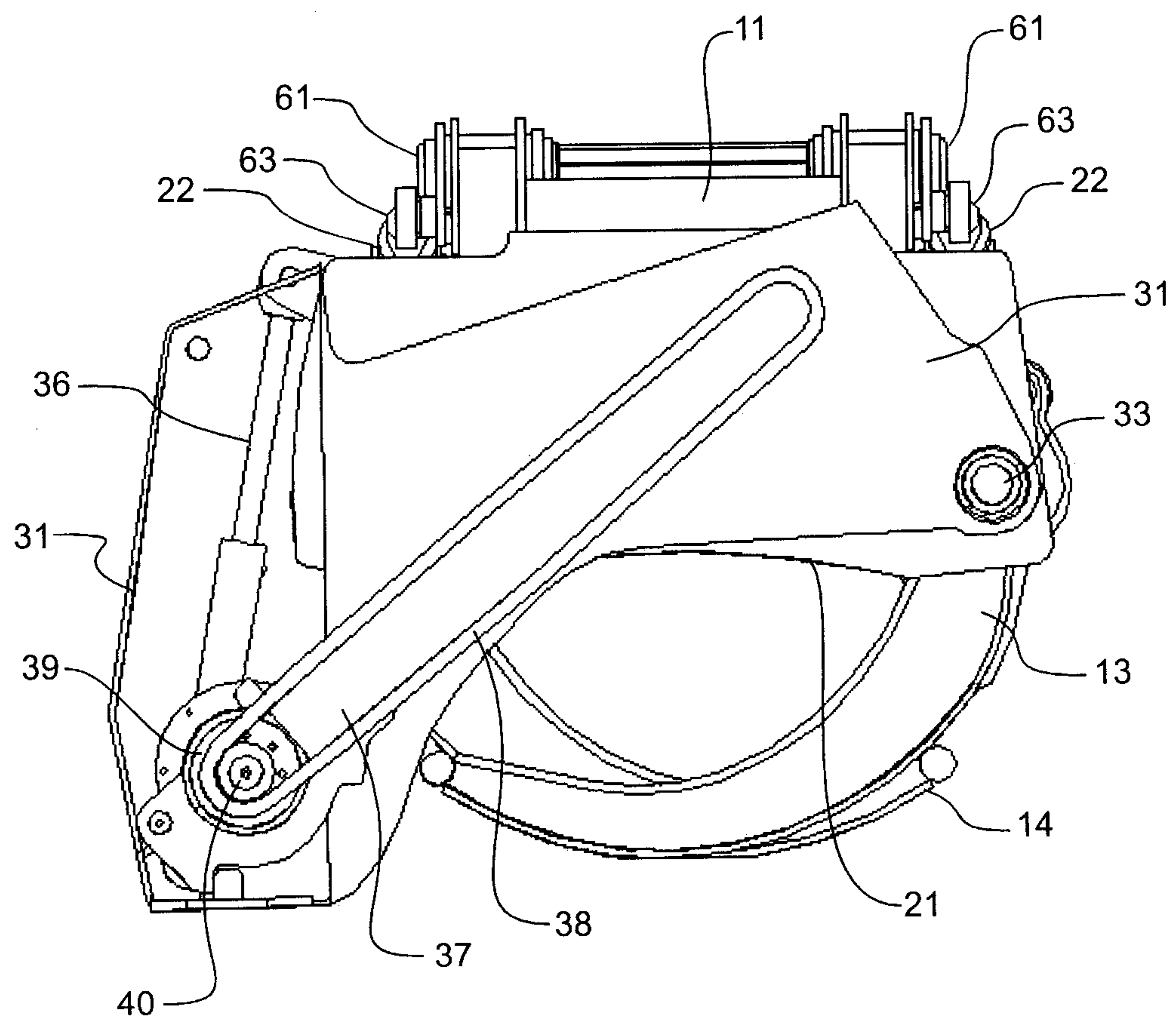


FIGURE 8

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**FIGURE 9**

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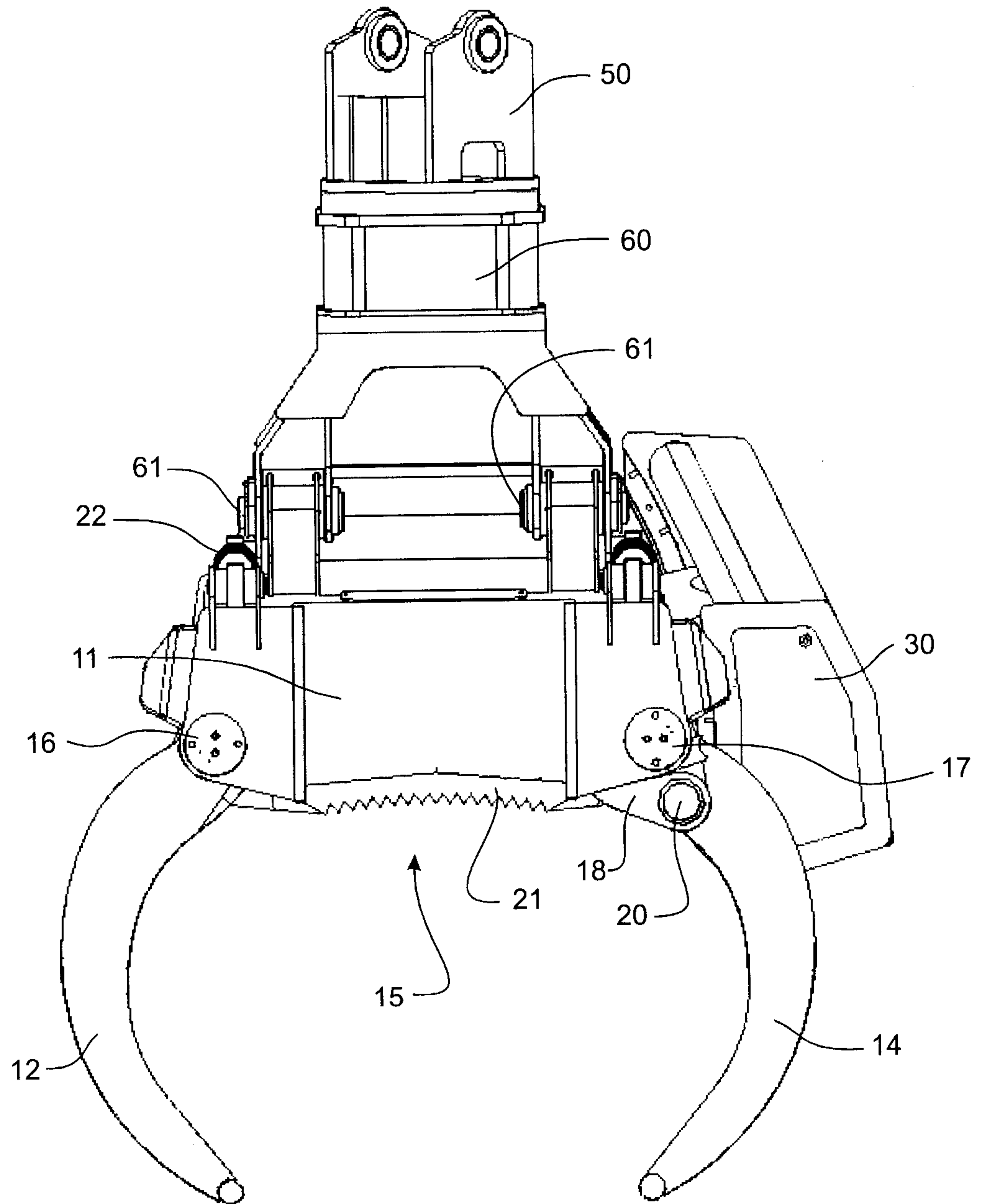


FIGURE 10

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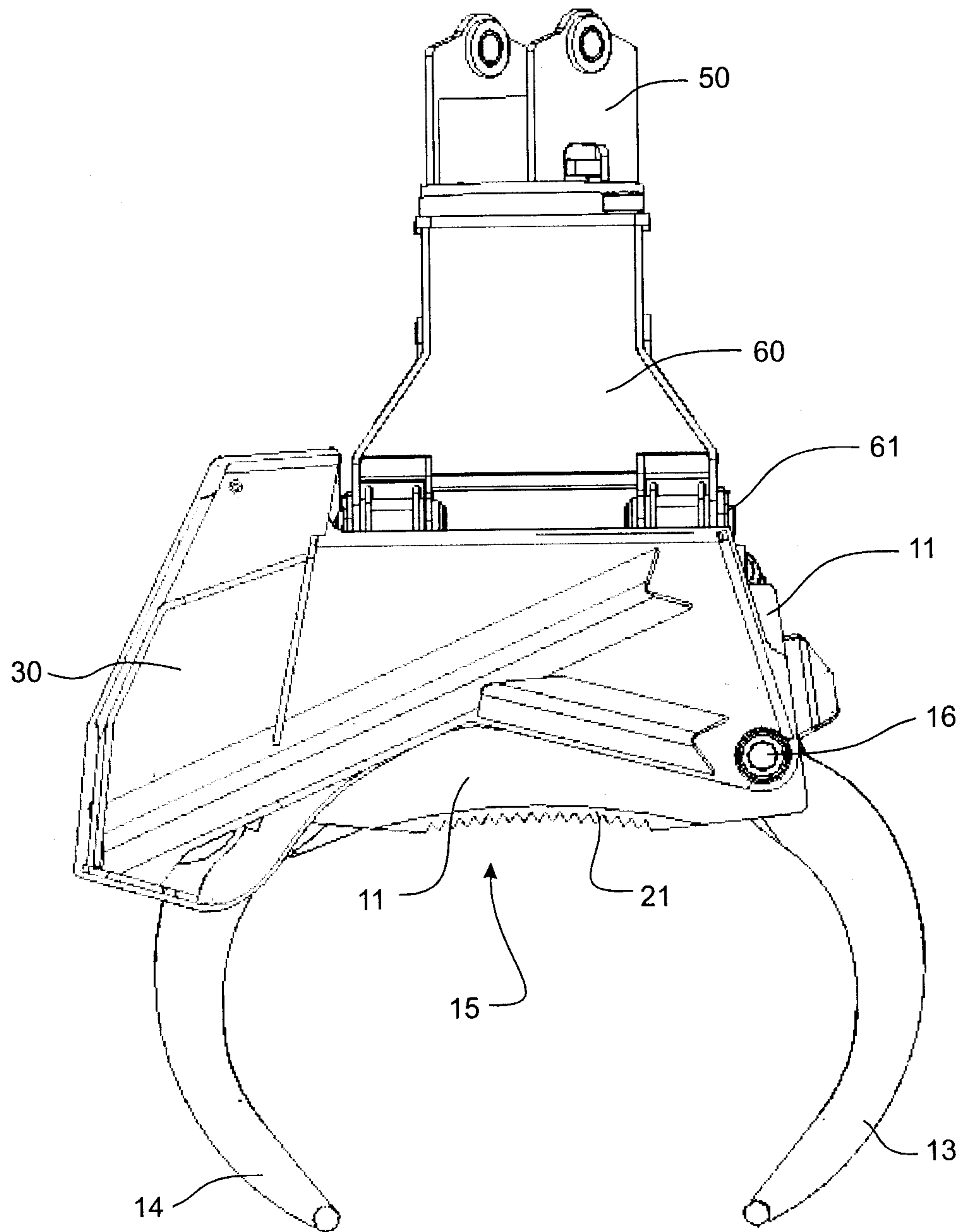


FIGURE 11

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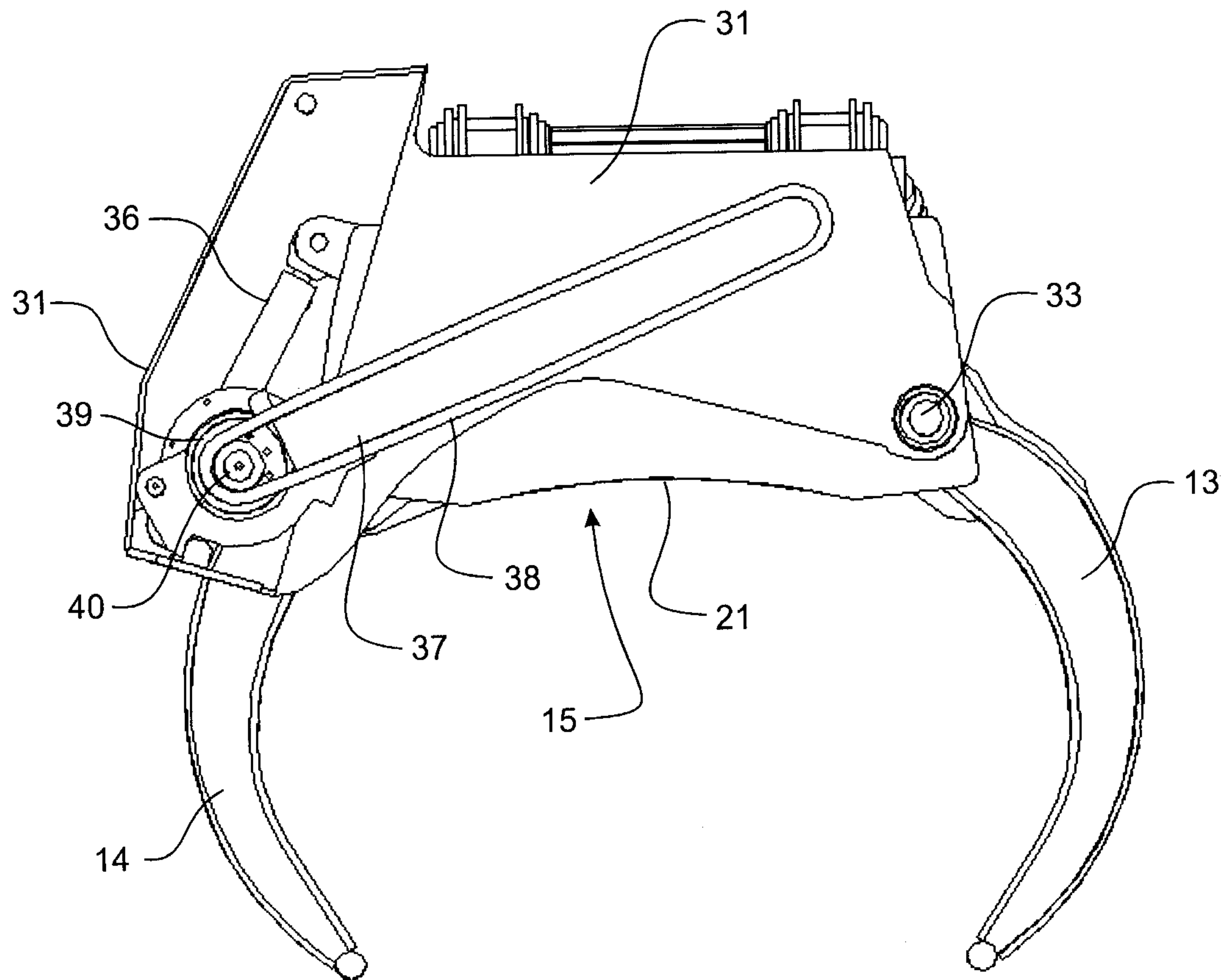


FIGURE 12

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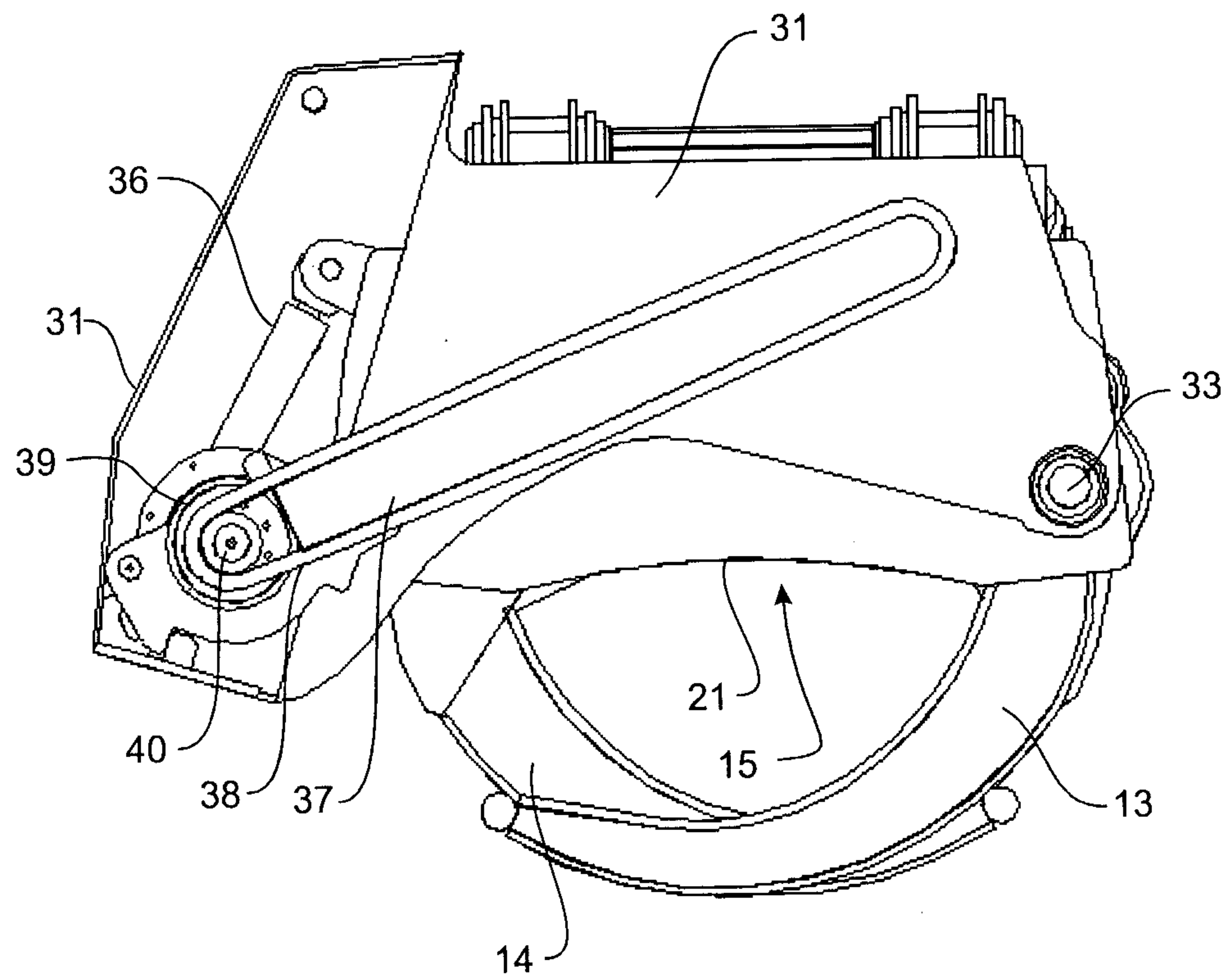


FIGURE 13

