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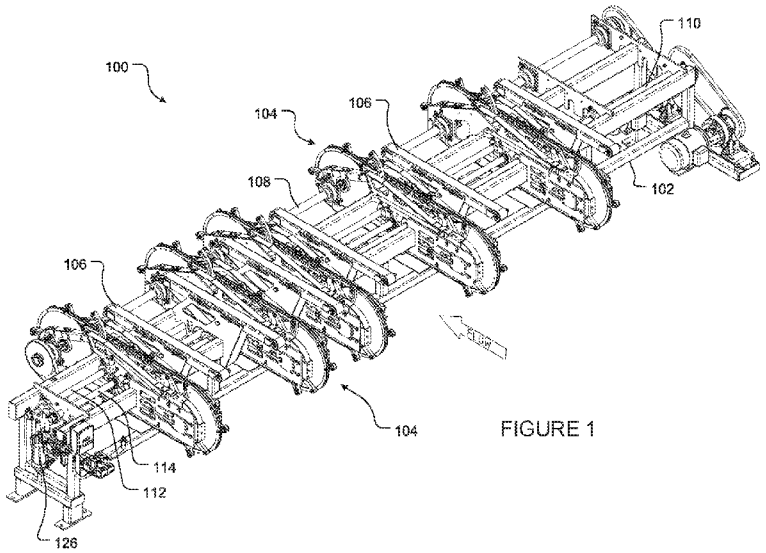


FIGURE 1

(57) Abstract: A board turner assembly may include an endless chain, first and second groups of turning arms pivotably coupled with the endless chain and disposed along opposite sides thereof, an upper guide with an inclined surface, an actuator selectively operable to move the upper guide between a resting position and an extended position, and one or more endless belts. The turning arms may be spaced apart at regular intervals that are offset on one side of the chain relative to the other. The groups of turning arms may be operated in an alternating fashion to turn selected boards to a desired orientation (e.g., wane side up). Corresponding methods and systems are also described.

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# BOARD TURNER

## Related Applications

**[0001]** The present application claims priority to U.S. Provisional Patent Application No. 62/254,714, filed Nov-13-2015, entitled "Board Turner," the disclosure of which is hereby incorporated by reference in its entirety for all purposes except for those sections, if any, that are inconsistent with this specification.

## Background

**[0002]** Scanning and optimization techniques are used in some sawmills to determine the best orientation and position for a workpiece upstream of a processing machine that will be used to remove material from the workpiece (e.g., by cutting, chipping, or planing) according to an optimized cut solution. Removing the material from a flawed portion of the workpiece, as opposed to a clear wood portion, can help to improve grade and profitability.

**[0003]** Planers typically remove more material from the top of the workpiece than from the bottom. For that reason, it is generally desirable to send boards through the planer in a wane-up orientation.

## Brief Description of the Drawings

**[0004]** Embodiments will be readily understood by the following detailed description in conjunction with the accompanying drawings. Embodiments are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings.

**[0005]** FIGURE 1A illustrates a perspective view of a board turner system, in accordance with various embodiments;

**[0006]** FIGURE 1B illustrates an enlarged view of a portion of FIG 1A, with some components removed for clarity;

**[0007]** FIGURE 2A illustrates a perspective view of the board turner system of FIG 1, with some components removed for clarity;

**[0008]** FIGURES 2B-F illustrate components of a board turner assembly;

**[0009]** FIGURE 3 illustrates a plan view of the board turner system components shown in FIG 2;

**[0010]** FIGURE 4 illustrates a side view of the board turner system components shown in FIG 2;

**[0011]** FIGURE 5 illustrates an end view of the board turner system components shown in FIG 2;

**[0012]** FIGURES 6A-6D illustrate sectional views taken along corresponding lines of FIG 5;

**[0013]** FIGURE 7 illustrates a plan view of the board turner system as shown in FIG 1;

**[0014]** FIGURES 8A-8D illustrate sectional views taken along corresponding lines of FIG 7;

**[0015]** FIGURE 9 illustrates an example of a planer infeed line with a board turner system; and

**[0016]** FIGURE 10 illustrates a flow diagram of a board turner control process, all in accordance with various embodiments.

## Detailed Description of Disclosed Embodiments

**[0017]** In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which are shown by way of illustration embodiments that may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope. Therefore, the following detailed description is not to be taken in a limiting sense, and the scope of embodiments is defined by the appended claims and their equivalents.

**[0018]** Various operations may be described as multiple discrete operations in turn, in a manner that may be helpful in understanding embodiments; however, the order of description should not be construed to imply that these operations are order dependent.

**[0019]** The description may use perspective-based descriptions such as up/down, back/front, and top/bottom. Such descriptions are merely used to

facilitate the discussion and are not intended to restrict the application of disclosed embodiments.

**[0020]** The terms "coupled" and "connected," along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. Rather, in particular embodiments, "connected" may be used to indicate that two or more elements are in direct physical or electrical contact with each other. "Coupled" may mean that two or more elements are in direct physical or electrical contact. However, "coupled" may also mean that two or more elements are not in direct contact with each other, but yet still cooperate or interact with each other.

**[0021]** For the purposes of the description, a phrase in the form "A/B" or in the form "A and/or B" means (A), (B), or (A and B). For the purposes of the description, a phrase in the form "at least one of A, B, and C" means (A), (B), (C), (A and B), (A and C), (B and C), or (A, B and C). For the purposes of the description, a phrase in the form "(A)B" means (B) or (AB) that is, A is an optional element.

**[0022]** The description may use the terms "embodiment" or "embodiments," which may each refer to one or more of the same or different embodiments. Furthermore, the terms "comprising," "including," "having," and the like, as used with respect to embodiments, are synonymous.

**[0023]** In exemplary embodiments, a computing device may be endowed with one or more components of the disclosed apparatuses and/or systems and may be employed to perform one or more methods as disclosed herein.

**[0024]** Embodiments herein provide embodiments of systems, methods, and apparatuses for turning a workpiece about a longitudinal axis of the workpiece by approximately 180 degrees, such that the formerly upward-facing side of the workpiece becomes the downwardly-facing side and vice versa. As used herein, the term "workpiece" encompasses boards, flitches, cants, and other articles with generally opposite faces.

**[0025]** A board turner assembly may include an endless chain rotatable in a flow direction within a reference plane, a first pivot member coupled to the endless chain, and at least one turner arm pivotably coupled to one side of the endless chain by the pivot member and generally parallel to the reference plane. The

endless chain may be rotated in the flow direction to thereby move the turner arm along a rotational path. In some embodiments, the endless chain may be a roller chain. Alternatively, the endless chain may be another type of chain or a belt. Although the description below refers to certain features as chains or belts by way of explanation, it is to be understood that in other embodiments a belt may be substituted for a chain and vice versa.

**[0026]** The turner arm may be generally angular or hook-shaped, with a base portion and an arcuate portion that meet at an angle to form a bend, and first and second terminal ends defined by the base portion and arcuate portion, respectively.

**[0027]** In various embodiments, a second pivot member may be coupled to the endless chain at a distance from the first pivot member, and the arcuate portion of the turner arm may include a pivot member guide surface (e.g., a slot, channel, groove, or the like) configured to engage the second pivot member. The pivot member guide surface may be generally arcuate along some or all of its length. The pivot member guide surface may have first and second ends located near the bend and the second terminal end of the turner arm, respectively. A guide member such as a cam follower, pin, roller, bearing, or the like may be coupled to the turner arm to extend from one side of the turner arm.

**[0028]** The first terminal end of the turner arm may be pivotably coupled to the endless chain by the first pivot member. The pivot member guide surface may be movably coupled to the second pivot member. For example, in some embodiments the pivot member guide surface may be a slot that extends through the arcuate portion, and the second pivot member may extend at least partially through the slot. Regardless, the turner arm may be pivotable around the first pivot member between a resting position and an extended position as the turner arm is moved in the flow direction by the endless chain. In the resting position the second end of the pivot member guide surface may be proximal to or in contact with the second pivot member, with most of the arcuate portion extending downwardly below the second pivot member. In the extended position, the first end of the pivot member guide surface may be proximal to or in contact with the second pivot member, with most of the arcuate portion extending above/forward of the second pivot member.

**[0029]** An upper guide may be provided within or near the plane of the turner arm. The upper guide may be coupled to an actuator that is selectively operable to raise and lower the upper guide between an engaging position and a resting position. The upper guide may have a guide surface that extends longitudinally in the flow direction and is inclined in the flow direction when the guide is in the engaging position. For example, in some embodiments the upstream end of the upper guide may be pivotably coupled to a frame or support surface and the downstream end of the upper guide may be raised and lowered by the actuator, and the guide surface may be substantially horizontal in the resting position and inclined in the engaging position. In other embodiments, both ends of the upper guide may be raised and lowered simultaneously by the actuator, and the guide surface may be inclined in both positions.

**[0030]** To execute a turning operation, the actuator may be operated to move the upper guide into the engaging position as the turner arm moves in the flow direction toward the upper guide from a starting position (e.g., at the top of the rotational path and upstream of the upper guide). As the guide member moves along the guide surface, the guide member may be pushed upwardly by the incline causing the turning arm to rotate from the resting position to the extended position. Once the turner arm passes the guide member and the guide member disengages from the downstream end of the guide surface, the turner arm may rotate back to the resting position. In some embodiments, a return guide may be provided along some or all of the rotational path of the turner arm to return the turner arm to the resting position and/or to maintain the turner arm in a resting position as the turner arm is moved back to the starting position again. Optionally, a lower guide may also be provided below the upper guide to thereby limit upward movement of the turner arm as it returns to the starting position.

**[0031]** In various embodiments, a board turner assembly may include a plurality of pivot members coupled to the endless chain at regular intervals, and turning arms may be arranged along at least one side of the endless chain and coupled to corresponding pivot members. Optionally, turning arms may be arranged along both sides of the endless chain in an alternating manner, and corresponding upper guides (and optionally, return guides and/or lower guides) may be provided on each side. In this configuration a turning arm on one side

may be used to turn one board and the next turning arm on the other side may be used to turn the next consecutive board.

**[0032]** In various embodiments, a board turning system may include two or more board turner assemblies positioned along a conveyor. Optionally, the conveyor may be a lugged chain/belt conveyor configured to convey the boards in a transverse orientation relative to the direction of flow. The board turner assemblies may be spaced apart in lateral alignment across the flow direction of the conveyor. In some embodiments one or more of the board turner assemblies may be positioned between chains or belts of the conveyor. In some embodiments the guides of the board turner assemblies may be operatively linked to one actuator. In other embodiments some of the guides may be operatively linked to one actuator and other guides may be operatively linked to another actuator. For example, at least some of the board turning assemblies may have turning arms and corresponding guides on both sides of the endless chain, with the guides on the left side linked to one actuator and the guides on the right side linked to a second actuator.

**[0033]** In various embodiments the system may further include a scanner positioned upstream of the board turner assemblies. The scanner may be configured to scan each board as it moves through the field of view of the scanner in the flow direction and to determine, based on the scan, whether the board should be turned (e.g., wane side down to wane side up, or vice versa). The scanner may be further configured to control the actuators, either directly or via a controller, to raise and lower the guides to thereby turn selected boards.

**[0034]** Figs. 1A-8D illustrate an example of a board turning system and components thereof, in accordance with various embodiments. As illustrated, a board turner system 100 (FIG 1A) may include a frame 102, a plurality of board turner assemblies 104 coupled with the frame, and a plurality of belt conveyors 106 coupled with the frame. The system 100 may further include a headshaft 108, belt drive shaft 110, and drive shafts 112 and 114. The belt conveyors and board turner assemblies may be arranged across, and oriented substantially parallel to, a flow direction. Collectively, the belt conveyors may form a workpiece support surface that extends within a plane above the upper surface of the endless chains. The belt conveyors and the endless chains may be driven by

corresponding separate drives 116 (FIG 7), which may be operable independently of one another.

**[0035]** Optionally, some or all of the belt conveyors may have separate drives such that they can be driven independently of one another at different speeds and/or in different directions (e.g., to correct workpiece skew). Similarly, some or all of the endless chains may have separate drives such that they can be driven independently of one another. Alternatively, all of the belt conveyors may be driven by one drive and all of the endless chains may be driven by another drive. As another alternative, at least one of the belt conveyors and at least one of the endless chains may be coupled together and driven by a single drive.

**[0036]** In various embodiments, as best shown in Figs. 2A-2F, 6B, and 8B, a board turner assembly 104 may include an endless chain 118 mounted on a pair of sprockets 120, first and second groups of turning arms 122 pivotably mounted to opposite sides of the endless chain, an upper guide 124 and an actuator 126 selectively operable to raise and lower the upper guide. The turning arms 122 may be generally planar and hook-shaped or sickle-shaped, with an arcuate portion 122a and a base portion 122b. The arcuate portion may have a pivot member guide surface 122c. The pivot member guide surface may be an arcuate track, slot, groove, channel, or other such feature formed on or through the arcuate portion. The free end of the base portion 122b may be pivotably coupled to the corresponding chain by a first pivot member 128, which may include a cam follower, pin, bolt, or other suitable fastener. As shown in Figs. 2D-F, in some embodiments pivot member 128 may include a rod or pin that extends through the chain, and the turner arm may have a corresponding hole at the terminal end of the base portion through which the rod may be inserted. Optionally, the turner arm may be retained on the rod or pin by one or more bolts or other fasteners on one or both sides of the turner arm. Other embodiments may include pivot members of other types and configurations, as will be readily appreciated by one with skill in the art in light of the present disclosure.

**[0037]** The free end of the arcuate portion 122a may be slideably coupled to the corresponding endless chain by a second pivot member 130, which may be of the same or different type as the first pivot member 128. One end of the second pivot member 130 may be coupled to the endless chain and the other end

may be disposed within or through the pivot member guide surface 122c. A guide member 132 may be coupled to one side of each turning arm in an orientation that is orthogonal to the plane of the turning arm. As the endless chain 118 is rotated on the sprockets 120 in the direction of flow, the turning arms 122 on each side of the endless chain may be circulated along an ovoid rotational path, such that each turning arm travels upwardly at the upstream end of the board turner system, moves in the direction of flow along the top of the path to the downstream end, travels downwardly at the downstream end of the board turner system, and subsequently travels against the direction of flow to return to the upstream end.

**[0038]** Each upper guide 124 may be positioned along, and proximal to, a corresponding side of a corresponding endless chain. The upper guides 124 may be movable between a resting position, in which the upper surface of the upper guide remains below the guide members 132 as they move in the flow direction, and an extended position, in which at least a portion of the upper surface of the upper guide is elevated above the path of an approaching guide member 132. Optionally, the actuator 126 may include an air cylinder. Alternatively, the actuator 126 may include a hydraulic cylinder, an electric screw drive or other linear positioner, an eccentric wheel, or any other suitable mechanism. In some embodiments, the upper guides 124 may include a generally elongate portion with opposite ends pivotably coupled with the actuator and the frame, respectively.

**[0039]** In various embodiments, actuator 126 may include first and second actuators 126a and 126b pivotably coupled to corresponding torque arms 134a and 134b, respectively (FIG. 1B). Each actuator 126a/126b may be pivotably coupled to the corresponding torque arm by a clevis or any other suitable fastener. The torque arms 134a and 134b may be rigidly coupled to shaft 112 and 114, respectively. Thus, each actuator 126a/126b may be actuable to rotate the corresponding shaft 112/114 in opposite rotary directions. Some of the upper guides 124 (e.g., those on one side of the endless chains, or on one side of the longitudinal center of the conveyor) may be operatively coupled to shaft 112, and other upper guides 124 (e.g., those on the opposite side of the endless chains, or those on the other side of the longitudinal center) may be operatively coupled to shaft 114. Optionally, a downstream end of each upper guide 124 may be coupled to the corresponding shaft by a corresponding torque arm 136 (Fig. 6B),

and an upstream end of each upper guide 124 may be pivotably coupled to the frame or a support member to thereby allow the downstream end of the upper guide to be raised relative to the upstream end. In other embodiments, all of the upper guides 124 may be operatively coupled to one shaft, or to corresponding actuators that are operable independently of one another.

**[0040]** In some embodiments, all of the turning arms 122 and upper guides 124 may be disposed along only one side of the endless chains 118. Alternatively, in some embodiments turning arms 122 and upper guides 124 may be positioned on both sides of some or all of the endless chains 118. Optionally, a return guide 156 may be provided along some or all of the rotational path of the turner arm (FIG 6B). Return guide 156 may be configured to return the turner arm to the resting position, and/or to maintain the turner arm in a resting position as the turner arm is moved back to the starting position again. Optionally, a lower guide 158 (FIG 6B) may be provided below the upper guide. The lower guide 158 may have a guide surface positioned near the return path of the guide members 132 to thereby limit upward movement of the turner arm as it returns to the starting position.

**[0041]** The pivot members 128/130 and turning arms 122 may be spaced at regular intervals along each endless chain. In embodiments with turning arms on both sides, the turning arms along the left side of each endless chain may be aligned with one another, and the turning arms along the right side of each endless chain may also be aligned one another. However, the intervals between the turning arms on one side may be offset relative to the intervals between the turning arms on the other side, such that a turning arm on one side is half (or some other fraction) of the interval distance upstream or downstream of the corresponding turning arm on the opposite side.

**[0042]** In some embodiments, the board turner system 100 may be disposed along a conveyor 138a (such as a lugged conveyor and/or multiple conveyors overlapping end-to-end), with the system's components arranged in groups between adjacent chains and positioned such that the belt conveyors 106 and the chains/belts of the conveyor form a common workpiece support surface. Some or all of the groups of components may include at least one of the endless chains 118, the corresponding pair of board turners 122 disposed along the

opposite sides of the endless chain 118, and at least one of the belt conveyors 106. The offset arrangement of the turning arms on the opposite sides of the endless chains allows the turning arms to be used in an alternating fashion, with a given side being used to turn only every second board. The board turning operation can thus be completed over two lug spaces to allow smoother operation, more rapid turning, and greater speed along the processing line. Alternatively, a similar offset arrangement may be achieved by mounting turning arms on only one side of some endless chains and only on the other side of other endless chains.

**[0043]** Board turner systems as described herein may be used in various locations along processing lines in facilities such as sawmills and planermills. FIG 9 is a schematic diagram of a planer infeed line with an on-demand board turner, in accordance with various embodiments.

**[0044]** As illustrated, a planer infeed line may include a tilt hoist 140, a lugged let-down 142, a pre-gap/storage table 144, a lug loader 146, a first sensor 148 positioned to detect workpieces engaged by the lug loader, a lugged conveyor 150, a second sensor 152 positioned to detect workpieces on the lugged conveyor, a board turner system 100, and a drop-out/articulating gate 154 upstream of a planer (not shown). Some or all of these components may be arranged sequentially. Optionally the planer infeed line may include one or more additional components such as a stick/dunnage collector, conveyor, transfer, storage table, bins, or the like. Collectively, the components may form a continuous flow path from the tilt hoist to the planer.

**[0045]** The tilt hoist 140 may be a Continuous Tilt Hoist (USNR, LLC), which may include linear transducers and servo valves actuated from a PLC. The Continuous Tilt Hoist may be configured to handle packages of particular dimensions (stickered), with packages stacked 2 high at the tilt hoist and dunnage between. Alternatively, the planer infeed line may include a beam-style, leaf-chain, or other type of tilt hoist, or any other suitable alternative, instead of a Continuous Tilt Hoist.

**[0046]** The lug loader 146 may be a Virtual Lug Loader (USNR, LLC) with a series of belts that are progressively adjusted to separate and/or deskew the workpieces, then feed the workpieces into the lug spaces of the lugged conveyor.

In other embodiments, the lug loader may instead be any other suitable type of lug loader.

**[0047]** The lugged conveyor 150 may be positioned at an output end of the lug loader 146. The first sensor 148 may be positioned to detect workpieces on the lug loader 146 or just upstream/downstream of the lug loader. In the illustrated example, the planer infeed line includes a MillTrak™ system (USNR, LLC) with a single vision camera, and the first sensor 146 (a single vision camera) is mounted above the lug loader. In this embodiment, the MillTrak™ System is configured to control both the backlog and actuation of the belts of the Virtual Lug Loader. In other embodiments, the first sensor may be one or more photoeyes, proximity sensors, or other sensor(s) in any suitable number, placement, and configuration, and may be operatively coupled with a computer system programmed to control the lug loader.

**[0048]** The lugged conveyor 150 may be positioned downstream of the lug loader 146 to accept workpieces from the lug loader. The second sensor 152 may be positioned along the lugged conveyor 150 to detect the orientation of the workpieces on the conveyor 150. In some embodiments, the second sensor 152 may include one or more geometric/laser profile sensors, such as LPS3 sensors (USNR). Alternatively, the second sensor 152 may include a vision sensor or other type of sensor.

**[0049]** The second sensor 152 may serve as a wane scanner for determining whether a board is wane side up or wane side down. The second sensor 152 may be configured to scan the board and determine, based on the scan data, whether the board is in a desired orientation. Alternatively, the second sensor may be coupled with a computer system with optimization software for determining, based on the scan data from the second sensor, whether the workpiece is in a desired orientation. The computer system may also be configured to determine the desired orientation for the workpiece based on the scan data from the second sensor, data from the first sensor, and/or data from other sensors further upstream. In response to a determination that the workpiece is not in the desired orientation, the computer system may generate and send a command to an actuator (e.g., actuator 126), or to a controller operatively coupled

to the actuator, to cause the board turner to turn the workpiece. Alternatively, the second sensor may be configured to perform some or all of these functions.

**[0050]** In operation, as boards travel in the flow direction in corresponding lug spaces, the boards may pass through the field of view of the second sensor 152. As shown for example in FIG. 10, the second sensor may detect the geometric profile of each workpiece, which may then be compared (by the second sensor or computer system) to the desired orientation for that workpiece. Such information may be organized/compared based on queue positions, on a first-in-first-out basis, or in any other suitable manner. Upon determining that a workpiece is not in the desired orientation, the second sensor or computer system may send a command to a PLC to cause the actuators 126 of the corresponding group of upper guides 124 to thereby move those upper guides into the extended position. As the corresponding group of guide members 132 engage the elevated upper guides 124, the guide members 132 may be moved along the incline, thereby causing forward rotation of the turning arms 122 and engagement of the leading surface of the arcuate portion 122a with the lagging lower edge of the workpiece. Optionally, the belt conveyors 106 may be rotated at a slower speed than the lugged conveyor to urge the workpiece backward against the leading surface of the arcuate portions, which helps to urge the lagging edge of the workpiece upward and forward and to turn the board over in a forward direction.

**[0051]** In other embodiments, a board turner system may be provided near a grading station. The board turner assemblies/system may be operated to turn over selected workpieces, or all workpieces, within the view of a human or mechanical grader. Alternatively, board turner assemblies and/or a board turner system may be provided upstream of an edger to selectively turn flitches prior to edging. Other applications for such assemblies and systems will be readily apparent to the skilled artisan.

**[0052]** Although certain embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent embodiments or implementations calculated to achieve the same purposes may be substituted for the embodiments shown and described without departing from the scope. Those with skill in the art will readily appreciate that embodiments may be implemented in a very wide variety of ways.

This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that embodiments be limited only by the claims and the equivalents thereof.

## Claims

What is claimed is:

1. A board turner assembly comprising:

an endless chain;

a first plurality of turner arms having first and second terminal ends, the first terminal ends being pivotably coupled to the endless chain at first intervals along a first side of the endless chain by corresponding first pivot members; and

a second plurality of turning arms pivotably coupled to the endless chain at second intervals along an opposite second side of the endless chain,

wherein the first intervals are offset from the second intervals.

2. The board turner assembly of claim 1, further comprising a control system configured to selectively control the first and second groups of turning arms to turn boards in an alternating manner.

3. A method of turning a board as described herein.

4. A processing line that includes a board turner assembly as described herein and one or more sensors operatively coupled with the board turner assembly

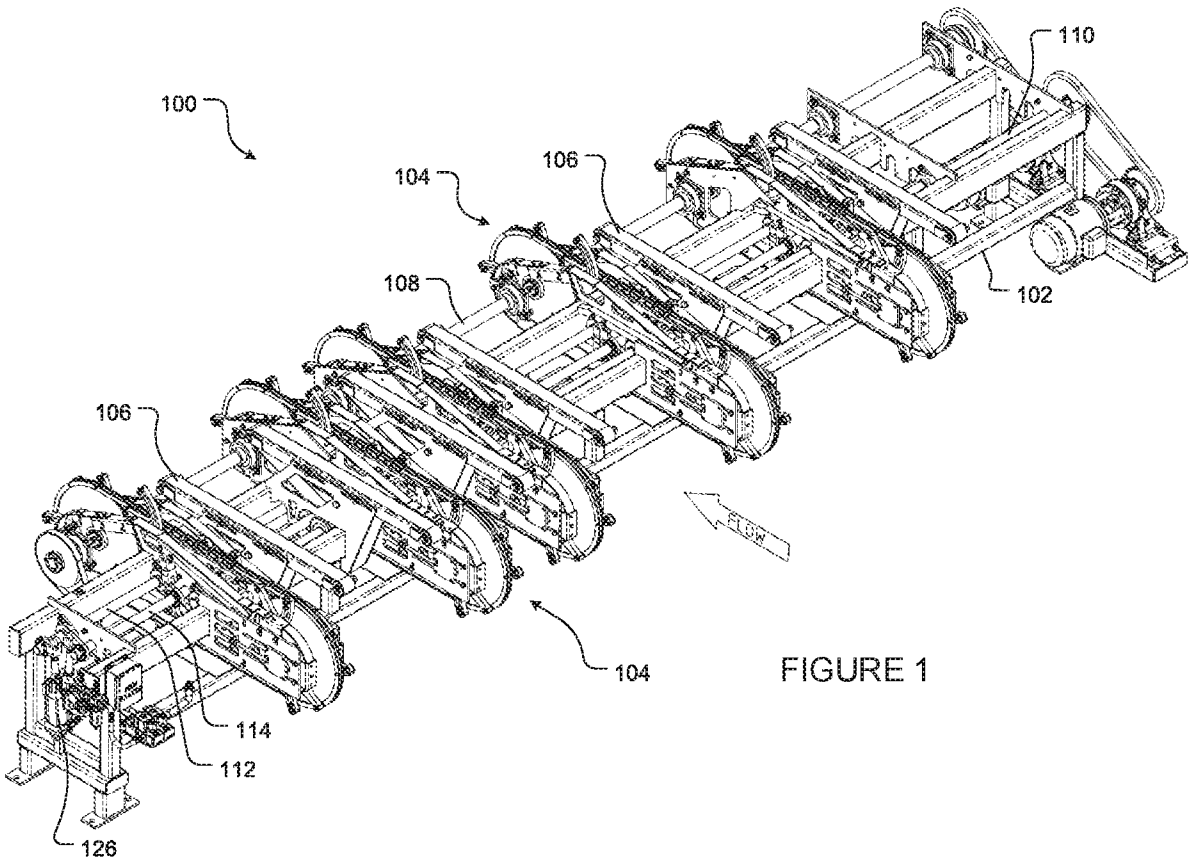



FIGURE 1

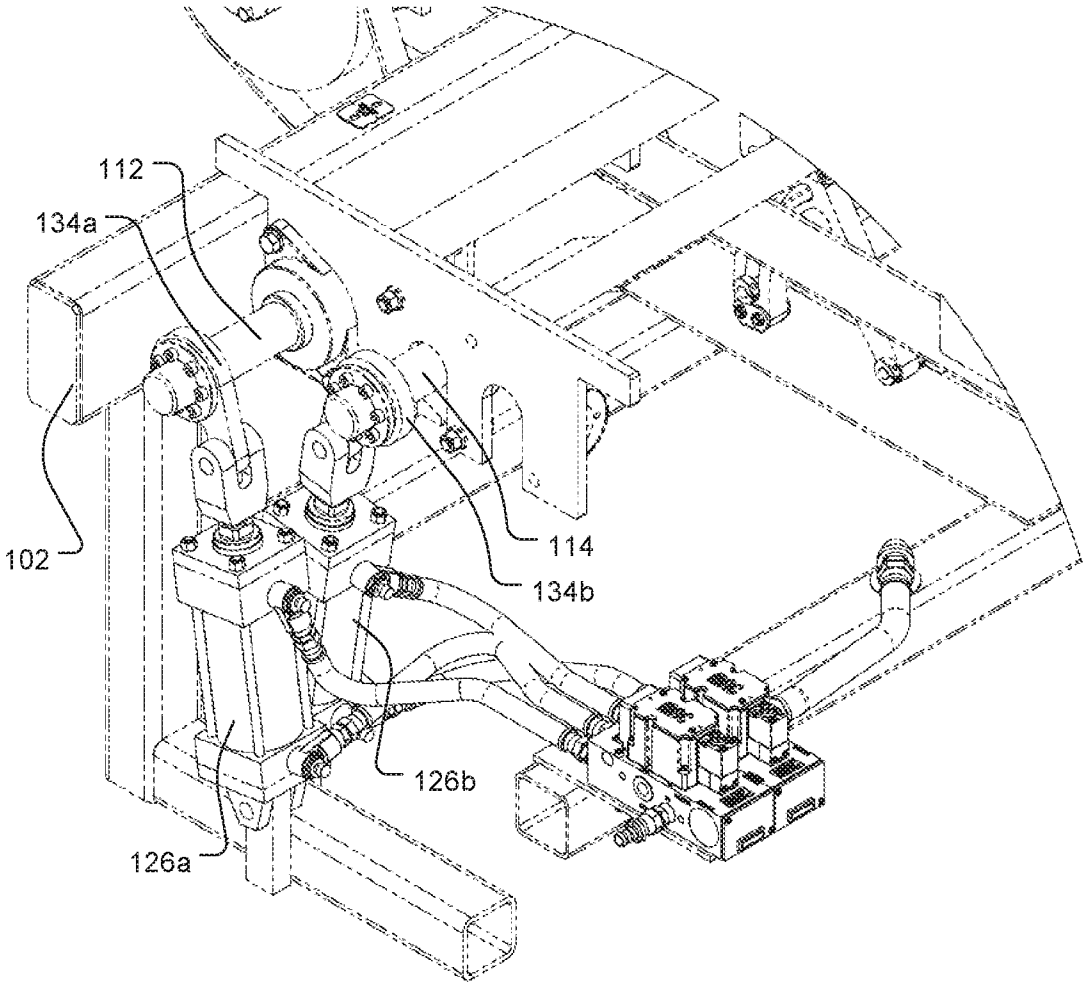



FIGURE 1B

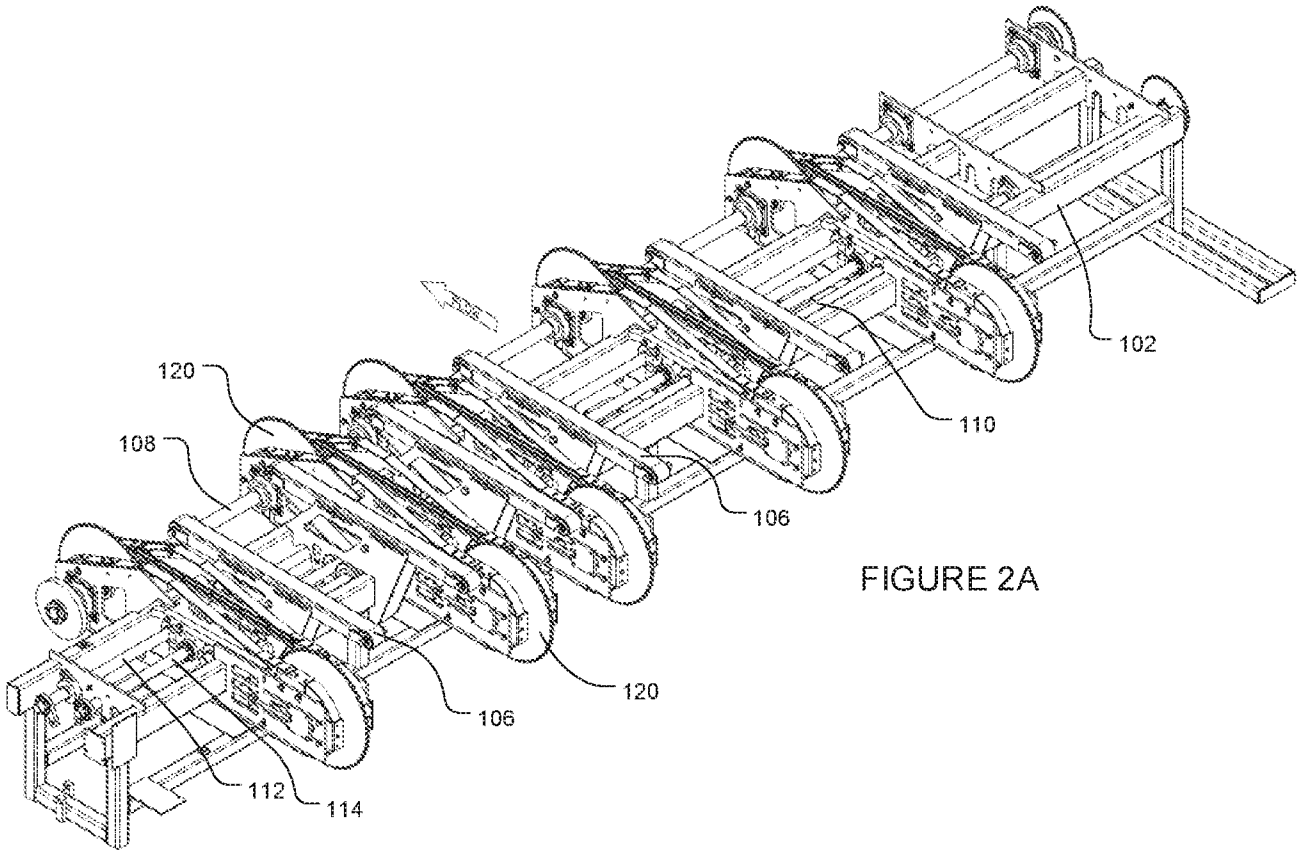



FIGURE 2A

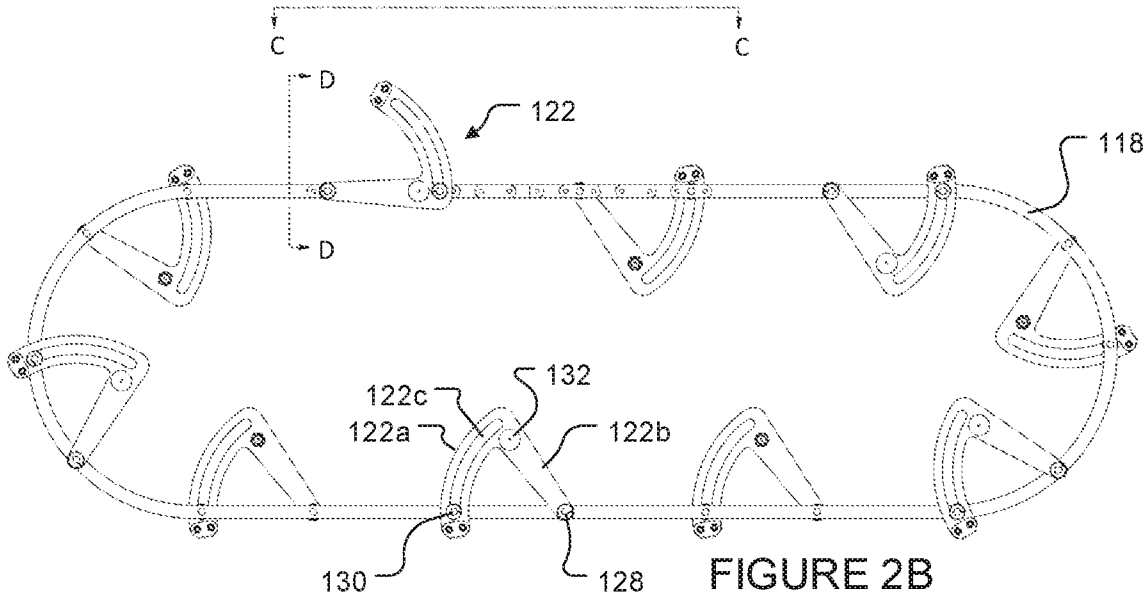



FIGURE 2B

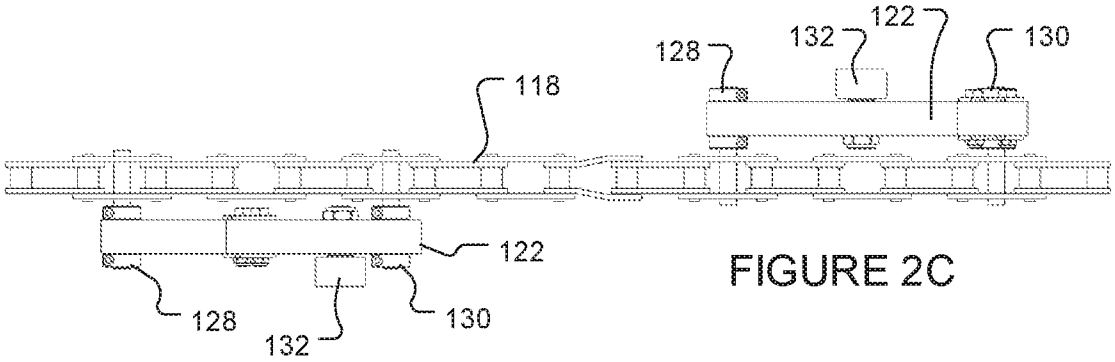



FIGURE 2C

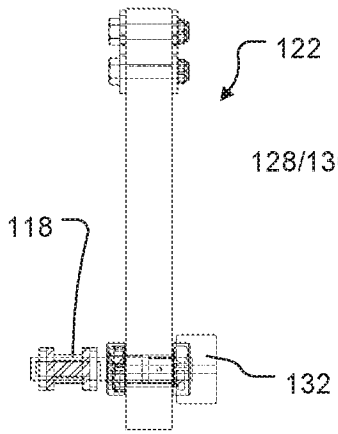



FIGURE 2D

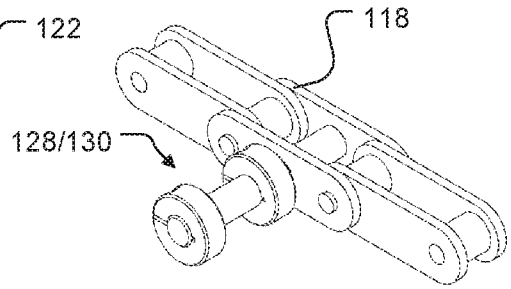



FIGURE 2E

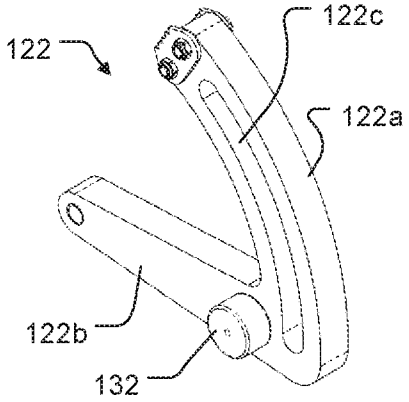
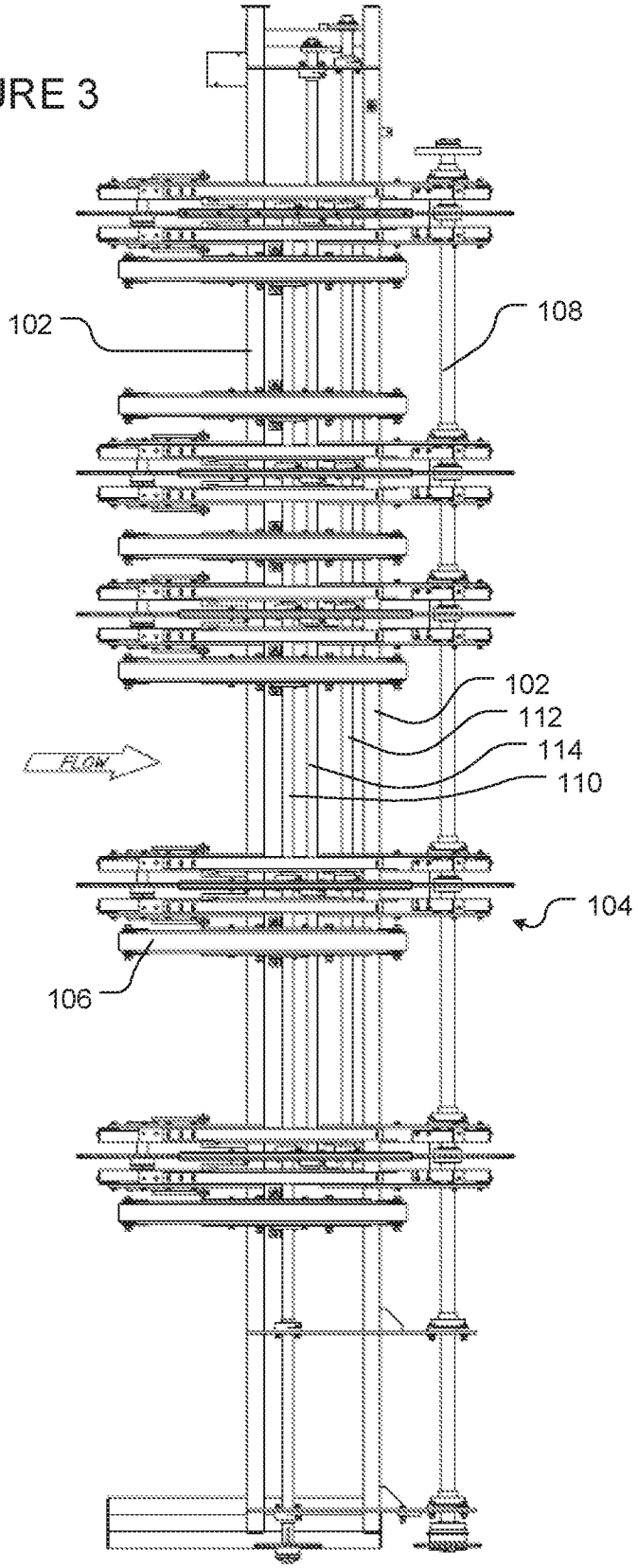



FIGURE 2F

FIGURE 3



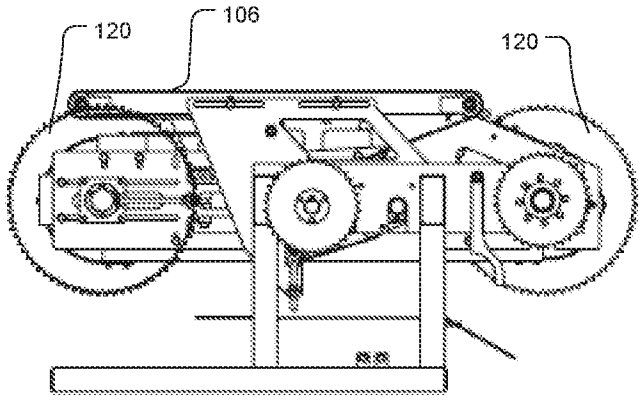



FIGURE 4

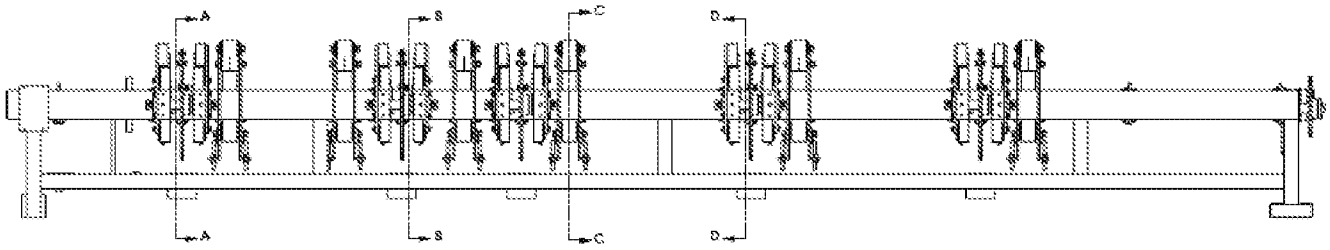
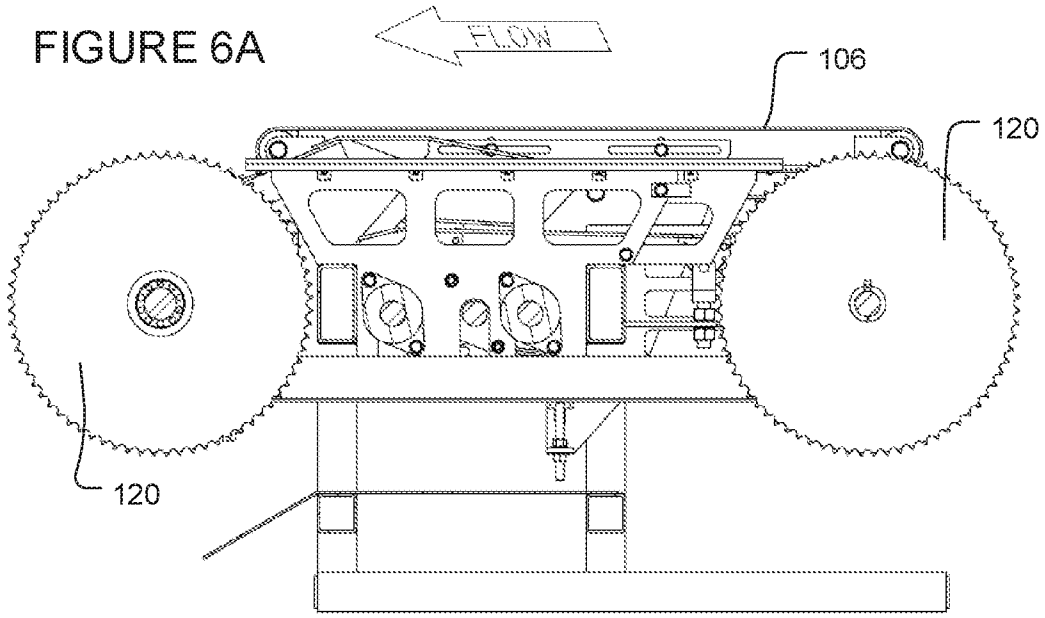


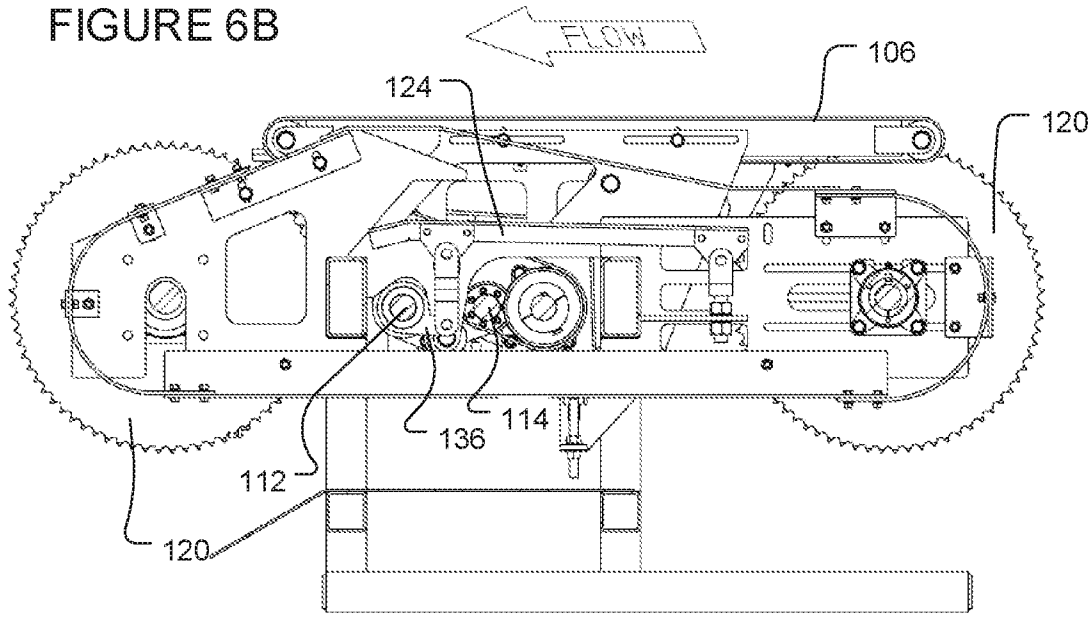

FIGURE 5

FIGURE 6A



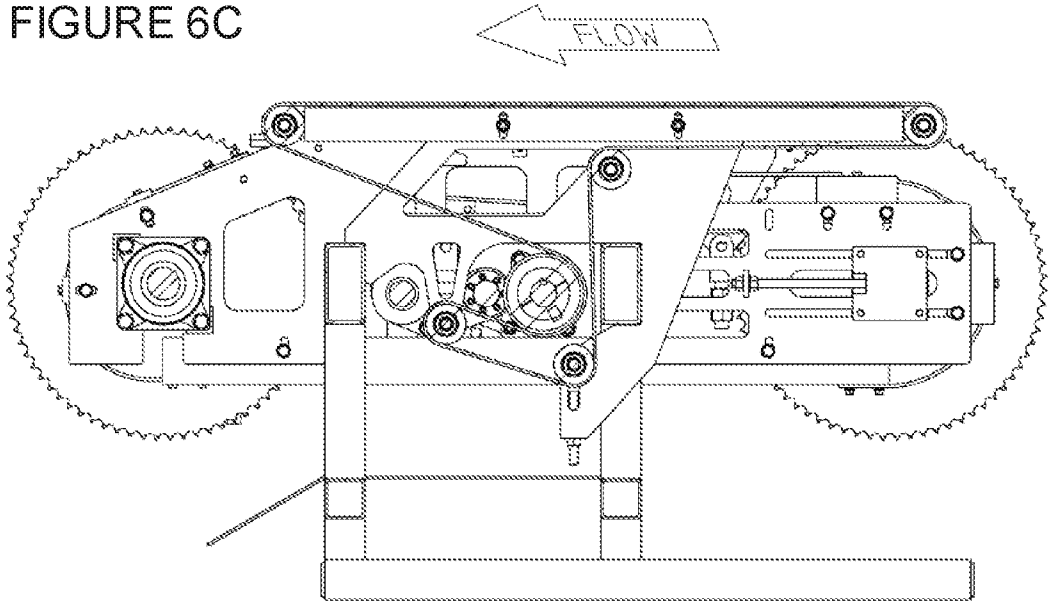

SECTION A-A

FIGURE 6B



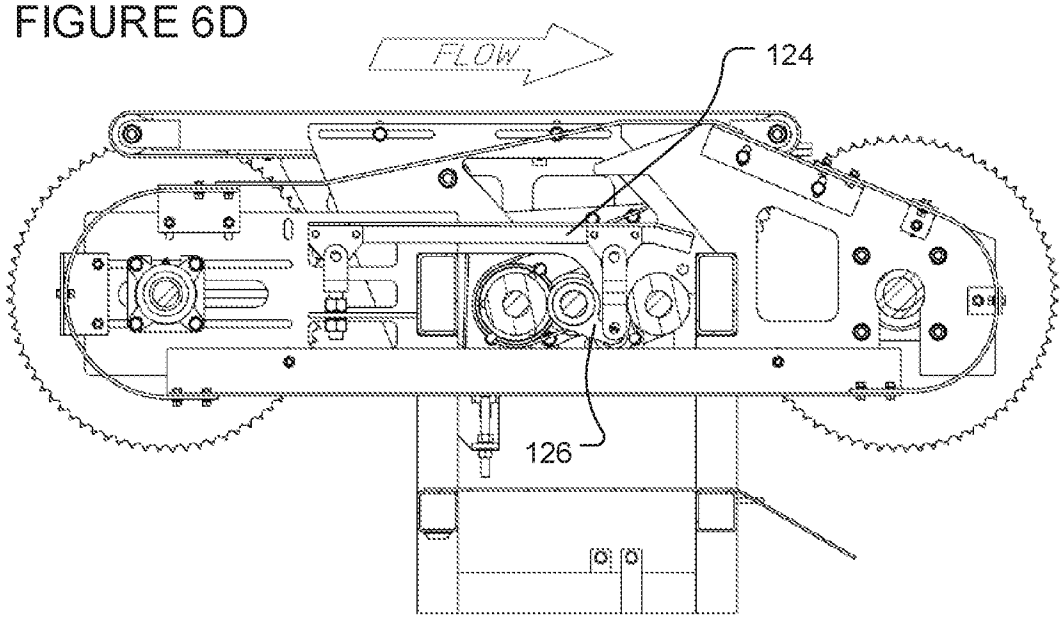

SECTION B-B

FIGURE 6C



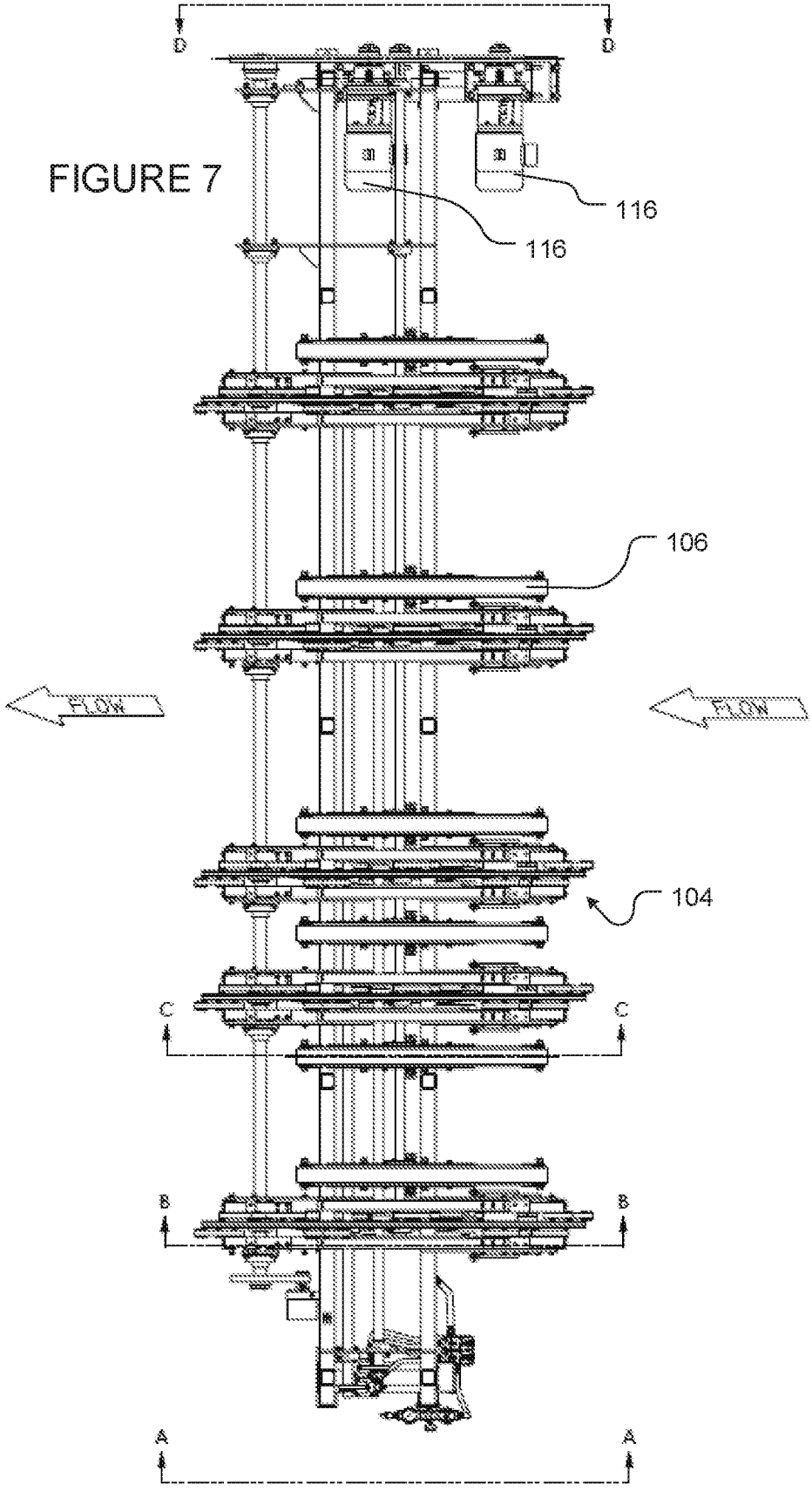

SECTION C-C

FIGURE 6D




SECTION D-D

FIGURE 7



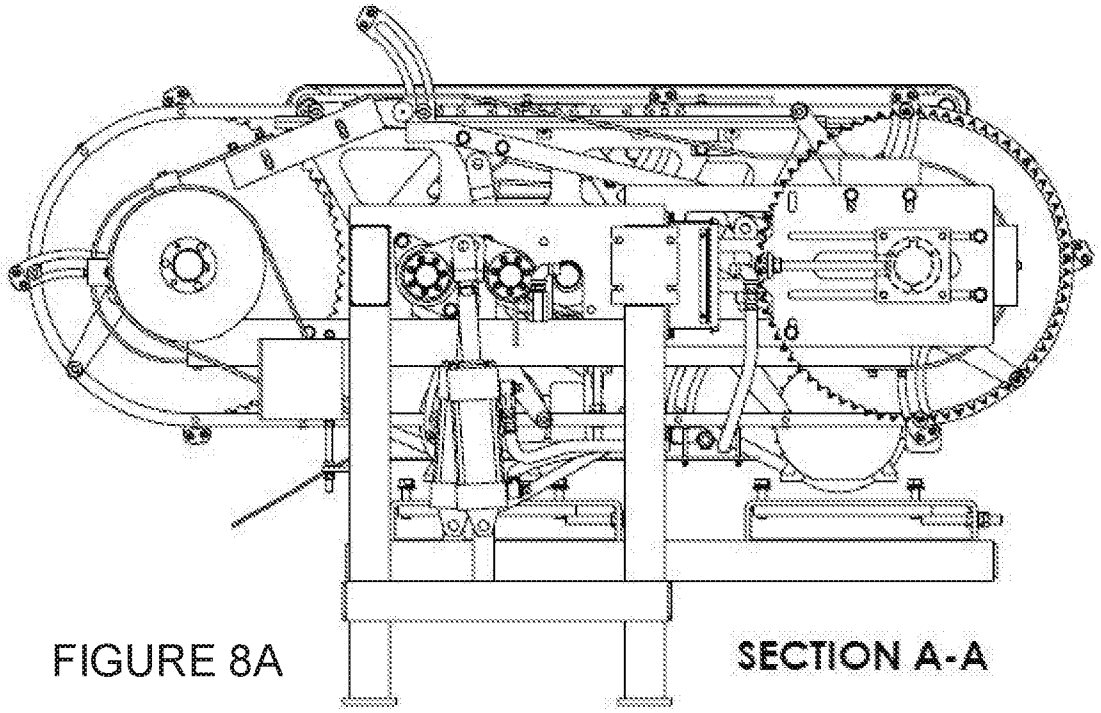


FIGURE 8A SECTION A-A

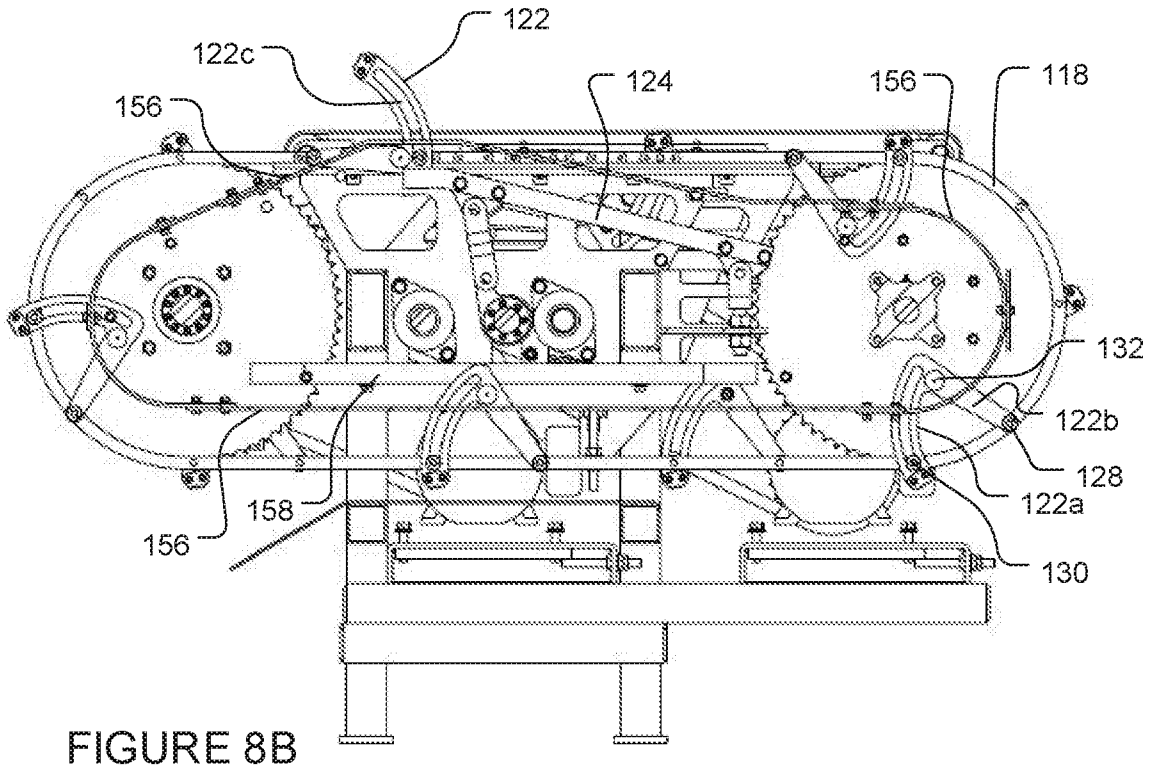



FIGURE 8B

SECTION B-B

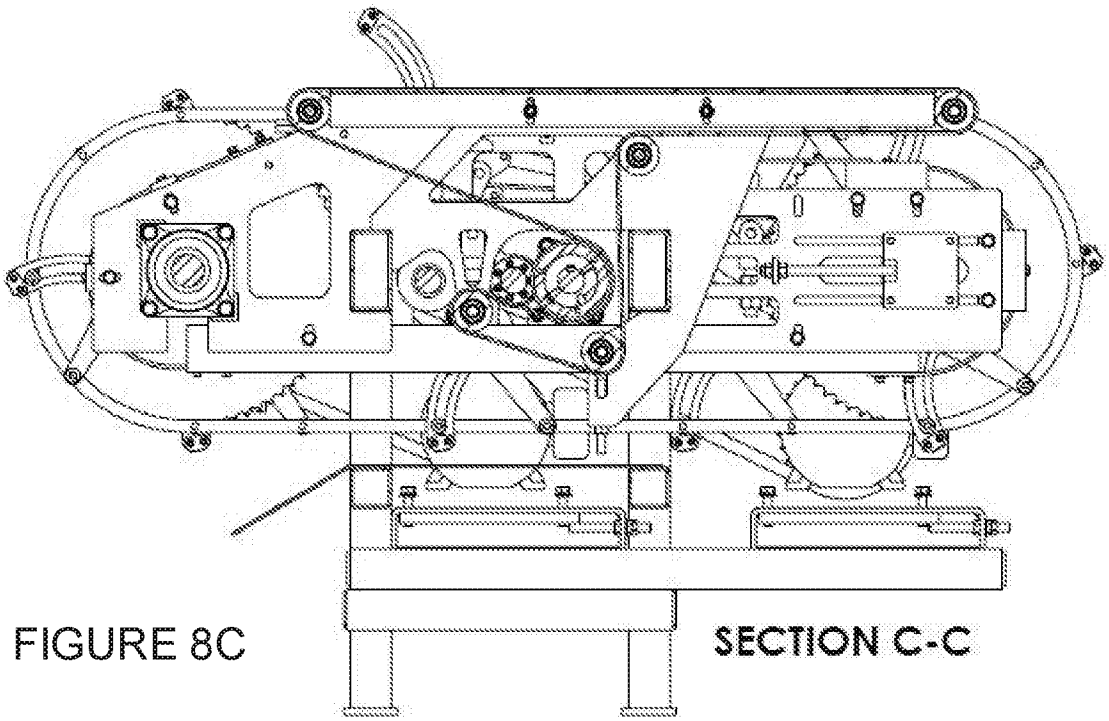
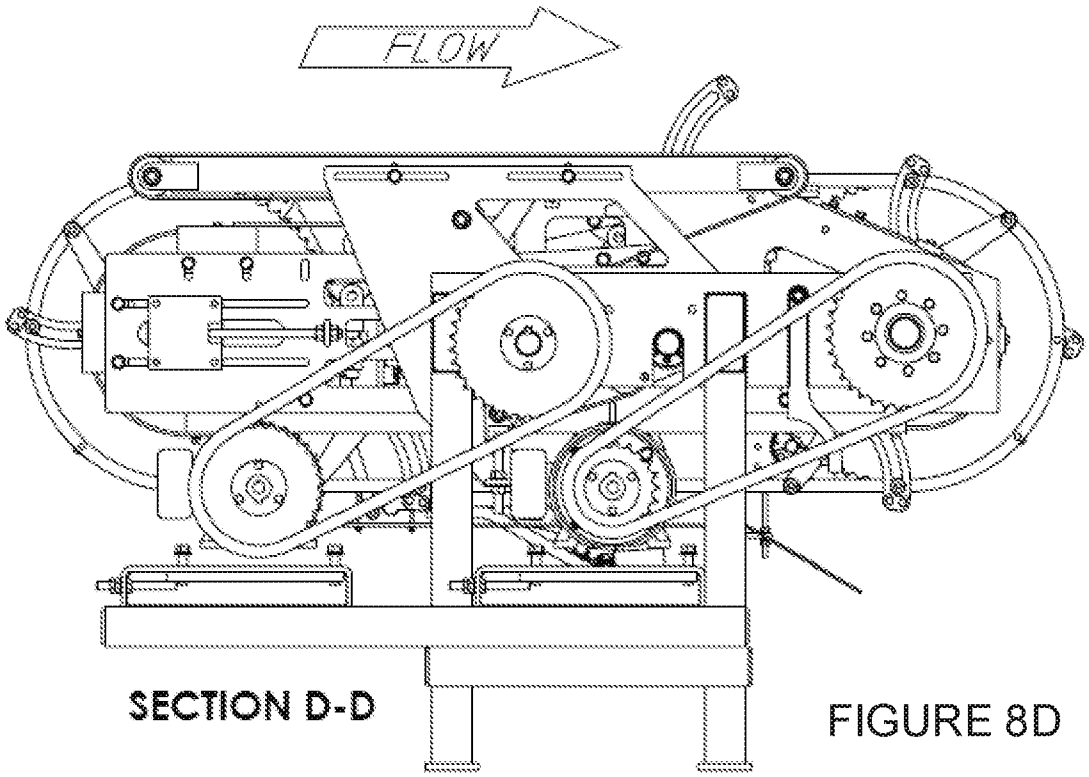
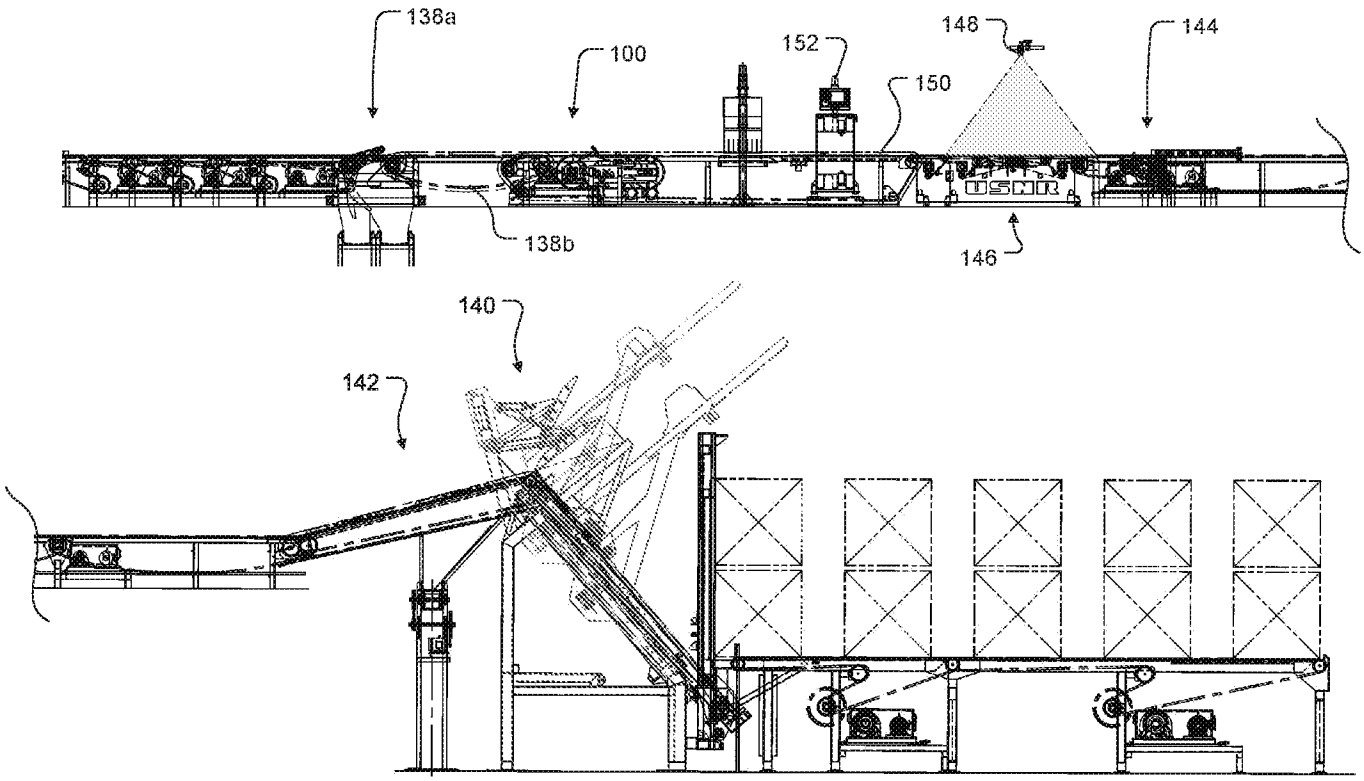


FIGURE 8C SECTION C-C




SECTION D-D FIGURE 8D

FIGURE 9



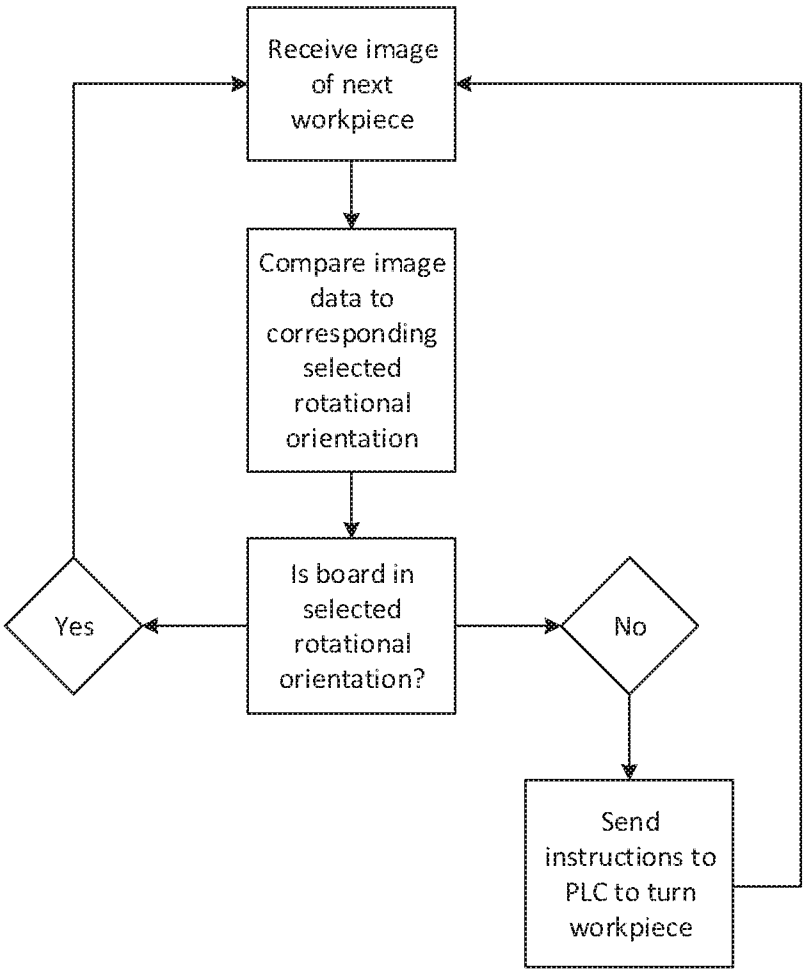

Receive image of next workpiece
Compare image data to corresponding selected rotational orientation
Is board in selected rotational orientation?
Yes
No
Send instructions to PLC to turn workpiece

FIGURE 10

**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/US2016/061923**

**A. CLASSIFICATION OF SUBJECT MATTER**

**B65G 47/248(2006.01)i, F16H 7/06(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)
B65G 47/248; B65G 47/24; B65G 47/252; B25J 1/00; B27B 31/04; F16H 7/06

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: board turner, endless chain, turner arm, pivot member, interval, terminal end

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 2005-0150743 A1 (HENDERSON, DEANE) 14 July 2005<br>See paragraphs [0002]-[0038]; and figures 1-7, 8a-8c. | 1-2 |
| A | US 2005-0135917 A1 (KAUPPILA et al.) 23 June 2005<br>See paragraphs [0002]-[0040]; and figures 1-5, 6A-6F. | 1-2 |
| A | US 5605216 A (RAYBON et al.) 25 February 1997<br>See column 1, line 5 - column 5, line 6; and figures 1-6. | 1-2 |
| A | US 4484675 A (DOHERTY et al.) 27 November 1984<br>See column 1, line 6 - column 7, line 41; and figures 1-2, 2A, 3-4. | 1-2 |
| A | EP 1344731 A1 (RENHOLMENS MEKANISKA VERKSTAD AB) 17 September 2003<br>See paragraphs [0001]-[0034]; and figures 1-4. | 1-2 |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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 | Date of mailing of the international search report |
|---|---|
| 23 February 2017 (23.02.2017) | **24 February 2017 (24.02.2017)** |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HWANG, Chan Yoon
Telephone No. +82-42-481-3347

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.
**PCT/US2016/061923**

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2005-0150743 A1 | 14/07/2005 | CA 2491620 A1 | 08/07/2005 |
| | | CA 2491620 C | 02/04/2013 |
| US 2005-0135917 A1 | 23/06/2005 | AT 361254 T | 15/05/2007 |
| | | AU 2003-296370 A1 | 29/07/2004 |
| | | CA 2507615 A1 | 22/07/2004 |
| | | EP 1597177 A1 | 23/11/2005 |
| | | EP 1597177 A4 | 15/03/2006 |
| | | EP 1597177 B1 | 02/05/2007 |
| | | US 2007-0215439 A1 | 20/09/2007 |
| | | US 7153086 B2 | 26/12/2006 |
| | | WO 2004-060778 A1 | 22/07/2004 |
| US 5605216 A | 25/02/1997 | None | |
| US 4484675 A | 27/11/1984 | None | |
| EP 1344731 A1 | 17/09/2003 | AT 314293 T | 15/01/2006 |
| | | CA 2422285 A1 | 15/09/2003 |
| | | CA 2422285 C | 01/02/2011 |
| | | DE 60302915 T2 | 03/08/2006 |
| | | EP 1344731 B1 | 28/12/2005 |
| | | SE 0200781 A | 16/09/2003 |
| | | SE 527394 C2 | 28/02/2006 |
| | | US 2004-0050658 A1 | 18/03/2004 |
| | | US 6782991 B2 | 31/08/2004 |

# INTERNATIONAL SEARCH REPORT

International application No.
**PCT/US2016/061923**

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 3-4
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 3-4 are unclear, because they include obscure expression such as "as described herein", which render the determination of the exact scope of the protection difficult.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.