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

(11) **EP 4 435 181 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.09.2024 Bulletin 2024/39

(21) Application number: **24159673.3**

(22) Date of filing: **26.02.2024**

(51) International Patent Classification (IPC):
E01B 29/06 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E01B 29/06

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

(30) Priority: **16.03.2023 US 202363490683 P**
18.12.2023 US 202318544349

(71) Applicant: **Transportation IP Holdings, LLC**
Norwalk, CT 06851 (US)

(72) Inventors:
- **Vanderlinden, Michael**
  Knoxville (US)
- **Wellings, Norman**
  Agency (US)
- **Bachman, Mark**
  Albia (US)

(74) Representative: **Worthington, Richard Easton**
Withers & Rogers LLP
2 London Bridge
London SE1 9RA (GB)

(54) TIE-ARRANGEMENT SYSTEM AND METHOD OF DELIVERING TIES

(57) Tie-arrangement system (106; 200) includes a conveyor assembly (204, 206; 304, 306) configured to receive ties (112, 214, 314, 402, 622, 722) for placement in a track (628, 630) for rail vehicles. The conveyor assembly (204, 206; 304, 306) is configured to receive the ties (112, 214, 314, 402, 622, 722) in a common plane relative to each other. The tie-arrangement system (106; 200) includes an accumulator assembly (122, 208, 400, 502, 922) configured to receive the ties (112, 214, 314, 402, 622, 722) in the common plane from the conveyor assembly (204, 206; 304, 306). The accumulator assembly (122, 208, 400, 502, 922) is configured to arrange the ties (112, 214, 314, 402, 622, 722) in a same orientation in groups and to move the groups of the ties (112, 214, 314, 402, 622, 722) out of the accumulator assembly (122, 208, 400, 502, 922). The tie-arrangement system (106; 200) includes a delivery assembly (124, 210, 406, 500, 600, 700, 924) configured to receive the groups of the ties (112, 214, 314, 402, 622, 722) arranged by the accumulator assembly (122, 208, 400, 502, 922) into the same orientation. The delivery assembly (124, 210, 406, 500, 600, 700, 924) is configured to place the groups of the ties (112, 214, 314, 402, 622, 722) onto a surface off the tie-arrangement system (106; 200) for placement of the ties (112, 214, 314, 402, 622, 722) in the track (628, 630) for the rail vehicles.

EP 4 435 181 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Application No. 18/544,349 (filed 18-December-2023), which claims priority to U.S. Provisional Application No. 63/490,683 (filed 16-March-2023), the entire disclosures of which are incorporated herein by reference.

BACKGROUND

Technical Field.

[0002] Embodiments of the inventive subject matter described herein relate to systems and methods for arranging and placing railway ties along a path of the railway.

Discussion of Art.

[0003] A railway track may include rails that are supported by ties (also called sleepers) extending transverse to the rails. The ties transfer the load from passing vehicles to the underlying surface (e.g., ballast and/or subgrade). The ties can also be used to maintain a separation distance between parallel rails. Railway tracks are periodically inspected to identify any components that should be repaired or replaced. For example, the ties along a section of the track may be scanned (e.g., using cameras and/or other sensors) to identify individual ties that need to be replaced. Individual ties that exhibit excessive creepage, damage (e.g., splitting), or other deterioration may be designated for replacement. Millions of ties can be replaced each year in the United States alone.

[0004] Replacing used ties can be a multi-step process that can include moving different types of heavy machinery along the same length of track. For example, after determining which used ties can be replaced, a spike puller can travel along the railway track and remove the spikes that secure the used ties to the ground. The spike puller may be followed by a separate machine called a tie extractor. The tie extractor grips and lifts the rails while pulling the used tie out from underneath the rails. Each used tie may be left alongside the track at the site from which the used tie was removed. The tie extractor then moves to the next site along the track and repeats the extracting process.

[0005] Following the tie extractors, cranes or excavators lift and load the used ties onto a vehicle for removal. For example, the used ties may be loaded onto rail cars or trucks that can be separate from the cranes. During the loading process, the crane can be off-track while the rail car or truck can be on-track. Alternatively, the crane can be on-track and the rail car or truck can also be on-track.

[0006] More recently, however, the crane has been mounted onto a rail car that receives the used ties such that both the crane and the rail car move together along the track. For example, a gondola rail car can be open along the top for an entire length of the rail car. A holding area for the used ties can be defined between two sidewalls of the rail car. The crane may be mounted onto top edges of the two sidewalls such that the crane extends across the open top. As the crane retrieves the used ties from alongside the railway tracks and places the used ties within the holding area of the rail car, the crane moves along the length of the rail car. After removing the used ties along the railway track, the rail car can be transported to a remote site, such as a facility for recycling or converting the used ties to cogeneration fuel. Replacement ties are delivered (e.g., by trucks or rail cars) and deposited alongside the railway track.

[0007] Delivering new ties can be relatively time-consuming and can potentially pose a risk to worker safety or damage to the replacement ties. It can be impractical to individually place (e.g., using a crane) each and every replacement tie alongside the railway track as the process can require careful manipulation of the crane. For this reason, the replacement ties may be deposited in batches alongside the road. However, depositing large batches of ties (e.g., 10-30 ties) alongside the railway track creates other challenges. The new replacement tie can be positioned within the trench left by the extracted tie. If a section of the railway track has relatively few ties-to-be-replaced, then the batch of replacement ties must be used for an even greater length of railway track. A different process for placing ties alongside the railway tracks may be desired.

BRIEF DESCRIPTION

[0008] In accordance with one example or aspect, a tie-arrangement system is provided. The tie-arrangement system may include a conveyor assembly configured to receive ties for placement in a track for rail vehicles. The conveyor assembly can be configured to receive the ties in a common plane relative to each other. The tie-arrangement system may include an accumulator assembly configured to receive the ties in the common plane from the conveyor assembly. The accumulator assembly may be configured to arrange the ties in a same orientation in groups and to move the groups of the ties out of the accumulator assembly. The tie-arrangement system may include a delivery assembly configured to receive the groups of the ties arranged by the accumulator assembly into the same orientation. The delivery assembly can be configured to place the groups of the ties onto a surface off the tie-arrangement system for placement of the ties in the track for the rail vehicles.

[0009] In accordance with one example or aspect, a method is provided that may include receiving ties for placement in a track for rail vehicles. The ties can be received in a common plane relative to each other. The method may include dividing the ties received in the common plane into one or more groups in which the ties of

each group have a same orientation. The method may include placing the one or more groups of ties onto a surface for placement of the ties adjacent to the track for the rail vehicles.

[0010] In accordance with one example or aspect, a tie-arrangement system that can be configured to be disposed onboard a vehicle is provided. The tie-arrangement system may include a collection assembly configured to receive ties for placement in a track for rail vehicles. The collection assembly can be configured to receive the ties in different planes. The collection assembly can include a first conveyor assembly that may be configured to move the ties in the different planes beneath a planarizing body that moves the ties into a common plane. The tie-arrangement system may include a second conveyor assembly that can be configured to receive the ties in the common plane from the collection assembly and to move the groups of the ties away from the collection assembly. The tie-arrangement system may include an accumulator assembly that can be configured to receive the ties in the common plane from the second conveyor assembly. The accumulator assembly can be configured to arrange the ties in a same orientation in groups and to move the groups of the ties out of the accumulator assembly. The tie-arrangement system may include a delivery assembly that can be configured to receive the groups of the ties arranged by the accumulator assembly into the same orientation. The delivery assembly can be configured to place the groups of the ties onto a surface off the tie-arrangement system for placement of the ties in the track for the rail vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The subject matter may be understood from reading the following description of non-limiting embodiments, with reference to the attached drawings, wherein below:

Figure 1 is a schematic side view of a tie-distribution unit in accordance with one embodiment;

Figure 2A is an isolated perspective view of a tie-arrangement system in accordance with one embodiment that may be used with a tie-distribution unit;

Figure 2B is another perspective view of the tie-arrangement system;

Figure 3A is a schematic side view of a collection assembly that moves and orients ties in accordance with one embodiment;

Figure 3B is a schematic top view of the collection assembly in Figure 3A;

Figure 4A is a perspective view of a tie-arrangement system that can include an accumulator assembly and a delivery assembly in accordance with an embodiment;

Figure 4B is a perspective view of the tie-arrangement system in Figure 4A;

Figure 5 is a perspective view of a portion of a tie-arrangement system in which a load space of a delivery assembly is tilted for delivering ties;

Figure 6 is a side view of a delivery assembly in accordance with an embodiment having a movable vertical gate;

Figure 7 is a side view of a delivery assembly in accordance with an embodiment having a movable vertical gate and also a movable lateral gate;

Figure 8 is a schematic view of a hydraulic system configured to operate one or more assemblies of a tie-distribution unit according to an embodiment;

Figure 9 is a perspective view of a tie-distribution unit according to an embodiment; and

Figure 10 is a flow chart illustrating a method of delivering a group of ties in accordance with one embodiment.

DETAILED DESCRIPTION

[0012] Embodiments of the subject matter described herein relate to systems and methods for collecting, arranging, and/or dispensing ties that will be placed in a track for rail vehicles. The ties may be temporarily positioned or set alongside the track. The track may be incomplete (e.g., under-construction) or the track may be an existing track undergoing repair or maintenance. The ties may be collected together to form a stack and then at least a portion of that stack may be placed alongside the track. The stack may be referred to as a batch or bundle. The stack may rest in a cargo bed. In particular embodiments, fewer than the entire stack may be dispensed from the cargo bed. For example, embodiments may select one or more ties from the stack to be delivered at one site and then select one or more of the ties remaining in the stack to be delivered at another site.

[0013] A stack of ties may include only a single level (or row) of ties or multiple levels of ties. Each level may be formed by one or more groups of ties. In some cases, a stack of ties can be formed by stacking multiple groups of ties on top of one another. Each group may have ties that are coplanar and have the same orientation. The ties may form an ordered stack of ties that can include a designated number of groups stacked onto one another. For example, an ordered stack may include five groups in which each group has the same number of ties (e.g., eight) that are coplanar and have the same orientation.

In this example, the ordered stack can be a five-by-eight (5 X 8) stack of ties. An ordered stack may enable selective dispensing such that fewer than the entire stack of ties may be placed alongside the track. A disordered stack of ties may include multiple groups of ties stacked onto one another in which the groups of ties may or may not have the same number and/or the same orientation of ties. Suitable ties may be wood, cement, metal, plastic composite, and the like.

[0014] Figure 1 is a schematic side view of a tie-distribution unit 100. The tie-distribution unit can include a well car 102, a crane or excavator 104 that can be mounted to or positioned near the well car, and a tie-arrangement system 106 that can be mounted to or positioned near the well car. In the illustrated embodiment, the crane and the tie-arrangement system can be mounted to the well car such that the crane and the tie-arrangement system move with the well car. For example, the well car may be a rail car that can be configured to move along rails. The rail car may be powered by an attached locomotive or other powered vehicle. The tie-arrangement system and the crane may be operably attached such that the crane moves the tie-arrangement system as the crane moves along the well car. In other embodiments, however, the crane and/or the tie-arrangement system may be attached to a side of the well car or the crane and/or the tie-arrangement system may be positioned separate from the well car. The tie-distribution unit in Figure 1 is on-track such that the tie-distribution unit can be configured for moving along a railway track 108. In other embodiments, however, the tie-distribution unit may travel along a parallel road or path (e.g., off-track).

[0015] As shown, the well car can be a gondola-type rail car having a cargo area 110 where ties 112 can be held during operation. The cargo area can be defined between two sidewalls 114 of the well car such that the cargo area opens toward a top of the well car. The crane can be mounted onto edges of the sidewalls and can be configured to move lengthwise along the well car over the open cargo area. For example, as ties are depleted at one portion of the cargo area, the crane may move itself and the tie-arrangement system along the length of the well car. In some embodiments, the well car can be adjoined to one or more other well cars 116 of the tie-distribution unit. For example, the tie-distribution unit may include sidewall bridges 118 that allow the tie-arrangement system and the crane to move from one well car to another.

[0016] The tie-arrangement system arranges the ties and dispenses the ties onto a surface off the tie-arrangement system for subsequent placement of the ties in the track for the rail vehicles. As will be described in greater detail below, the tie-arrangement system arranges ties into a stack and then delivers the stack off the tie-arrangement system. Arranging the ties into stacks may include separate or overlapping stages. In some embodiments, the tie-arrangement system can include a collection assembly 120, an accumulator assembly 122, and a delivery assembly 124. The collection assembly receives the ties from the crane. More specifically, the crane may include an arm 126 having a grapple 128 that grabs one or more ties. The arm and the grapple can be directed by an operator to place the one or more ties onto the collection assembly. The collection assembly receives the ties and at least partially aligns the ties toward a common orientation. The accumulator assembly receives, from the collection assembly, the ties having the same or nearly the same orientation. The accumulator assembly may form separate rows of ties that can be stacked to form the tie stack. The accumulator assembly then transfers the stack to the delivery assembly. The delivery assembly dispenses the ties off of the tie-distribution unit. Optionally, the various stages of the tie-arrangement system may be powered by a hydraulic system 130. Alternatively or in addition to the hydraulic system, a hydraulic sub-system of the crane may be used to power the tie-arrangement system.

[0017] Figures 2A and 2B provide different perspective views of a tie-arrangement system 200. The tie-arrangement system can include a collection assembly 202 having a first conveyor assembly 204 and a second conveyor assembly 206. For clarity, the first conveyor assembly may be referred to as an alignment conveyor assembly and the second conveyor assembly may be referred to as a feeding conveyor assembly. The tie-arrangement system also can include an accumulator assembly 208. As shown more clearly in Figure 2A, the tie-arrangement system can also have a delivery assembly 210 and a hydraulic system 212.

[0018] As shown in Figures 2A and 2B, the feeding conveyor assembly can be located upstream from the alignment conveyor assembly and can be configured to provide ties 214 to the alignment conveyor assembly. The feeding conveyor assembly can include a receiving space 216 that opens to a top of the feeding conveyor assembly. The receiving space can be configured (e.g., sized and shaped) to receive ties having unaligned orientations. For example, a crane may provide a single tie having an unknown orientation or a bunch of ties in which the ties have different orientations. The feeding conveyor assembly also can include one or more conveying elements 218 that frictionally engage and transport the ties. In the illustrated embodiment, the conveying elements can be belts (e.g., four to six chains) that rotate along wheels 220 (e.g., pulleys) powered by the hydraulic system and transport the ties toward the alignment conveyor assembly. Alternatively, the conveying elements may include a plurality of chains that can be similarly sized as the belts in Figure 2. The chains may rotate along wheels (e.g., including sprockets) powered by the hydraulic system and transport the ties in a similar manner. Alternatively, the conveying elements may include a single wide belt or mesh powered by wheels. Other conveying technologies may be used.

[0019] The alignment conveyor assembly may include a similar or identical conveying mechanism as the feed-

ing conveyor assembly. In particular embodiments, the conveying mechanism of the alignment conveyor assembly and the conveying mechanism of the feeding conveyor assembly operate at different speeds. As shown in Figure 2A, the alignment conveyor assembly can include conveying elements 222 for transporting the ties along a transport plane (described in greater detail below). The alignment conveyor assembly can be configured to adjust an orientation of each tie received from the feeding conveyor assembly. For example, the alignment conveyor assembly may include a planarizing body 224 that can be positioned a height over the transport plane of the alignment conveyor assembly. If the tie is not sufficiently aligned, the planarizing body can deflect the tie into an aligned orientation. The alignment conveyor assembly also include limiting bodies 226 that prevent the aligned ties from moving into misalignment. For example, the limiting bodies form a ceiling that prevents the ties from rotating from a broad side to an edge of the tie. The limiting bodies may also prevent errant ties from entering the alignment conveyor assembly above.

[0020] In other embodiments, the tie-arrangement system may not include the feeding conveyor assembly. Instead, the ties may be fed into the alignment conveyor assembly by other means. For example, the alignment conveyor assembly may be positioned under a chute that receives the ties. Gravity may pull the ties along the chute and the alignment conveyor assembly may be configured to receive only one tie at a time.

[0021] The accumulator assembly can include a housing frame 228 that supports a first movable sidewall 230 and a second movable sidewall 232. The first and second movable sidewalls oppose each other with a stack-forming space 234 therebetween. Each of the first and second movable sidewalls can include a plurality of brackets 236 (shown in Figure 2A) that extend toward the opposite movable sidewall. A bracket of the first movable sidewall can align with (or can be level with) a bracket of the second movable sidewall to form a slot for receiving ties from the alignment conveyor assembly. The brackets from the first and second movable sidewalls effectively form a column of slots in which each slot can be sized and shaped to receive a group of ties. For each slot, the pair of brackets may support opposite ends of each tie such that each tie extends across the stack-forming space between the two brackets. Each pair of brackets (or each slot) may receive a plurality of ties (e.g., six) such that the ties extend parallel to one another and have a common orientation.

[0022] The accumulator assembly (or the delivery assembly) can include one or more stack gates 240 that can be configured to block the ties at ends of the slots. As shown, the stack gates can be movable flaps that extend transverse to the brackets or to the slots. When the stack gates are closed, the movable flaps can be positioned to block or stop movement of the ties. When the stack gates are open, the movable flaps can be positioned to permit the tie stack to exit the accumulator assembly and enter the delivery assembly.

[0023] After a first slot receives a designated number of ties, the accumulator assembly may raise or lower the slots along a stacking axis 242 so that a second shelf can receive incoming ties. The process may be repeated until the accumulator assembly includes a stack of ties formed by multiple groups of ties located withing respective slots. Each group of ties can be stacked relative to at least one other group of ties. When the stack of ties is complete, the accumulator assembly may move the stack relative to a stack transport 244 (shown in Figure 2B) of the alignment conveyor assembly so that the stack transport engages at least one side of the stack. For example, when the stack of ties is complete, the accumulator assembly may lower the stack of ties into a holding area of the stack transport. As described in greater detail below, the stack transport can be configured to engage a trailing side of the stack and move the stack toward the toward the delivery assembly. The stack transport may further bundle or pack the ties more closely together upon engaging and moving the stack.

[0024] Figures 3A and 3B show a schematic side view and top view, respectively, of a collection assembly 300 that may form part of a tie-arrangement system. The collection assembly has a first conveyor assembly 304 and a second conveyor assembly 306. For clarity, the first conveyor assembly may be referred to as an alignment conveyor assembly and the second conveyor assembly may be referred to as a feeding conveyor assembly.

[0025] The feeding conveyor assembly can be located upstream from the alignment conveyor assembly and can be configured to provide ties 314 to the alignment conveyor assembly. The feeding conveyor assembly can include a receiving space 316 that opens to a top of the feeding conveyor assembly. Ties can be provided through the receiving space. For example, the grapple of a crane may release a bunch of ties onto the feeding conveyor assembly.

[0026] The feeding conveyor assembly can include conveying elements 318 that frictionally engage and transport the ties. The conveying elements may be, for example, belts, cables, or chains that can be rotated by wheels 320 (Figure 3A) powered by a hydraulic system (not shown). The conveying elements transport the ties toward a feeding conveyor end 321 of the feeding conveyor assembly.

[0027] The alignment conveyor assembly can include conveying elements 322 that frictionally engage and transport the ties. The conveying elements can be driven by wheels 323 (Figure 3B) powered by a hydraulic system (not shown). The alignment conveyor assembly has a receiving conveyor end 327. Optionally, the collection assembly can include a conveyor bridge 330 that extends across a gap between the feeding conveyor end and the receiving conveyor end. The conveyor bridge can provide the ties with a smoother transition from the feeding conveyor assembly to the alignment conveyor assembly. For example, the conveyor bridge may allow the ties to slide

across a surface of the conveyor bridge onto conveying elements of the alignment conveyor assembly.

[0028] The alignment conveyor assembly can be configured to at least partially align the ties received from the feeding conveyor assembly . While traveling along the feeding conveyor assembly the ties may extend approximately parallel to one another. Nevertheless, the ties will have different orientations with respect to one another and will likely have a non-desired (or skewed) orientation for making a stack of ties. The tie 314E illustrates an aligned tie. The aligned tie can be oriented with respect to a longitudinal axis 391 that extends lengthwise through a geometric center of the tie, a lateral axis 392 that extends along a width of the tie, and a normal axis 393 that extends along a height or thickness of the tie. The longitudinal, lateral, and normal axes can be like the roll, pitch, and yaw axes, respectively, for aircraft orientation.

[0029] As shown in Figures 3A and 3B, the ties have a shorter side and a broader side. In the illustrated example, the aligned or desired orientation can include the ties resting upon the broader side. While unaligned in the feeding conveyor assembly, the ties may extend lengthwise generally parallel to one another but have different orientations about the longitudinal axis (e.g., different amounts of roll) and/or the normal axis (e.g., different amounts of yaw). In Figures 3A and 3B, the tie 314A is askew with respect to the normal axis (e.g., improper amount of yaw) and the ties 314B and 314C are askew in different amounts with respect to the normal axis and are both rotated 90 degrees about the longitudinal axis. Although not shown, it is also possible that the ties will have slight differences about the lateral axis (e.g., different amount of pitch).

[0030] The alignment conveyor assembly can include a planarizing body 324 near the receiving conveyor end. For ties that are askew or skewed, the planarizing body can be configured to move the tie about at least one of the longitudinal axis or the normal axis. For example, during operation, a surface of the conveying elements of the alignment conveyor assembly define a transport plane 332 (Figure 3A). The planarizing body can be positioned a height 334 over the transport plane of the alignment conveyor assembly. The height can be configured to permit ties lying on a broader side clear the planarizing body. If the tie is not lying on a broader side but the shorter side, then the planarizing body deflects the tie causing the tie to tip over onto the broader side.

[0031] Optionally, the planarizing body can also deflect the tie about the normal axis. The planarizing body can be oriented to extend parallel to the longitudinal axis of an aligned tie. If the tie is not aligned properly about the normal axis (see, e.g., ties 314B and 314C), a leading portion of the tie will first strike the planarizing body. Before tipping over, the conveying elements will continue to move the tie. As such, the other portion of the tie will rotate about the normal axis. When the tie is closer to being aligned about the normal axis, the planarizing body will cause the tie to tip over onto the broader side.

[0032] In some embodiments, operation of the feeding conveyor assembly and operation of the alignment conveyor assembly are the same. For example, the conveying elements and the wheels may be identical and may be driven at the same speed. In other embodiments, however, operation of the feeding conveyor assembly and operation of the alignment conveyor assembly can be different. For instance, the conveying elements of the feeding conveyor assembly and the alignment conveyor assembly may be driven at different speeds. As one example, the conveying elements of the alignment conveyor assembly may be driven at a faster speed than the conveying elements of the feeding conveyor assembly. In such instances, the faster speed of the alignment conveyor assembly may cause improperly oriented ties to tip over into the proper orientation.

[0033] Accordingly, the planarizing body permits ties having a designated orientation to pass therethrough while engaging and moving ties that are improperly oriented about the longitudinal axis. For the improperly oriented ties, the planarizing body causes the ties to rotate into the designated orientation and then permits the ties to pass therethrough. As such, ties that have passed the planarizing body are arranged along a common plane.

[0034] After clearing the planarizing body, the conveying elements transport the aligned ties toward an output conveyor end 340. Optionally, the alignment conveyor assembly may also include limiting bodies 326 that prevent the aligned ties from moving out of alignment. For example, the limiting bodies form a ceiling that prevents the ties from rotating from the broader side to the shorter side. The limiting bodies may also prevent errant ties from entering the alignment conveyor assembly above.

[0035] Optionally, the alignment conveyor assembly may include other alignment bodies 342 for aligning the ties. For example, the other alignment bodies in Figures 3A and 3B can be resilient flaps (or bumpers) that engage end portions of the ties. The resilient flaps provide some resistance to the ties moving along the conveying elements but do not prevent forward movement entirely. For example, a tie that can be rotated about the normal axis will have one end portion that engages one of the resilient flaps. The resilient flaps may cause the skewed tie to rotate about the normal axis before yielding and allowing the tie to pass underneath.

[0036] As shown by Figures 3A and 3B, the ties exit the accumulator assembly along a common plane, such as the transport plane or a plane that includes or is parallel to the lateral and longitudinal axes of the ties. As such, the accumulator assembly (described in greater detail below) can receive the ties in a common plane.

[0037] Figures 4A and 4B are perspective views of an accumulator assembly 400 that may be used with a tie-arrangement system. Figures 4A and 4B illustrate different stages of the accumulator assembly. In Figure 4A, the accumulator assembly has received the ties 402 (e.g., from an alignment conveyor assembly). In Figure

4B, the accumulator assembly has lowered the ties onto a stack transport 425 for providing the ties as a tie stack 404 to a delivery assembly 406.

[0038] As shown in Figure 4A, the accumulator assembly can include a housing frame 408 that supports a first movable sidewall 410 and a second movable sidewall 412 having a stack-forming space 414 therebetween. The housing frame and the first and second movable sidewalls may be shaped from materials sufficient for holding heavy loads as described herein. For example, the housing frame and the first and second movable sidewalls may include heavy duty steel frame construction. The first and second movable sidewalls include brackets 416, 418, respectively. The brackets of the first and second movable sidewalls align with one another to form a column of slots 421, 422, 423 in which each slot can be sized and shaped to receive a group of ties. For each slot, the pair of brackets may support each tie in a manner similar to brackets that support a shelf. More specifically, two aligned brackets hold opposite ends of each tie such that each tie extends across the stack-forming space between the two brackets.

[0039] Each pair of brackets (or each slot) may receive a group of ties (e.g., six) such that the ties extend parallel to one another and have a common orientation. Accordingly, the slots hold respective groups of ties. One or more groups of ties can form a tie stack. In the illustrated embodiment, the tie stack can include three slots that each hold one group (or six ties) for a total of eighteen ties. In other embodiments, however, the accumulator assembly and tie-arrangement system may hold more or fewer ties. For example, the accumulator assembly may include only one slot or only two slots or more than three slots (e.g., four, five, six or more slots). Furthermore, each slot may hold fewer or more ties. For example, each slot may hold two, three, four, or five ties, or each slot may hold seven, eight, nine, or ten or more ties. Moreover, the slots may have different numbers of ties. For example, the bottom group of ties may include six ties. But the middle group may include four ties and the top group may include four or fewer ties.

[0040] The accumulator assembly has an elevator assembly 430 for lifting and lowering the ties. The elevator assembly may include the housing frame, the first and second movable sidewalls, and stack gates 432. A hydraulic system 434 of the accumulator assembly may power the elevator assembly. As shown, the first and second movable sidewalls can be movably coupled to the housing frame. The housing frame may have upright beams 436. Each of the first and second movable sidewalls can include an interior wall 438 that supports the brackets and one or more grip walls 440. The beams of the housing frame reside within gaps that can be defined between the interior wall and the grip wall(s). The hydraulic system can include actuators 442 that can be configured to lift and lower the elevator assembly. More specifically, the actuators can be directly or indirectly coupled to the first and second movable sidewalls at one end and to the housing frame (or other part of the tie-arrangement system) at an opposite end. The hydraulic system controls the actuators to lift and lower the first and second movable sidewalls. The first and second movable sidewalls slide along the beams of the housing frame.

[0041] The accumulator assembly can define a shape of the tie stack. In the illustrated embodiment, the tie stack can be a rectangular cuboid (or parallelepiped). It should be understood, however, that the tie stack may have other three-dimensional structures based upon, for example, the shape of the ties and the design of the components of the accumulator assembly. For example, the first and second movable sidewalls and the brackets define the bottom broad side of the tie stack. The first and second movable sidewalls and the brackets also define opposite end sides of the tie stack. The stack gates define a leading broad side of the tie stack.

[0042] The stack transport can include a transport frame 450. Like the housing frame, the transport frame may be shaped from materials that can be suitable for withstanding heavy loads, such as heavy duty steel. The transport frame can include a transport stage 452 and at least one transport grip 454. The transport stage can be configured to receive the tie stack from the elevator assembly and support the tie stack thereon such that the bottom broad side of the tie stack rests upon the transport stage. The transport grip can be configured to engage a different side of the tie stack to move the tie stack. In the illustrated embodiment, the transport grip engages a trailing broad side of the tie stack.

[0043] For the embodiment shown in Figures 4A and 4B, the transport frame can be L-shaped with one leg forming the transport stage and the other leg forming the transport grip. The transport frame may have other configurations. For example, the transport frame can include two transport frames with one as shown in Figures 4A and 4B and another extending over a top of the tie stack. As another example, the transport frame may include separate grip elements that engage separate groups of the ties. As yet another example, the transport grip can be movable with respect to the transport stage. After the transport frame receives the tie stack, the transport grip can rotate with respect to the transport stage until the transport grip engages the trailing broad side of the tie stack.

[0044] The transport frame can be configured to move the tie stack into the delivery assembly. The transport frame may be powered by the hydraulic system. Alternatively, a separate motor may power the transport frame. The transport grip engages the trailing broad side of the tie stack and shifts the ties toward the delivery assembly. As the ties are pushed by the transport grip, the ties of each group become more tightly packed. More specifically, the ties within each slot may have gaps therebetween that were inadvertently formed as each tie moved into the slot. As such, the transport grip may tighten or further pack the tie stack along a first dimension.

[0045] The stack gates can be moved to allow the tie

stack to clear the accumulator assembly. The stack gates may be opened prior to the transport grip engaging the trailing broad side. Alternatively, the stack gates may remain closed while the transport grip engages and pushes the ties toward the delivery assembly and against the closed stack gates. In this manner, the ties may be packed more tightly along the first dimension (e.g., horizontal direction).

[0046] With the stack gates opened, the transport frame may move the tie stack into the delivery assembly. As the transport frame moves toward the delivery assembly, the ties slide along the brackets of the first and second movable sidewalls. When the ties clear the brackets, gravity may cause the ties to settle (or drop) into the tie stack. More specifically, the bottom group of ties can be supported by the transport stage. When the second group (or middle group) of ties clears the brackets, the ties of the second group may settle onto the ties of the bottom group. Similarly when the third group (or top group) of ties clears the brackets, the ties of the third group may settle onto the ties of the second group. In this manner, the ties can be more tightly packed along a second dimension (e.g., vertical dimension) within the tie stack. Accordingly, the accumulator assembly can be configured to arrange the ties in groups having a same or common orientation. The accumulator assembly can be also configured to move the groups of the ties out of the accumulator assembly.

[0047] Figure 5 is a perspective view of a delivery assembly 500 that may be used with a tie-arrangement system. An accumulator assembly 502 is shown adjacent to the delivery assembly. The accumulator assembly has a tie stack 504 lowered onto a stack transport 506. The stack transport can be poised to move the tie stack into the delivery assembly.

[0048] The delivery assembly can include a tilting bed 508 that can include a housing frame 510 configured to receive and hold a tie stack. For example, the housing frame defines a cargo-holding space 512 and a housing window 514 that provides access to the cargo-holding space. The housing window can be aligned with a path of the stack transport and can be sized and shaped to receive the tie stack being transferred from the accumulator assembly. The delivery assembly can allow the stack transport to move at least partially into or through the delivery assembly. For example, the housing frame may have a cut-out 516 that permits the stack transport to carry the tie stack entirely through the window and into the housing frame.

[0049] As the stack transport moves the tie stack toward the cargo-holding space, the stack transport supports or carries the tie stack. At some point, however, the stack transport transfers the tie stack onto the tilting bed. While residing in the cargo-holding space, the tie stack can be supported by the tilting bed. The transfer from the stack transport to the tilting bed may be accomplished in various manners. For example, the path of the stack transport may initially hold the bottom broad side of the tie stack at an elevation above a support surface of the tilting bed. As the stack transport moves the tie stack, the path of the stack transport may cause the stack transport to lower or decrease in elevation. The decrease may be gradual or incremental as the stack transport moves along the path or the decrease may be an immediate step-down at an end of the path. Alternatively, the stack transport may reach an end of the path with the tilting bed being lower than the bottom broad side of the tie stack. The tilting bed may then be raised to lift the tie stack from the stack transport. After the stack transport is relieved of the tie stack, the stack transport can be withdrawn and returns toward a starting position for moving the next tie stack. Figure 5 illustrates the stack transport in a starting position after having delivered a tie stack onto the delivery assembly.

[0050] Figure 5 also shows the tilting bed in a raised or tilted position. The tilting bed can include actuators 520 that are operatively coupled to a hydraulic system. The tilting bed can be raised to direct the ties out of the cargo-holding space and onto a designated side of the tie-arrangement system. More specifically, the ties will be directed onto an external surface. An external surface can be a surface that is off the tie-arrangement system. The external surface does not form a part of the tie-arrangement system. For example, the external surface may be the ground alongside a track that is being maintained or constructed. After placing the ties on the external surface, the tie-arrangement system may then travel to a new location for placing other ties on an external surface at the new location.

[0051] The housing frame can include a first exit window 522 through which the ties may pass. In the illustrated embodiment, the tilting bed may include one or more gates 524 for blocking or permitting the ties to exit the cargo-holding space. As described with respect to Figures 6 and 7, the gates may be used to selectively output one or more ties of the tie stack.

[0052] In some embodiments, the tilting bed can be also configured to direct the ties out of the cargo-holding space onto the other side of the tie-arrangement system. In such instances, the housing frame can include a second exit window 526 that can be opposite the first exit window. The tilting bed may also include one or more gates (not shown) for blocking or permitting the ties to exit the cargo-holding space through the second exit window.

[0053] The housing frame may be raised or lowered to advance the ties out of the cargo-holding space. The housing frame can include a first housing side 530 having the first exit window and a second housing side 532 that can be opposite the first housing side of the housing frame and can include the second exit window. When the delivery assembly is located on a track, the first housing side faces one side of the track and the second housing side faces the other side of the track. Each of the first and second housing sides may be coupled to an actuator. To deliver one or more ties through the first housing side,

the one or more actuators coupled to the second housing side may lift the second housing side while the other one or more actuators coupled to the first housing side remain deactivated (or at least less activated). The support surface of the housing frame may form an inclined plane that will allow gravity to pull the ties from the cargo-holding space. To deliver one or more ties through the second housing side, the one or more actuators coupled to the first housing side may lift the first housing side while the other one or more actuators coupled to the second housing side remain deactivated (or at least less activated).

[0054] In some instances, gravity alone may pull the ties from the cargo-holding space. In some embodiments, however, additional mechanisms may be used to encourage the ties to move from the cargo-holding space. For example, one or more vibrating mechanisms may be applied to the support surface or ties, thereby temporarily reducing the static friction holding the ties. Optionally, the actuators may move quickly to a fully tilted position and then drop a small distance (e.g., one or two centimeters) causing the ties to be temporarily suspended, thereby temporarily reducing the static friction. Alternatively or in addition to the above, the delivery assembly may include motors that push the ties toward the exit window. For example, a wheel may be pressed against one or more ties and rotated to push the one or more ties toward the exit window.

[0055] Also shown in Figure 5, the delivery assembly or the tie-arrangement system can include a vehicle lock 540. The vehicle lock can be configured to fasten the tie-arrangement system (or the delivery assembly) to an edge of the vehicle onto which the delivery assembly can be mounted.

[0056] Figure 6 is a side view of a delivery assembly 600 in accordance with an embodiment having a movable vertical gate 602 selectively positioned within an exit window 604 of a housing frame 606. A tie stack 620 of ties 622 can be disposed within a cargo-holding space 609 of the housing frame. The ties within the stack can be positioned such that the ties have a known order.

[0057] As indicated by the double-ended arrow, the movable vertical gate can move upward in a first direction or downward in a second direction. When positioned within the exit window, the movable vertical gate blocks one or more groups 611-615 of ties (or levels of ties) from moving through an exit window 604. The movable vertical gate may be similar to a rolling shutter or garage door. For example, the movable vertical gate may include a series of panels 624 that can be coupled to one another through hinges. Rollers 626 along the edges of the panels may be directed along track 628, 630. Optionally, the movable vertical gate may cover an entirety of the exit window. For example, the movable vertical gate may prevent ties from inadvertently moving through the exit window. When the exit window is completely open, such that the entire tie stack may slide therethrough, the movable vertical gate may be extending along the tracks beneath the cargo-holding space.

[0058] The movable vertical gate may be at least one of automatically controlled by a controller or controlled by an operator of the delivery assembly. The movable vertical gate may be raised or lowered to designated positions so that one or more of the groups of ties may move through the partially open exit window. For example, the movable vertical gate, as shown in Figure 6, can be positioned to allow the top group of ties to move through the exit window while blocking the other groups of ties. Although not shown, the movable vertical gate may be positioned to allow more than one group of ties to move through the exit window. For example, the movable vertical gate may be lowered to permit the top two groups of ties to move through the exit window while blocking the other groups.

[0059] In some embodiments, the ties can be considered delivered or unloaded after the ties move through the exit window. In particular embodiments, the delivery assembly may place the ties onto an external surface where the ties will eventually be placed in the track. As described herein, the delivery assembly may selectively deliver one or more groups of the tie stack or, optionally, may deliver fewer than an entire group. For example, the delivery assembly may deliver only two or three ties of a single group. In some instances, however, the tie stack may be delivered entirely at once such that all groups of the tie stack move through the exit window simultaneously and can be delivered at one site.

[0060] Figure 7 is a side view of a delivery assembly 700 having a housing frame 706 that defines an exit window 704. A tie stack 720 of ties 722 can be disposed within a cargo-holding space 709 of the housing frame. The delivery assembly also has a movable vertical gate 702 and a movable horizontal gate 703. The movable vertical gate and the movable horizontal gate may be constructed and operate in a similar manner as the movable vertical gate of Figure 6. However, the tracks of the movable vertical gate and the movable horizontal gate can be positioned to allow the other gate to operate within the exit window. In some embodiments, the movable vertical gate can be positioned between the ties and the movable horizontal gate. In other embodiments, the movable horizontal gate can be positioned between the ties and the movable vertical gate.

[0061] The movable vertical gate and the movable horizontal gate may be controlled by at least one of a controller or an operator of the tie-arrangement system. The movable vertical gate and the movable horizontal gate may be selectively controlled to permit fewer than an entire group of ties to move through the exit window. For example, the movable vertical gate and the movable horizontal gate can be positioned, as shown in Figure 7, to permit three ties of the top group of ties to move through the exit window. In other examples, the movable vertical gate and the movable horizontal gate may be positioned to allow only one tie or only two ties. However, the movable vertical gate and the movable horizontal gate may be positioned to permit all but one of the ties in group to

move through the exit window. Moreover, the movable vertical gate and the movable horizontal gate may be positioned to allow an entire group of ties to move through the exit window and also a portion of an adjacent group of ties. In this manner, any number of ties in the tie stack may be delivered to a designated site.

[0062] In an alternative embodiment, the delivery assembly may include only a movable horizontal gate, like the movable horizontal gate of Figure 7. In this case, columns of ties may be unloaded when the tilting bed is raised.

[0063] Although Figures 6 and 7 illustrate a rolling shutter-type of gate, the movable gates may have other constructions. By way of example only, the movable gate may include a series of flaps. The first flap may be positioned closest to the ties and block only the bottom group of ties. The second flap may be positioned after the first flap and block the bottom group of ties and the next group of ties resting on the bottom group of ties. A final third flap may be positioned after the second flap and block all groups of ties or, alternatively, all but a top group of ties.

[0064] As another example, the movable gate may include a series of multi-jointed arms. Each arm could extend across and entire column of ties or an entire row (or group) of ties. The multi-jointed arm could be configured to selectively move or roll away to open more of the exit window. In this manner, the arm could allow individual ties to be unloaded.

[0065] Figure 8 is a schematic view of a hydraulic system 800 that can be configured to power one or more assemblies of a tie-distribution unit or a tie-arrangement system. The hydraulic system may be configured to drive each heavy function for the tie-arrangement unit or the tie-arrangement system. In other embodiments, however, at least one or more of the operations can be powered by another system. For example, the wheels of the crane or excavator may be powered by a separate diesel motor. As shown, the hydraulic system can include a pumping sub-system 802 that can be operably coupled to a motor 804. The pumping system feeds a working fluid through a network 806 of lines and valves to cylinders 808 and/or motors 810. The cylinders may control, for example, movement of the elevator assembly and tilting bed as described herein. The motors may control, for example, movement of the conveying elements within the conveyor assemblies.

[0066] Figure 9 is a perspective view of a tie-distribution unit 900. The tie-distribution unit can include a well car 902 having a crane or excavator 904 mounted to the well car. The tie-distribution unit in Figure 9 can be on-track such that the tie-distribution unit can be configured for moving along a previously-constructed railway track 905. In other embodiments, however, the tie-distribution unit can move along a railway track that is currently being constructed. Alternatively, the tie-distribution unit may be off-track and travel along a pathway that can be parallel to the track.

[0067] The well car can be a gondola-type rail car having a cargo area 906 defined between sidewalls of the well car. The cargo area can be sized and shaped to hold railway ties 908. The crane can be configured to move over the cargo area. For example, the crane may move along a length of the well car parallel to a longitudinal axis 910 of the well car. The crane can include an arm 912 having a grapple 914 that can be configured to lift one or more ties within the cargo area.

[0068] Using the grapple, the crane feeds ties into a tie-arrangement system 916. The tie-arrangement system can be also mounted onto the well car and capable of moving over the cargo area, such as along the longitudinal axis. The tie-arrangement system can include a collection assembly 920, an accumulator assembly 922, and a delivery assembly 924. One or more of the assemblies of the tie-arrangement system can be powered by a hydraulic system 930.

[0069] As described herein, the tie-arrangement system arranges the ties and dispenses the ties onto a surface off the tie-arrangement system for subsequent placement of the ties in the track for the rail vehicles. The tie-arrangement system can arrange the ties into a stack and then deliver one or more ties from the stack or deliver the entire stack. More specifically, the collection assembly receives the ties from the crane and may at least partially align the ties before the ties are received by the accumulator assembly. For example, the collection assembly may align the ties in a generally common orientation such that the ties extend approximately parallel to one another. The accumulator assembly receives the ties from the collection assembly and forms a tie stack. The accumulator assembly then transfers the tie stack to the delivery assembly. The delivery assembly dispenses the ties off of the tie-distribution unit.

[0070] In some embodiments, the tie-distribution unit can be attached at one end to another tie-distribution unit (not shown) (called adjacent tie-distribution unit) and, optionally, at the other end to another adjacent tie-distribution unit. The crane and the tie-arrangement system may be capable of moving onto the adjacent tie-distribution units. For example, after delivering all of the new ties within the cargo area, the crane and the tie-arrangement system may move onto an adjacent tie-distribution unit and begin the process of delivering the new ties within the cargo area of the adjacent tie-distribution unit.

[0071] The recently-used well car may travel to a remote location for receiving new ties. In some circumstances, the recently-used well car may be loaded with extracted, used ties. Optionally, the used ties may be deposited into the cargo area of the well car as the new ties are removed from the cargo area and delivered alongside the track. Alternatively, the used ties may be deposited into the cargo area after all of the new ties have been removed.

[0072] With respect to the embodiments of the tie-arrangement systems and tie-arrangement units described herein, along with the various assemblies of the embod-

iments, it should be noted that the particular arrangement of components/elements/features (e.g., the number, types, placement, or the like) of the illustrated embodiments may be modified in various alternate embodiments. In various embodiments, different numbers of a given component/element/feature may be employed, a different type or types of a given component/element/feature may be employed, a given component/element/feature may be added, or a given component/element/feature may be omitted.

[0073] Figure 10 is a flow chart illustrating a method 1000 of delivering ties. At step 1002, the method can include at least one of generating or receiving tie-delivery instructions. The tie-delivery instructions may be based on inspection data that identifies ties to be replaced along a route. The inspection data can reveal one or more unwanted conditions of the ties, such as tie-splitting, hollowness, or density loss. By way of example, the inspection data may include at least one of video image data obtained by one or more cameras (e.g., CMOS image sensor), x-ray backscatter data, laser-surface scan data, magnetic proximity data, light-detection and ranging (LIDAR) data, and/or sonic or ultrasonic impact velocity data, and/or sonic or ultrasonic impact echo data. The inspection data may include location data for the ties. The location data can identify the ties to-be-replaced using longitude and latitude coordinates or a relative distance from designated points along the route. In some instances, the ties may be physically identified by painting, etching, adding barcodes, and the like.

[0074] The tie-delivery instructions may be generated by analyzing the inspection data to identify the ties to-be-replaced. In some embodiments, the tie-delivery instructions may be generated on-board using, for example, a controller of the tie-distribution unit. In other embodiments, however, the tie-delivery instructions can be generated off-board at a remote location and communicated to an operator of the tie-distribution unit.

[0075] The tie-delivery instructions can include a location (e.g., GPS coordinates) for delivering the new ties and a number of ties to be delivered at the location. Optionally, the tie-delivery instructions may include a side of the route to deliver the new ties. If more than one tie is to be delivered, the tie-delivery instructions may optionally include a stack configuration of the delivery. For example, the ties may be delivered as a stack (e.g., 6 ties wide and 3 ties tall or 6x3). The stack may have other configurations, such as 3x6 or 4x4 or 2x1 or 4x1. Alternatively, the ties may be delivered individually one after the other.

[0076] At step 1003, ties can be loaded onto a conveyor assembly, such as a feeding conveyor assembly. For example, a crane can grab a bundle of the ties using the grapple of the crane and lift and load the ties onto the conveyor assembly. In particular embodiments, the ties can be stored within a cargo area of a rail car on which the crane is mounted. In other embodiments, the ties may be stored at other locations or within cargo areas of other vehicles. Yet in other embodiments, the crane may not be mounted to a rail car or other vehicle.

[0077] Although the step of loading the ties appears to occur after generating or receiving the tie-delivery instructions in Figure 10, it is understood that the step of generating or receiving the tie-delivery instructions can be completed prior to, during, or after dividing the ties into one or more groups. Furthermore, the method may employ structures or aspects of various embodiments (e.g., tie-arrangement systems, tie-arrangement units, and/or assemblies thereof) described herein. In various embodiments, certain steps may be omitted or added, certain steps may be combined, certain steps may be performed simultaneously, certain steps may be performed concurrently, certain steps may be split into multiple steps, certain steps may be performed in a different order, or certain steps or series of steps may be re-performed in an iterative fashion. For example, embodiments may not include the steps of receiving the ties in different orientations, moving the ties into the common plane, and supplying/maintaining the ties along the common plane.

[0078] The method may include receiving, at step 1004, the ties in different orientations. For example, a bundle of ties may be supplied essentially simultaneously to a tie-arrangement system. When the bundle of ties is grabbed from the cargo area, the ties can have various orientations. For example, one or more ties may be oriented with an edge side on top while one or more other ties may be oriented with a broad side on top. Furthermore, the ties of the bundle may not extend parallel to each other.

[0079] At step 1006, the ties can be individually moved in a common plane relative to each other. For example, one or more conveyor assemblies of the tie-arrangement system can separate the ties from one another along conveying elements (e.g., belts or chains). The conveying elements may, for at least a portion of the conveyor assembly, extend parallel to a common plane. As such, the ties move individually along the common plane.

[0080] In particular embodiments, the conveyor assemblies can include a feeding conveyor assembly and an alignment conveyor assembly. The feeding conveyor assembly can receive the ties in different orientations. Ties can have different orientations when the ties are rotated differently about a longitudinal axis (e.g., different amounts of roll). For example, one or more of the ties may be standing on the conveying elements along a broad side of the tie and one or more ties may be standing on the conveying elements along an edge side of the tie. Alternatively or in addition to the above, the ties can have different orientations about a normal axis (e.g., different amounts of yaw) such that the ties do not extend parallel to one another while on the conveying elements.

[0081] Optionally, the ties can be at least partially reoriented while moving along the one or more conveyor assemblies. For example, a planarizing body can engage at least some of the ties causing the ties that are engaged

to change orientations. For example, the planarizing body may engage ties standing on an edge side thereby causing the ties to rotate onto the broad side of the tie. In such circumstances, the ties that clear the planarizing body will have a common orientation about the longitudinal axis of the tie. As another example, the planarizing body can engage and move at least some of the ties that are skew or otherwise not parallel to the other ties. Optionally, moving the ties along the common plane can include maintaining the ties in the common plane by moving the ties beneath one or more limiting bodies during the movement of the ties.

[0082] At step 1008, the ties moving in the common plane can be supplied to an accumulator assembly that receives, at step 1010, the ties in the common plane. Accordingly, in some embodiments, the feeding conveyor assembly supplies ties to the alignment conveyor assembly that supplies ties to the accumulator assembly. The ties can be at least partially re-oriented by the conveyor assemblies prior to being received by the accumulator assembly.

[0083] In other embodiments, however, the ties can be fed directly into the accumulator assembly such that the accumulator assembly receives the ties in the common plane. For example, instead of a grapple, the crane can hold a conveyor assembly that is similar to the feeding conveyor assemblies and/or the alignment conveyor assemblies described herein. The ties may be loaded onto the crane conveyor assembly. The crane conveyor assembly can be moved into an aligned position relative to the accumulator assembly. Once sufficiently aligned, the crane conveyor assembly can be operated to feed the ties into the accumulator assembly such that the ties can be received in the common plane.

[0084] At step 1012, the ties can be divided into one or more same orientation groups. A same orientation group can include multiple ties that have a same orientation. For example, the ties can have essentially the same orientation about the respective longitudinal axis of each tie. When having the same orientation about the respective longitudinal axis, each of the ties in the same orientation group may rest upon a broad side of the tie or each of the ties in the same orientation group may rest upon an edge side. When having the same orientation about the respective normal axis of each tie, the ties are not required to be perfectly parallel. For example, each the ties may be rotated no more than 15 degrees about a desired normal axis when having the same orientation as other ties.

[0085] The ties may be divided by receiving a designated number of ties within each group. For example, the accumulator assembly can include an elevator assembly that can be configured to vertically move relative to the common plane of the ties. After receiving a designated number of the ties having a same orientation, thereby forming one group of ties, the elevator assembly can move vertically to allow a different group of ties to form. The process can be repeated additional times for each level or row of ties.

[0086] Optionally, at step 1014, the tie-arrangement unit having the tie-arrangement system may be moved to a designated location for delivering the ties. At step 1016, one or more groups of the ties can be placed on a surface. Placing the one or more groups of the ties can include (a) placing an entire tie stack on the surface, (b) placing one or more levels (or portions thereof) on the surface, or (c) placing one or more columns (or portions thereof) on the surface. As described herein, the step of placing the ties on the surface can be caused by tilting the tie stack and, optionally, using one or more gates to block or allow designated ties sliding out of the accumulator assembly.

[0087] Before, after, or during the execution of one or more steps, a system or an operator can query whether a sufficient number of ties exists within the cargo area for forming another group of ties or another tie stack. If a sufficient number of ties exists within the cargo area, the method may continue forming groups of ties. If an insufficient number of ties exists within the cargo area, the method can include moving, at step 1018, the crane and the tie-arrangement system to a new area that can include a larger supply of ties. Once positioned for loading new ties, the method may proceed to the step of loading new ties.

[0088] In an embodiment, a tie-arrangement system is provided. The tie-arrangement system may include a conveyor assembly configured to receive ties for placement in a track for rail vehicles. The conveyor assembly can be configured to receive the ties in a common plane relative to each other. The tie-arrangement system may include an accumulator assembly configured to receive the ties in the common plane from the conveyor assembly. The accumulator assembly may be configured to arrange the ties in a same orientation in groups and to move the groups of the ties out of the accumulator assembly. The tie-arrangement system may include a delivery assembly configured to receive the groups of the ties arranged by the accumulator assembly into the same orientation. The delivery assembly can be configured to place the groups of the ties onto a surface off the tie-arrangement system for placement of the ties in the track for the rail vehicles.

[0089] The tie-arrangement system can include a collection assembly configured to receive the ties in skew or different orientations and to move the ties into the common plane. The collection assembly can be configured to deliver the ties in the common plane to the conveyor assembly.

[0090] Optionally, the conveyor assembly is a first conveyor assembly, and the collection assembly may include a second conveyor assembly that can be configured to move the ties received in the skew or different orientations relative to the common plane. The collection assembly can include a planarizing body that may be configured to move at least some of the ties from the different orientations and into the common plane.

[0091] In some aspects, the planarizing body can include a mechanism that is configured to move the at least some of the ties that are skew or otherwise not arranged in a common plane to arrange the ties in the common plane.

[0092] In some aspects, the conveyor assembly can include one or more limiting bodies positioned to maintain the ties in the common plane during movement of the ties to the accumulator assembly.

[0093] In some aspects, the accumulator assembly can include an elevator assembly configured to vertically move relative to the common plane of the ties. The elevator assembly can be configured to vertically move after each of the groups is loaded into the accumulator assembly.

[0094] In some aspects, the delivery assembly can be configured to receive several of the groups of the ties from the accumulator assembly at a common time.

[0095] In some aspects, the delivery assembly can be configured to tilt to move the groups of the ties off the delivery assembly.

[0096] In some aspects, the conveyor assembly, the accumulator assembly, and the delivery assembly can be configured to be coupled with each other and configured to be positioned on a rail car configured to move along the track.

[0097] In an embodiment, a method is provided that may include receiving ties for placement in a track for rail vehicles. The ties can be received in a common plane relative to each other. The method may include dividing the ties received in the common plane into one or more groups in which the ties of each group have a same orientation. The method may include placing the one or more groups of ties onto a surface for placement of the ties adjacent to the track for the rail vehicles.

[0098] In some aspects, the method may include previously receiving the ties in different orientations and individually moving the ties into the common plane.

[0099] In some aspects, individually moving the ties into the common plane may include moving the ties beneath a planarizing mechanism.

[0100] In some aspects, the ties can be moved beneath a horizontal bar of the planarizing mechanism to move the at least some of the ties that are not arranged in a common plane to the common plane for arranging the ties in the common plane.

[0101] In some aspects, the method can also include maintaining the ties in the common plane during movement of the ties by moving the ties beneath one or more limiting bodies during the movement of the ties.

[0102] In some aspects, the method can also include moving each group of ties while maintaining the ties in the group in a common plane that is defined by the orientation of the ties.

[0103] In some aspects, placing the groups of the ties can include tilting the groups of the ties.

[0104] In an embodiment, a tie-arrangement system that can be configured to be disposed onboard a vehicle is provided. The tie-arrangement system may include a collection assembly configured to receive ties for placement in a track for rail vehicles. The collection assembly can be configured to receive the ties in different planes. The collection assembly can include a first conveyor assembly that may be configured to move the ties in the different planes beneath a planarizing body that moves the ties into a common plane. The tie-arrangement system may include a second conveyor assembly that can be configured to receive the ties in the common plane from the collection assembly and to move the groups of the ties away from the collection assembly. The tie-arrangement system may include an accumulator assembly that can be configured to receive the ties in the common plane from the second conveyor assembly. The accumulator assembly can be configured to arrange the ties in a same orientation in groups and to move the groups of the ties out of the accumulator assembly. The tie-arrangement system may include a delivery assembly that can be configured to receive the groups of the ties arranged by the accumulator assembly into the same orientation. The delivery assembly can be configured to place the groups of the ties onto a surface off the tie-arrangement system for placement of the ties in the track for the rail vehicles.

[0105] In some aspects, the second conveyor assembly can include one or more limiting bodies positioned to maintain the ties in the common plane during movement of the ties to the accumulator assembly.

[0106] In some aspects, the accumulator assembly can include an elevator assembly that may be configured to vertically move relative to the common plane of the ties. The elevator assembly can be configured to vertically move after each of the groups is loaded into the accumulator assembly.

[0107] In some aspects, the delivery assembly can be configured to tilt to move the groups of the ties off the delivery assembly.

[0108] As used herein, an element or step recited in the singular and proceeded with the word "a" or "an" do not exclude the plural of said elements or operations, unless such exclusion is explicitly stated. Furthermore, references to "one embodiment" of the invention do not exclude the existence of additional embodiments that incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments "comprising," "comprises," "including," "includes," "having," or "has" an element or a plurality of elements having a particular property may include additional such elements not having that property. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and do not impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. § 112(f),

unless and until such claim limitations expressly use the phrase "means for" followed by a statement of function devoid of further structure.

[0109] The above description is illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the inventive subject matter without departing from its scope. While the dimensions and types of materials described herein define the parameters of the inventive subject matter, they are exemplary embodiments. Other embodiments will be apparent to one of ordinary skill in the art upon reviewing the above description.

[0110] This written description uses examples to disclose several embodiments of the inventive subject matter, including the best mode, and to enable one of ordinary skill in the art to practice the embodiments of inventive subject matter, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the inventive subject matter is defined by the claims, and may include other examples that occur to one of ordinary skill in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

Claims

1. A tie-arrangement system (106; 200), comprising:

a conveyor assembly (204, 206; 304, 306) configured to receive ties (112, 214, 314, 402, 622, 722) for placement in a track (628, 630) for rail vehicles, the conveyor assembly (204, 206; 304, 306) configured to receive the ties (112, 214, 314, 402, 622, 722) in a common plane relative to each other;

an accumulator assembly (122, 208, 400, 502, 922) configured to receive the ties (112, 214, 314, 402, 622, 722) in the common plane from the conveyor assembly (204, 206; 304, 306), the accumulator assembly (122, 208, 400, 502, 922) configured to arrange the ties (112, 214, 314, 402, 622, 722) in a same orientation in groups and to move the groups of the ties (112, 214, 314, 402, 622, 722) out of the accumulator assembly (122, 208, 400, 502, 922); and

a delivery assembly (124, 210, 406, 500, 600, 700, 924) configured to receive the groups of the ties (112, 214, 314, 402, 622, 722) arranged by the accumulator assembly (122, 208, 400, 502, 922) into the same orientation, the delivery assembly (124, 210, 406, 500, 600, 700, 924) configured to place the groups of the ties (112, 214, 314, 402, 622, 722) onto a surface off the tie-arrangement system (106; 200) for placement of the ties (112, 214, 314, 402, 622, 722) in the track (628, 630) for the rail vehicles.

2. The tie-arrangement system (106; 200) of claim 1, further comprising a collection assembly (120, 202, 300, 920) configured to receive the ties (112, 214, 314, 402, 622, 722) in skew or different orientations and to move the ties (112, 214, 314, 402, 622, 722) into the common plane, the collection assembly (120, 202, 300, 920) configured to deliver the ties (112, 214, 314, 402, 622, 722) in the common plane to the conveyor assembly (204, 206; 304, 306).

3. The tie-arrangement system (106; 200) of claim 2, wherein the conveyor assembly (204, 206; 304, 306) is a first conveyor assembly (204, 206; 304, 306), and the collection assembly (120, 202, 300, 920) includes a second conveyor assembly (204, 206; 304, 306) configured to move the ties (112, 214, 314, 402, 622, 722) received in the skew or different orientations relative to the common plane, the collection assembly (120, 202, 300, 920) including a planarizing body (224, 324) configured to move at least some of the ties (112, 214, 314, 402, 622, 722) from the different orientations and into the common plane, preferably

wherein the planarizing body (224, 324) includes a mechanism that is configured to move the at least some of the ties (112, 214, 314, 402, 622, 722) that are skew or otherwise not arranged in a common plane to arrange the ties (112, 214, 314, 402, 622, 722) in the common plane.

4. The tie-arrangement system (106; 200) of claim 1, wherein the conveyor assembly (204, 206; 304, 306) includes one or more limiting bodies positioned to maintain the ties (112, 214, 314, 402, 622, 722) in the common plane during movement of the ties (112, 214, 314, 402, 622, 722) to the accumulator assembly (122, 208, 400, 502, 922).

5. The tie-arrangement system (106; 200) of claim 1, wherein the accumulator assembly (122, 208, 400, 502, 922) includes an elevator assembly configured to vertically move relative to the common plane of the ties (112, 214, 314, 402, 622, 722), the elevator assembly configured to vertically move after each of the groups is loaded into the accumulator assembly (122, 208, 400, 502, 922).

6. The tie-arrangement system (106; 200) of claim 1, wherein the delivery assembly (124, 210, 406, 500, 600, 700, 924) is configured to receive several of the groups of the ties (112, 214, 314, 402, 622, 722) from the accumulator assembly (122, 208, 400, 502, 922)

at a common time.

7. The tie-arrangement system (106; 200) of claim 1, wherein the delivery assembly (124, 210, 406, 500, 600, 700, 924) is configured to tilt to move the groups of the ties (112, 214, 314, 402, 622, 722) off the delivery assembly (124, 210, 406, 500, 600, 700, 924).

8. The tie-arrangement system (106; 200) of claim 1, wherein the conveyor assembly (204, 206; 304, 306), the accumulator assembly (122, 208, 400, 502, 922), and the delivery assembly (124, 210, 406, 500, 600, 700, 924) are configured to be coupled with each other and configured to be positioned on a rail car configured to move along the track (628, 630).

9. A method, comprising:

receiving ties (112, 214, 314, 402, 622, 722) for placement in a track (628, 630) for rail vehicles, the ties (112, 214, 314, 402, 622, 722) received in a common plane relative to each other;
dividing the ties (112, 214, 314, 402, 622, 722) received in the common plane into one or more groups in which the ties (112, 214, 314, 402, 622, 722) of each group have a same orientation; and
placing the one or more groups of ties (112, 214, 314, 402, 622, 722) onto a surface for placement of the ties (112, 214, 314, 402, 622, 722) adjacent to the track (628, 630) for the rail vehicles.

10. The method of claim 9, further comprising:

previously receiving the ties (112, 214, 314, 402, 622, 722) in different orientations; and
individually moving the ties (112, 214, 314, 402, 622, 722) into the common plane.

11. The method of claim 10, wherein individually moving the ties (112, 214, 314, 402, 622, 722) into the common plane includes moving the ties (112, 214, 314, 402, 622, 722) beneath a planarizing mechanism, preferably
wherein the ties (112, 214, 314, 402, 622, 722) are moved beneath a horizontal bar of the planarizing mechanism to move the at least some of the ties (112, 214, 314, 402, 622, 722) that are not arranged in a common plane to the common plane for arranging the ties (112, 214, 314, 402, 622, 722) in the common plane.

12. The method of claim 9, further comprising maintaining the ties (112, 214, 314, 402, 622, 722) in the common plane during movement of the ties (112, 214, 314, 402, 622, 722) by moving the ties (112, 214, 314, 402, 622, 722) beneath one or more limiting bodies during the movement of the ties (112, 214, 314, 402, 622, 722).

13. The method of claim 9, further comprising moving each group of ties (112, 214, 314, 402, 622, 722) while maintaining the ties (112, 214, 314, 402, 622, 722) in the group in a common plane that is defined by the orientation of the ties (112, 214, 314, 402, 622, 722).

14. The method of claim 9, wherein placing the groups of the ties includes tilting the groups of the ties.

15. A tie-arrangement system according to claim 1 and configured to be disposed onboard a vehicle, wherein the conveyor assembly is second first conveyor assembly (204, 206; 304, 306) and the tie-arrangement system further comprising:

a collection assembly (120, 202, 300, 920) configured to receive ties (112, 214, 314, 402, 622, 722) for placement in a track for rail vehicles, the collection assembly configured to receive the ties in different planes, the collection assembly including a first conveyor assembly (204, 206; 304, 306) configured to move the ties in the different planes beneath a planarizing body (224, 324) that moves the ties into a common plane; and
the second conveyor assembly configured to receive the ties in the common plane from the collection assembly and to move the groups of the ties away from the collection assembly.

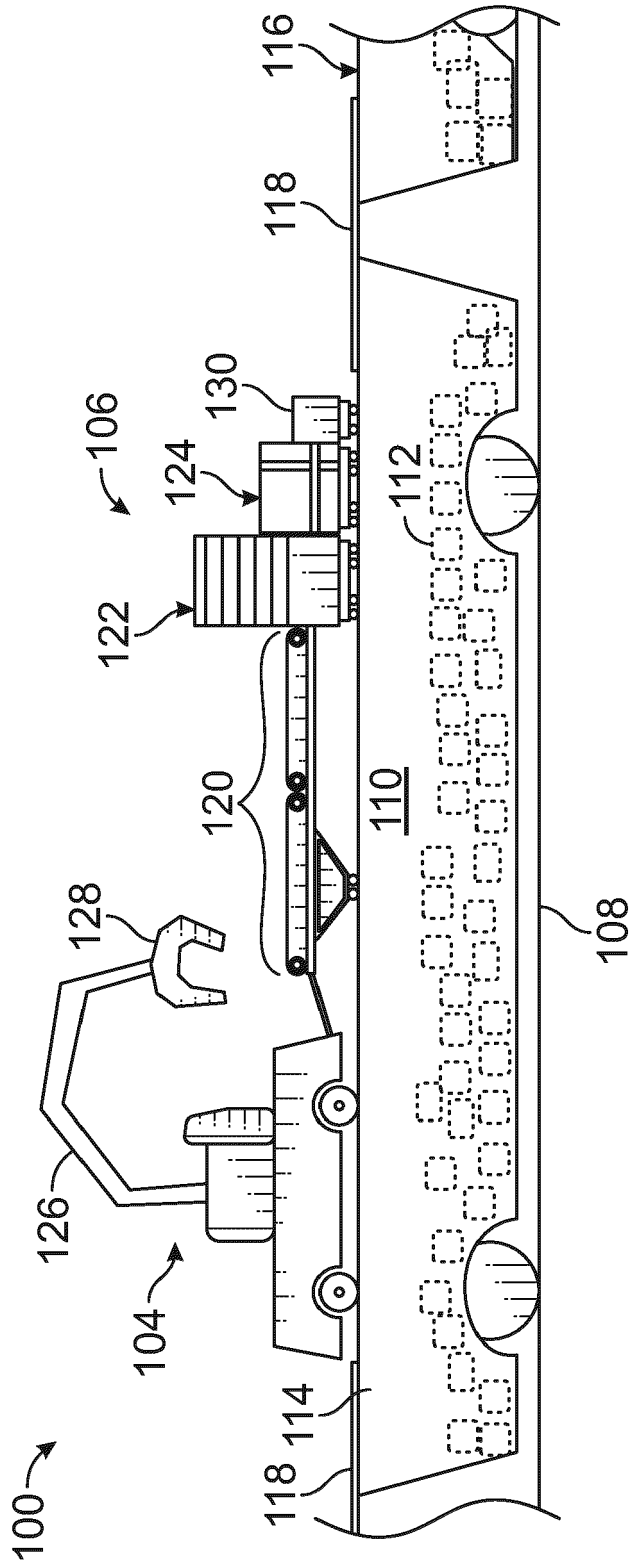

FIG. 1

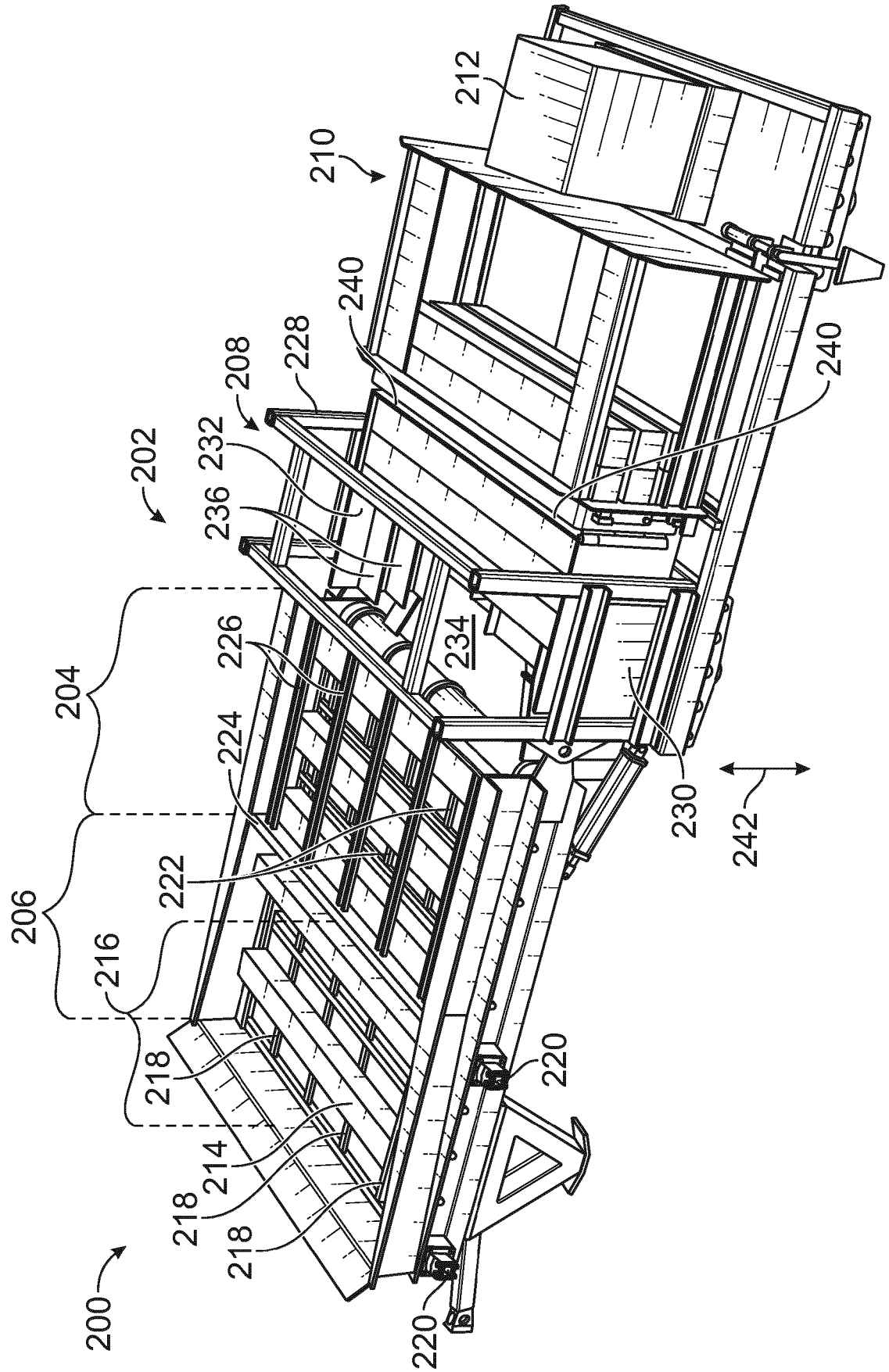
212
210
240
228
208
240
232
202
236
204
226
234
224
206
222
230
242
216
218
220
214
218
218
200
220

FIG. 2A

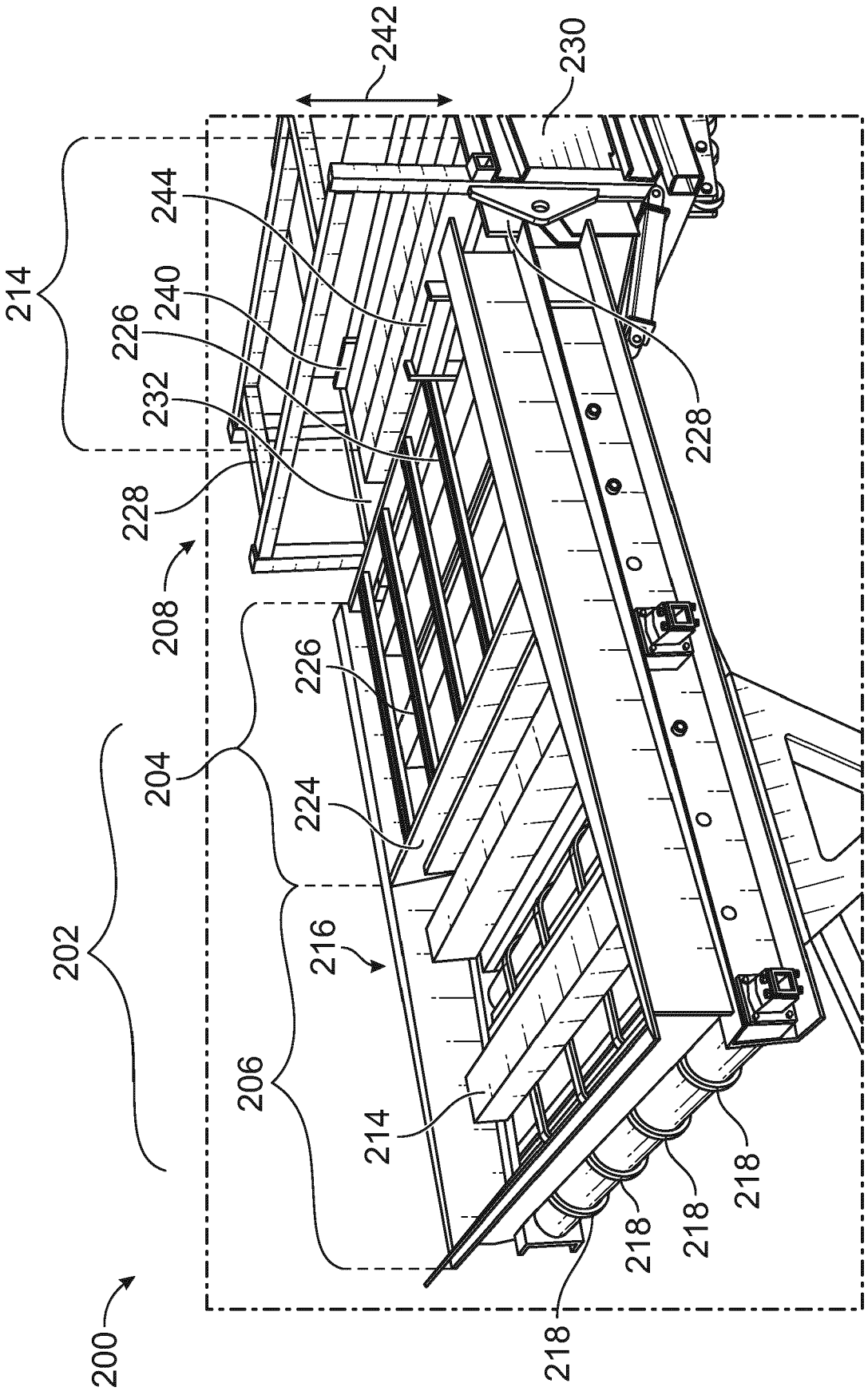
242
230
244
214
240
226
232
228
228
208
226
204
224
202
216
206
214
218
218
218
218
200

FIG. 2B

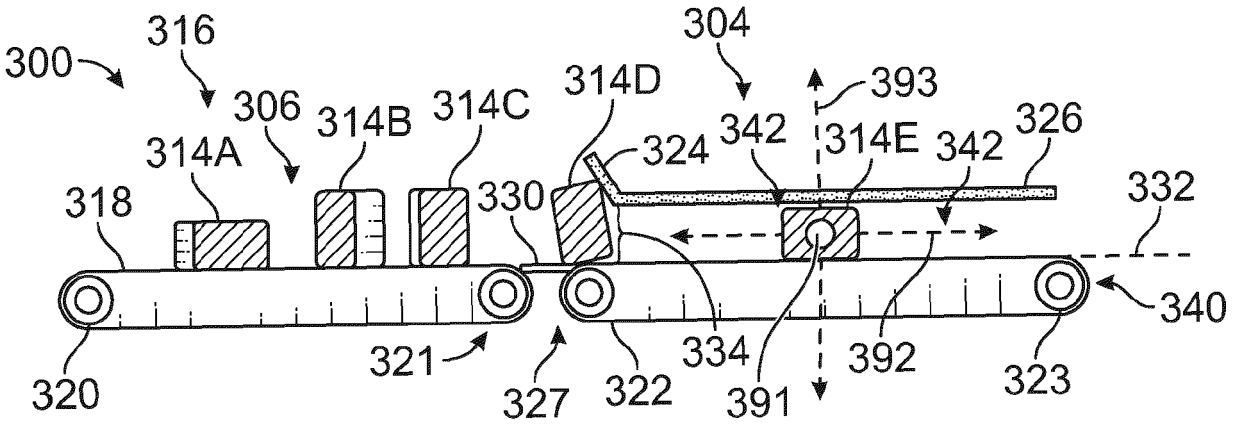
300
316
306
314A
314B
314C
314D
304
393
342
324
314E
342
326
318
330
332
340
320
321
327
322
334
391
392
323

FIG. 3A

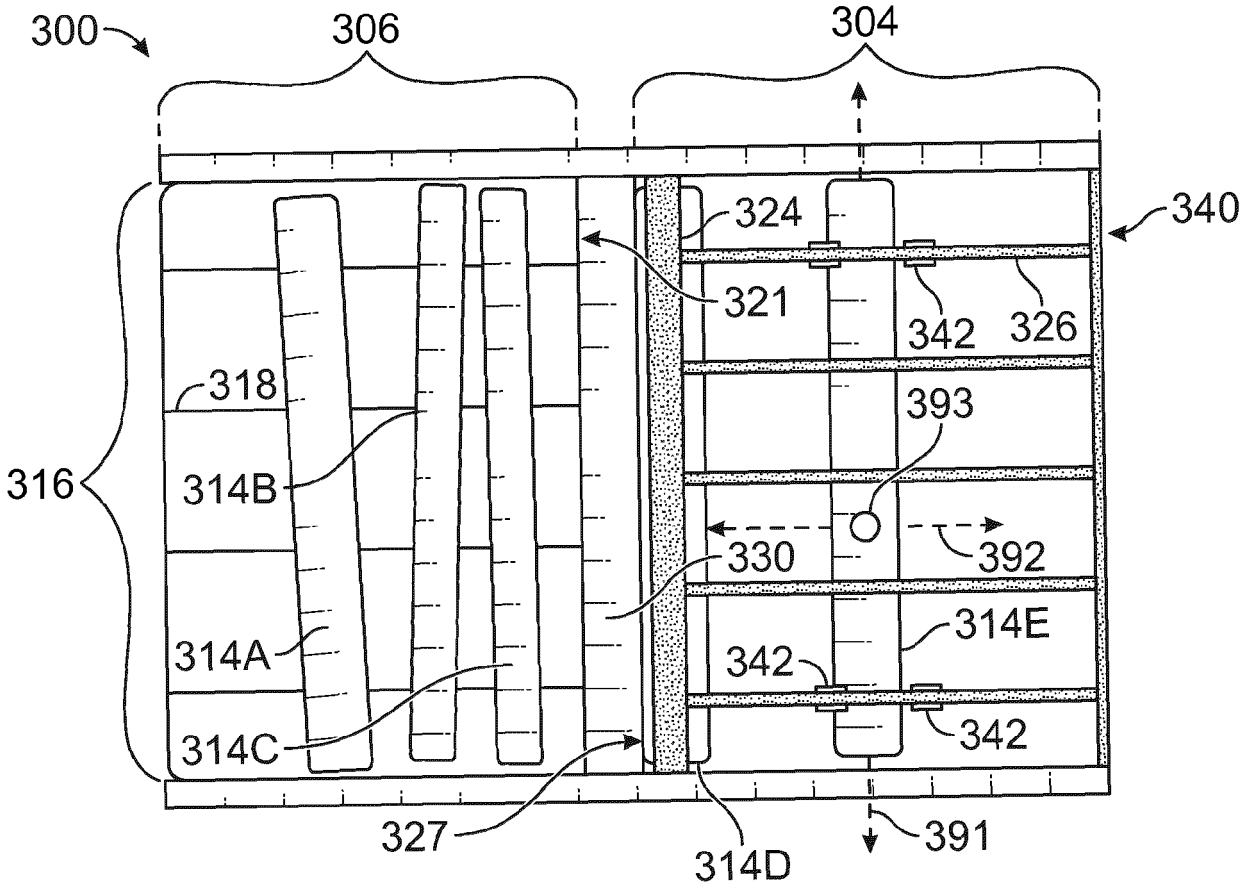
300
306
304
340
324
321
342
326
318
393
316
314B
330
392
314A
314E
342
342
314C
327
314D
391

FIG. 3B

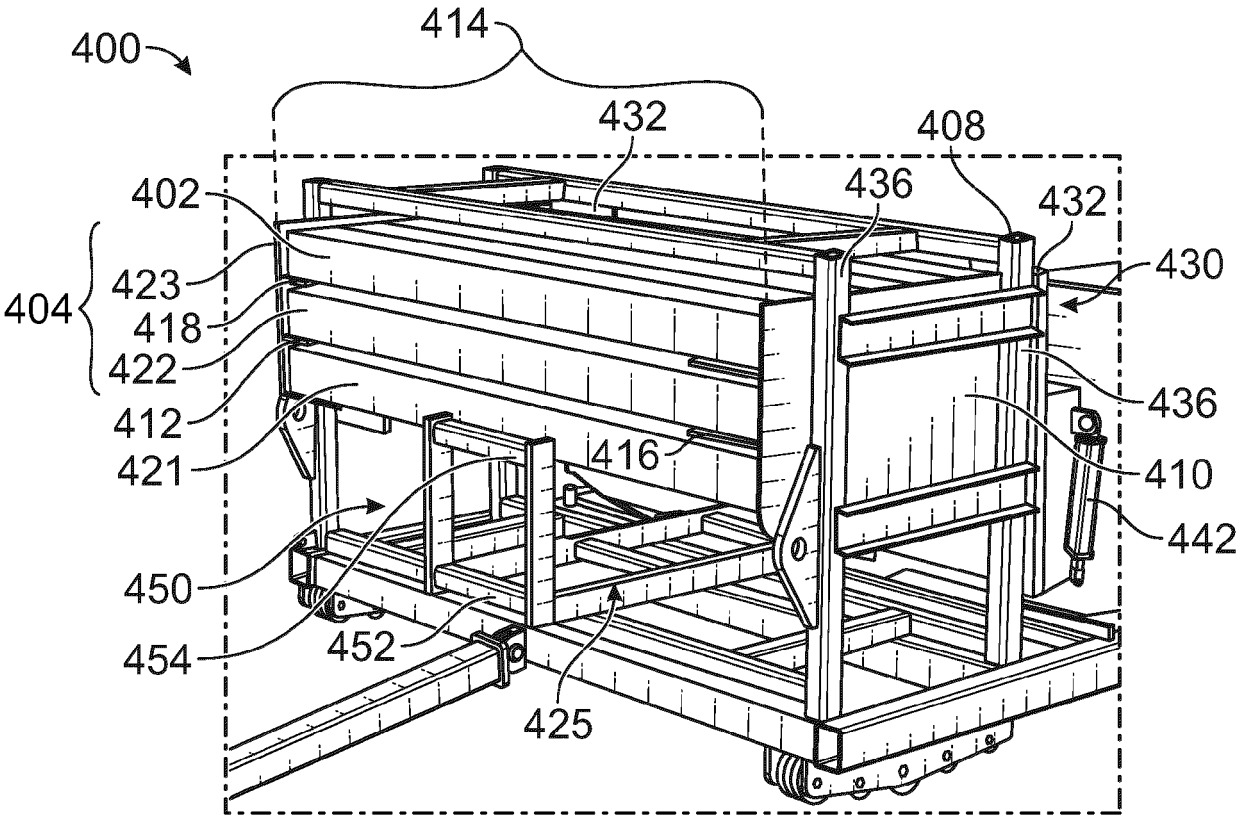
400
414
432
408
402
436
432
404
423
418
422
412
421
430
436
410
442
416
450
454
452
425

FIG. 4A

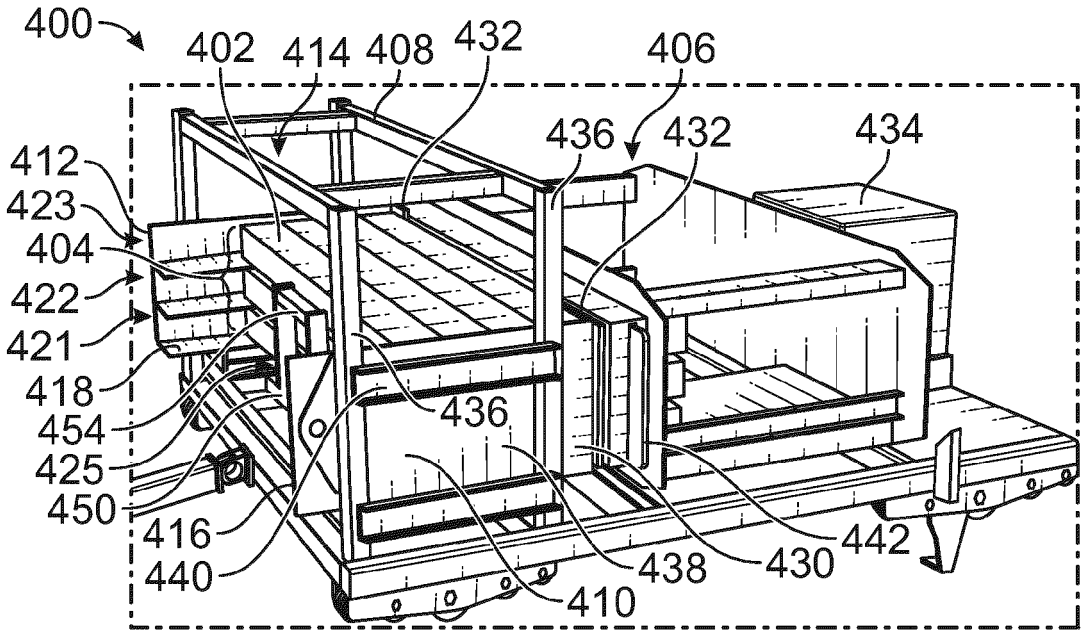
400
402
414
408
432
406
436
432
434
412
423
404
422
421
418
454
425
450
436
416
440
438
430
442
410

FIG. 4B

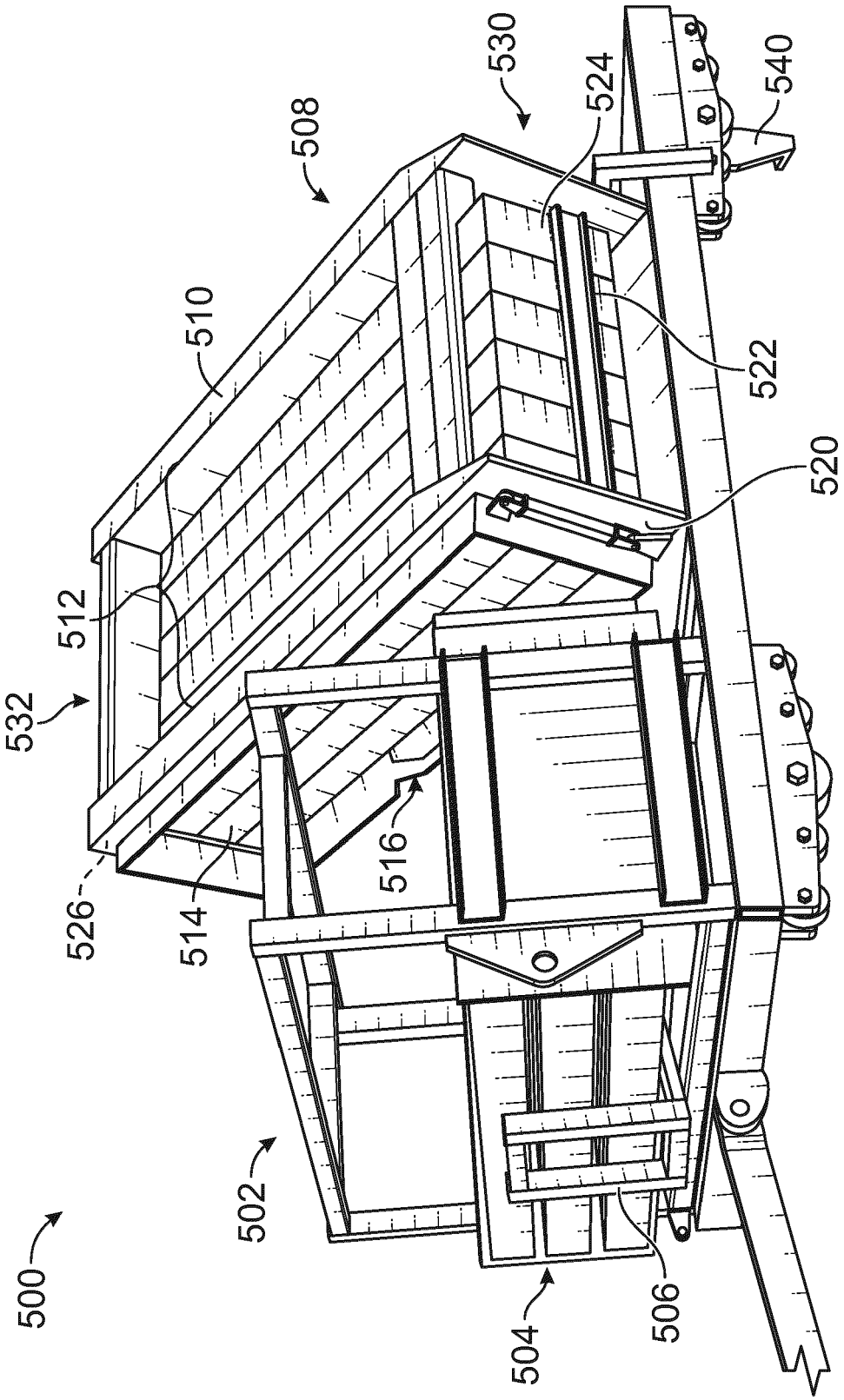

FIG. 5

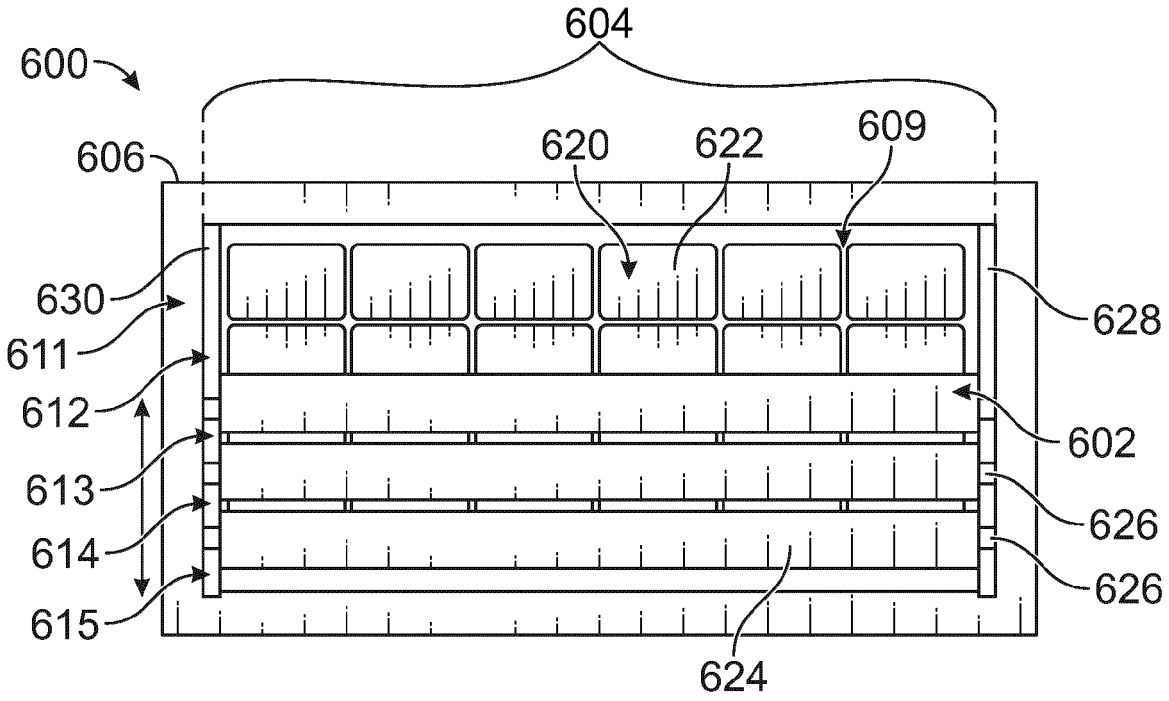
604
600
606
620
622
609
630
611
612
613
614
615
628
602
626
626
624

FIG. 6

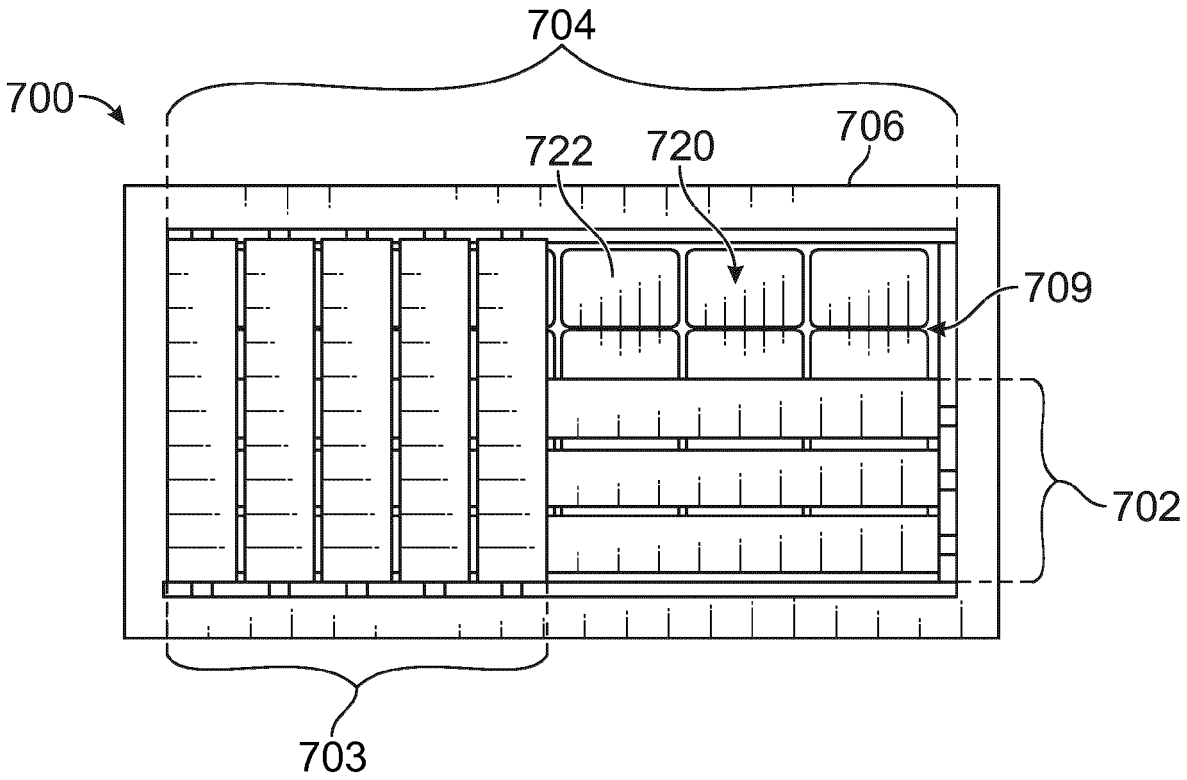
704
700
722
720
706
709
702
703

FIG. 7

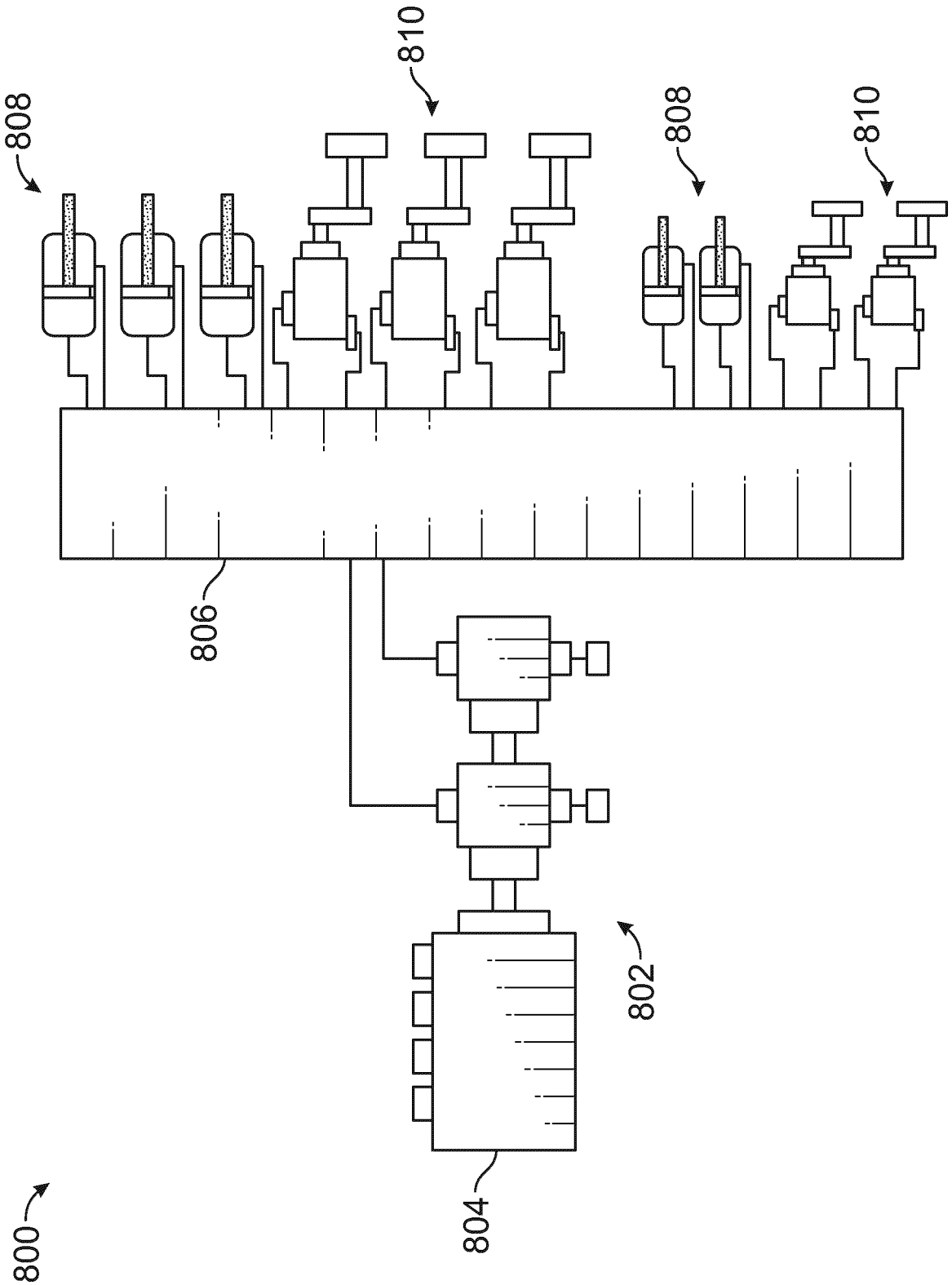

FIG. 8

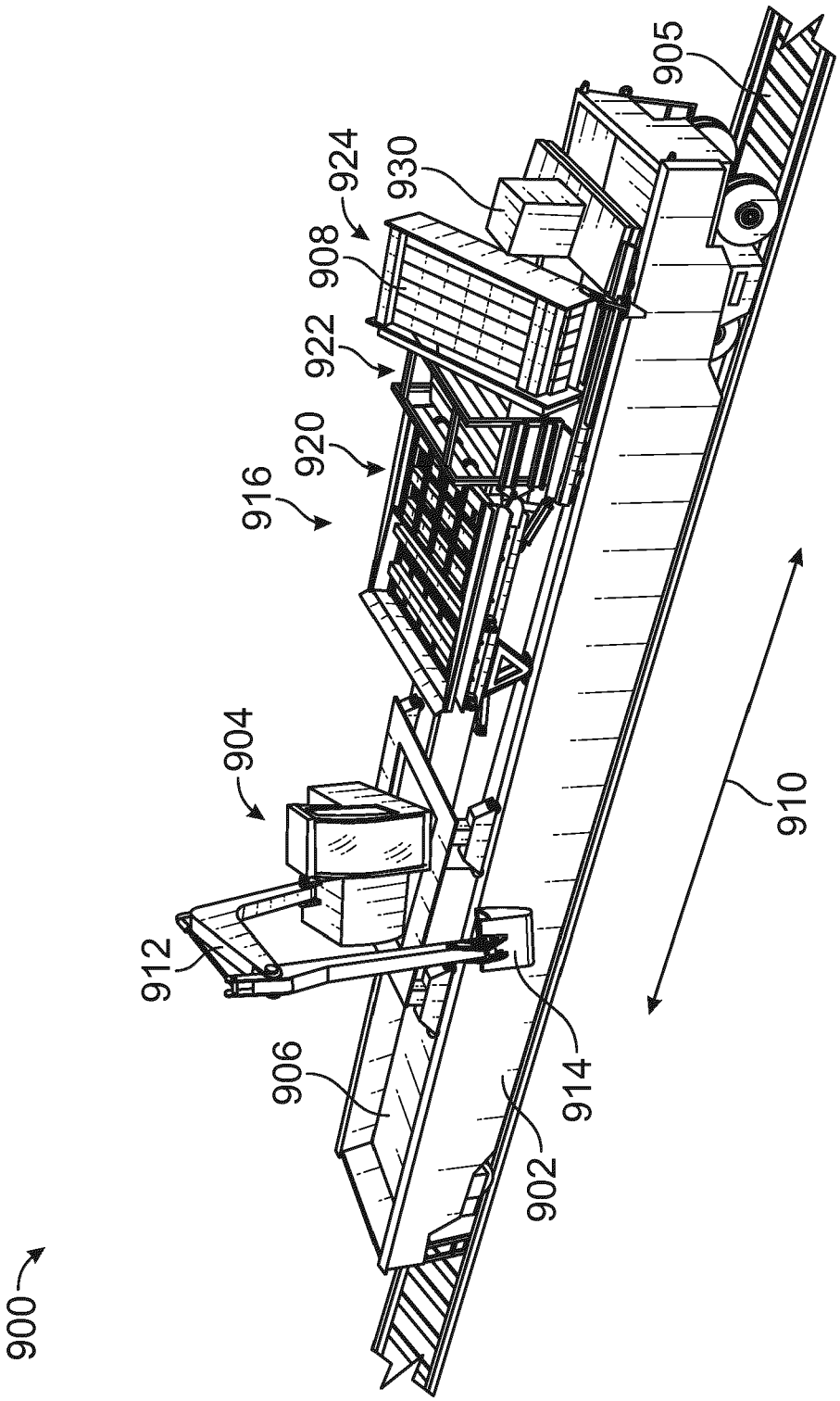

FIG. 9

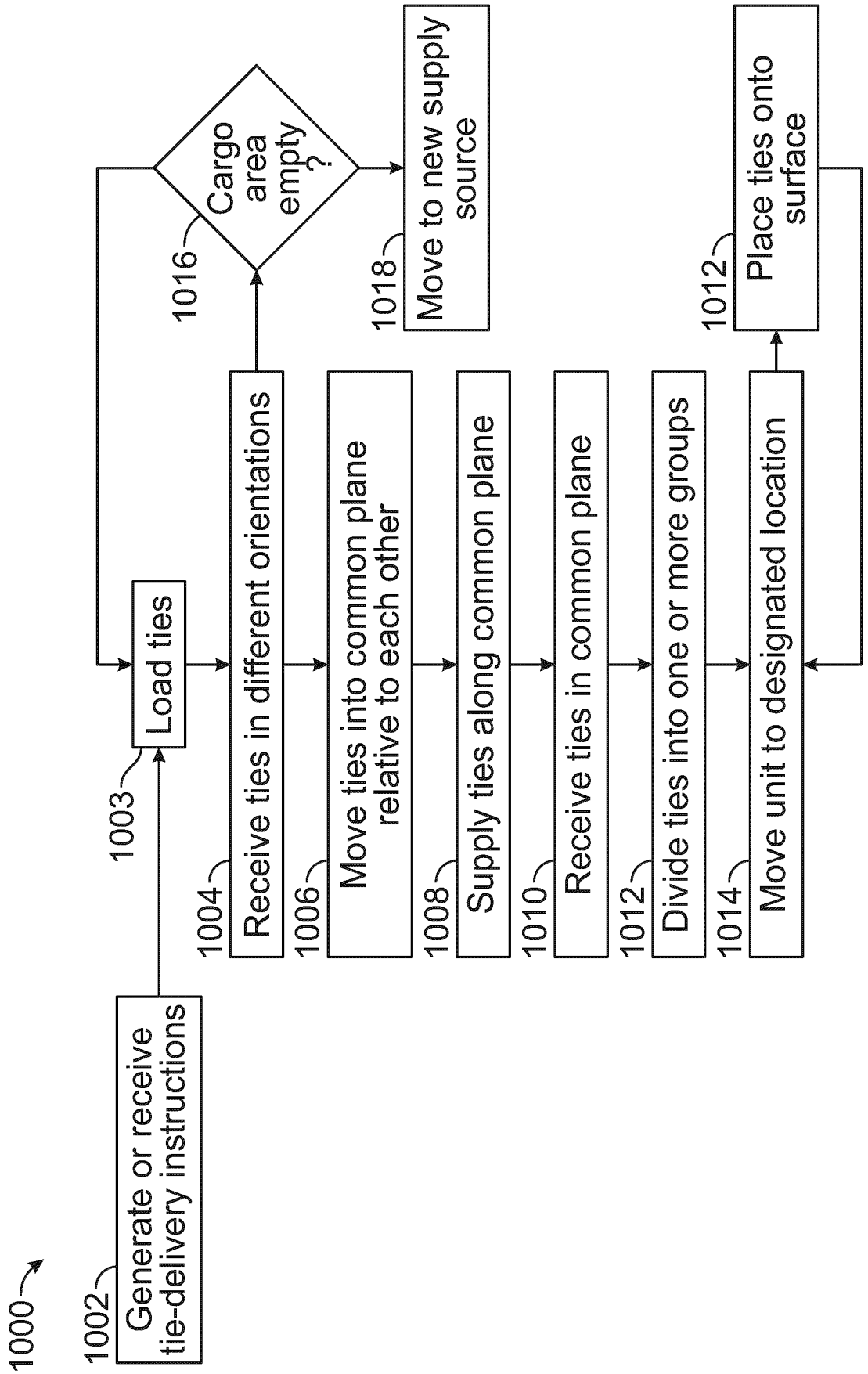
1000
1002
Generate or receive tie-delivery instructions
1003
Load ties
1004
Receive ties in different orientations
1006
Move ties into common plane relative to each other
1008
Supply ties along common plane
1010
Receive ties in common plane
1012
Divide ties into one or more groups
1014
Move unit to designated location
1012
Place ties onto surface
1016
Cargo area empty ?
1018
Move to new supply source

FIG. 10

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 15 9673

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2020/385934 A1 (SALCICCIA GILBERTO [IT]) 10 December 2020 (2020-12-10) * figures 1-11 * * paragraphs [0009], [0033], [0036], [0040], [0045], [0046], [0094], [0103], [0137], [0140], [0141] * * the whole document *	1-15	INV. E01B29/06
X	CN 112 482 104 A (YU CILONG) 12 March 2021 (2021-03-12) * figures 1-4 * * the whole document *	1-15	
X	DE 25 29 975 A1 (PLASSER BAHNBAUMASCH FRANZ) 6 May 1976 (1976-05-06) * figures 1-7 * * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 August 2024	Klein, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 15 9673

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-08-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2020385934 A1	10-12-2020	EP 3748081 A1	09-12-2020
		US 2020385934 A1	10-12-2020
CN 112482104 A	12-03-2021	NONE	
DE 2529975 A1	06-05-1976	AT 340460 B	12-12-1977
		DE 2529975 A1	06-05-1976

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- US 54434923 **[0001]**
- US 63490683 **[0001]**