



US 20240149969A1

(19) **United States**

(12) **Patent Application Publication**  
**Kapps**

(10) **Pub. No.: US 2024/0149969 A1**

(43) **Pub. Date: May 9, 2024**

(54) **FRAME FOR MULTI-WHEELED VEHICLE**

(52) **U.S. Cl.**  
CPC ..... **B62K 19/00** (2013.01); **B62K 5/06** (2013.01)

(71) Applicant: **John Campbell Kapps**, Rhineland, WI (US)

(72) Inventor: **John Campbell Kapps**, Rhineland, WI (US)

(57) **ABSTRACT**

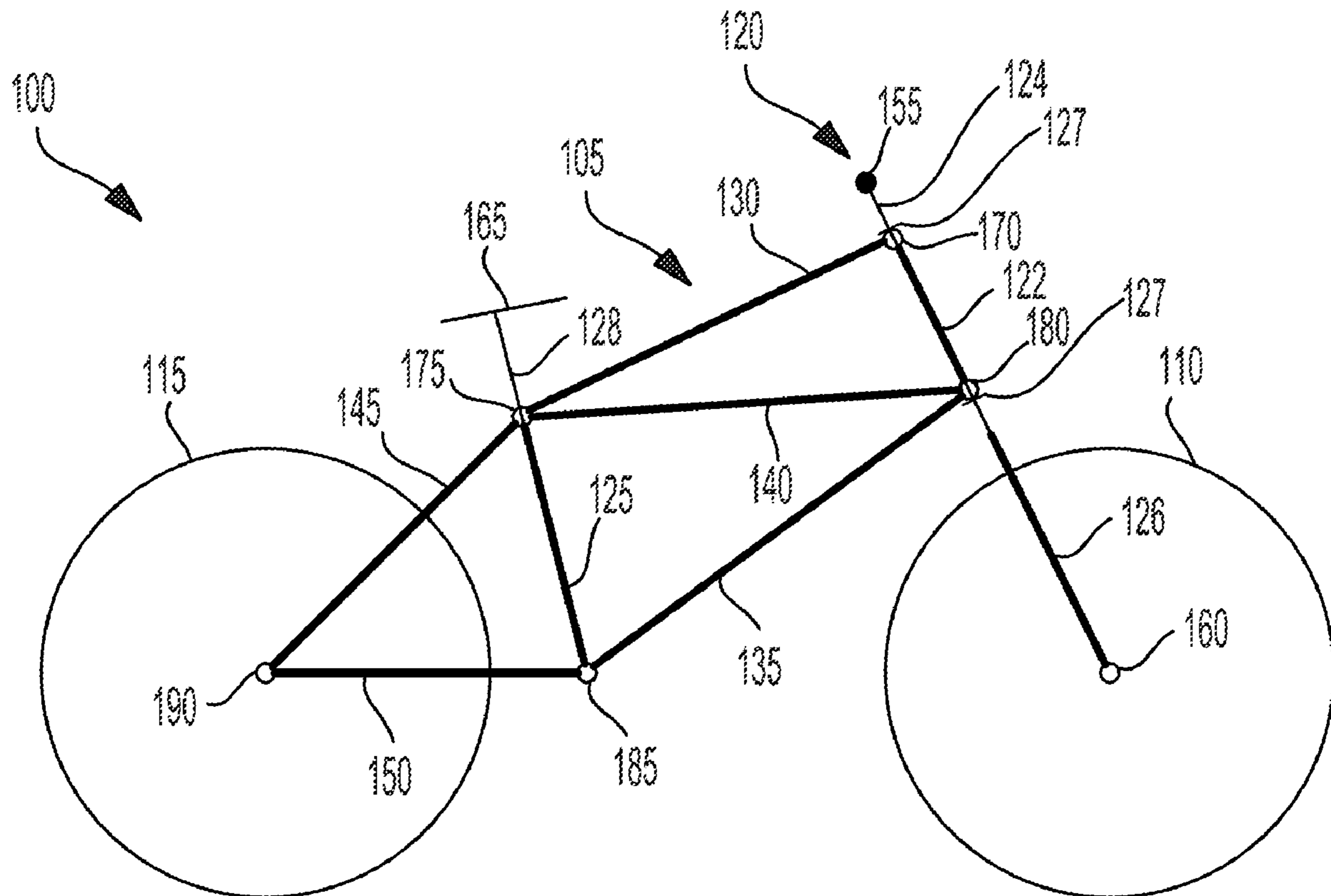
(21) Appl. No.: **17/981,347**

(22) Filed: **Nov. 4, 2022**

A multi-wheeled vehicle (e.g., bicycle, tricycle, quadricycle) frame includes a head tube, a seat tube, a top tube, a brace tube, and a down tube. The seat tube is disposed away from the head tube. The top tube is pivotally coupled to the seat tube and pivotally coupled to the head tube. The brace tube is pivotally coupled to the seat tube and pivotally coupled to the head tube. The down tube is pivotally coupled to the seat tube and pivotally coupled to the head tube.

**Publication Classification**

(51) **Int. Cl.**  
**B62K 19/00** (2006.01)  
**B62K 5/06** (2006.01)



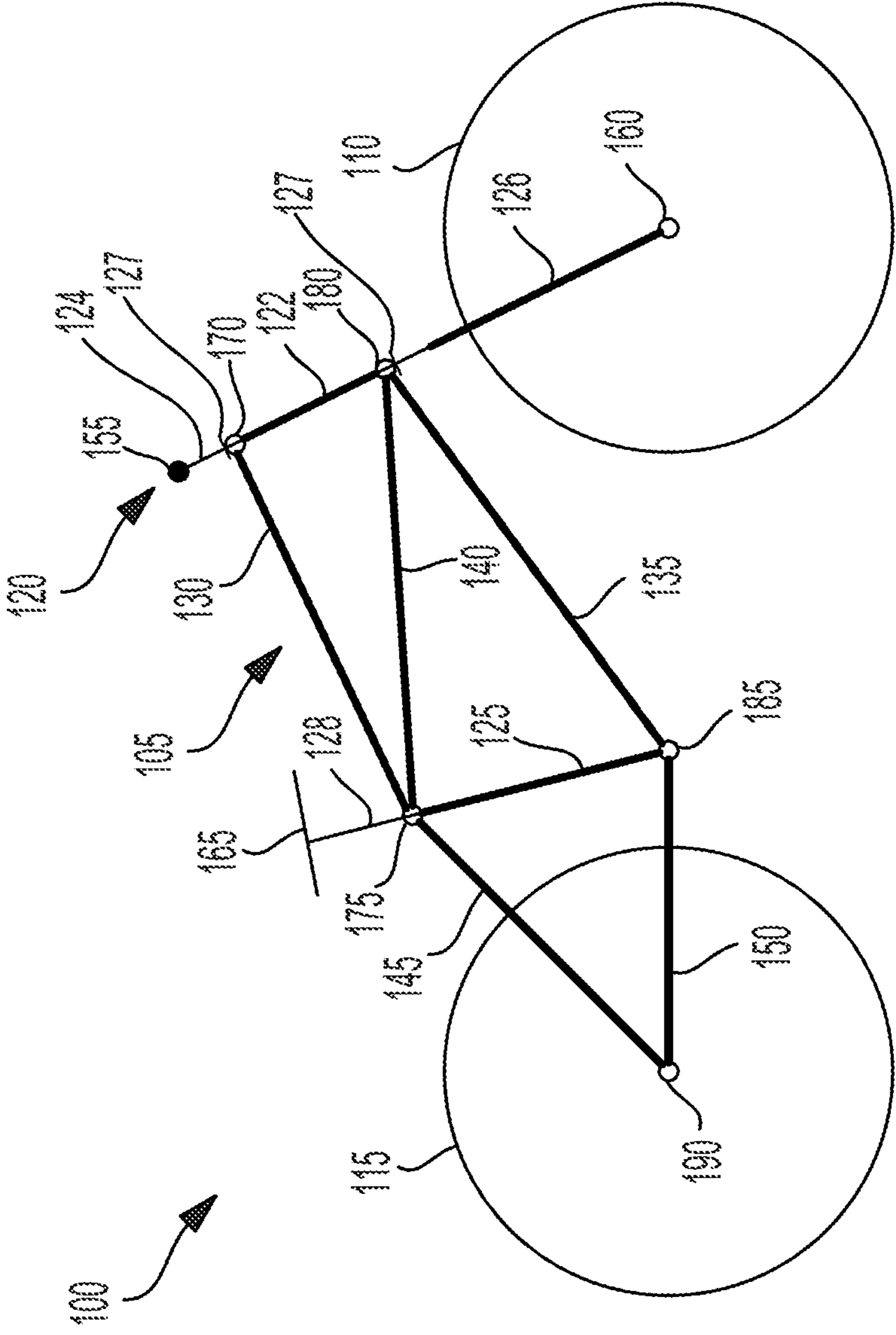


FIG. 1

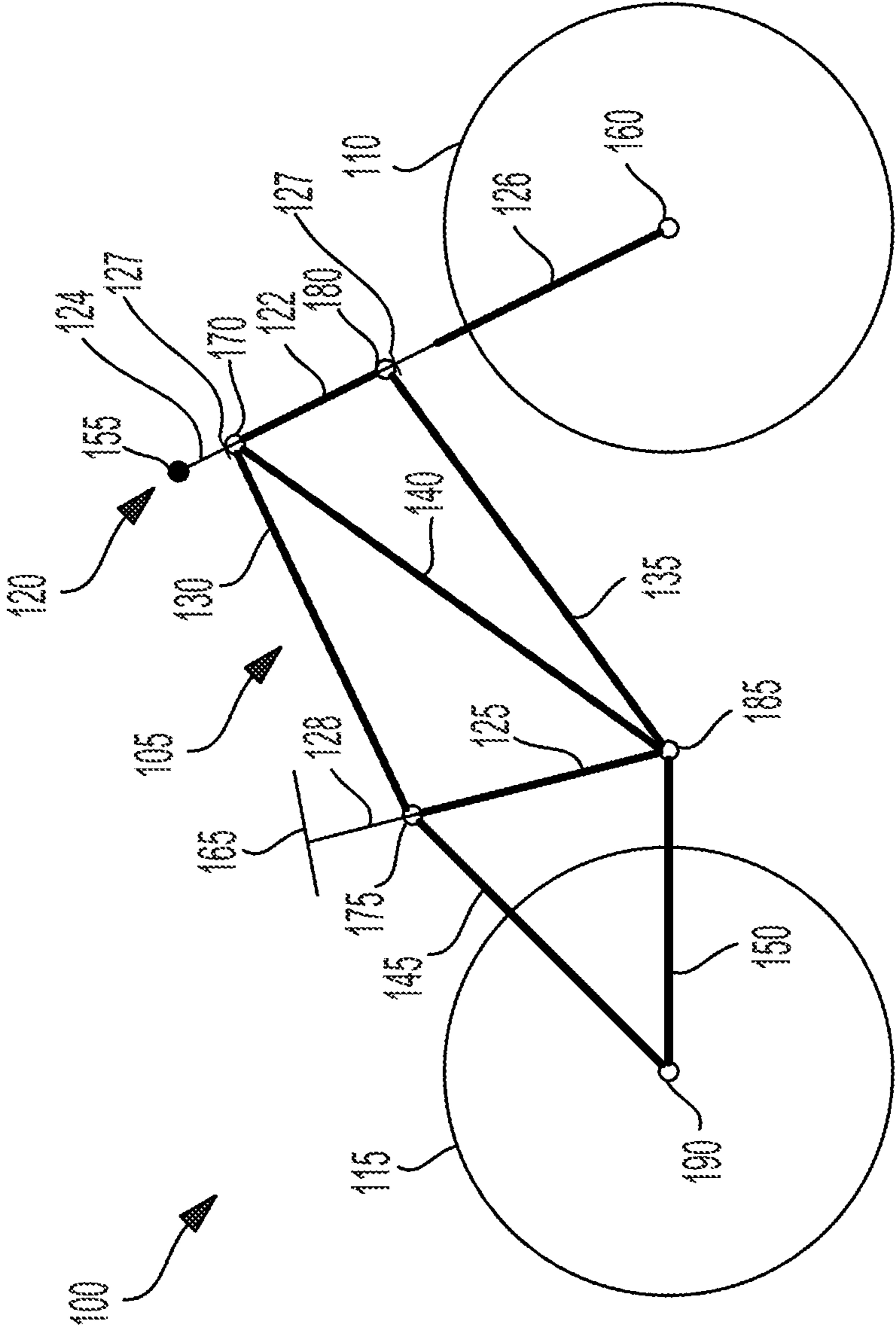


FIG. 2

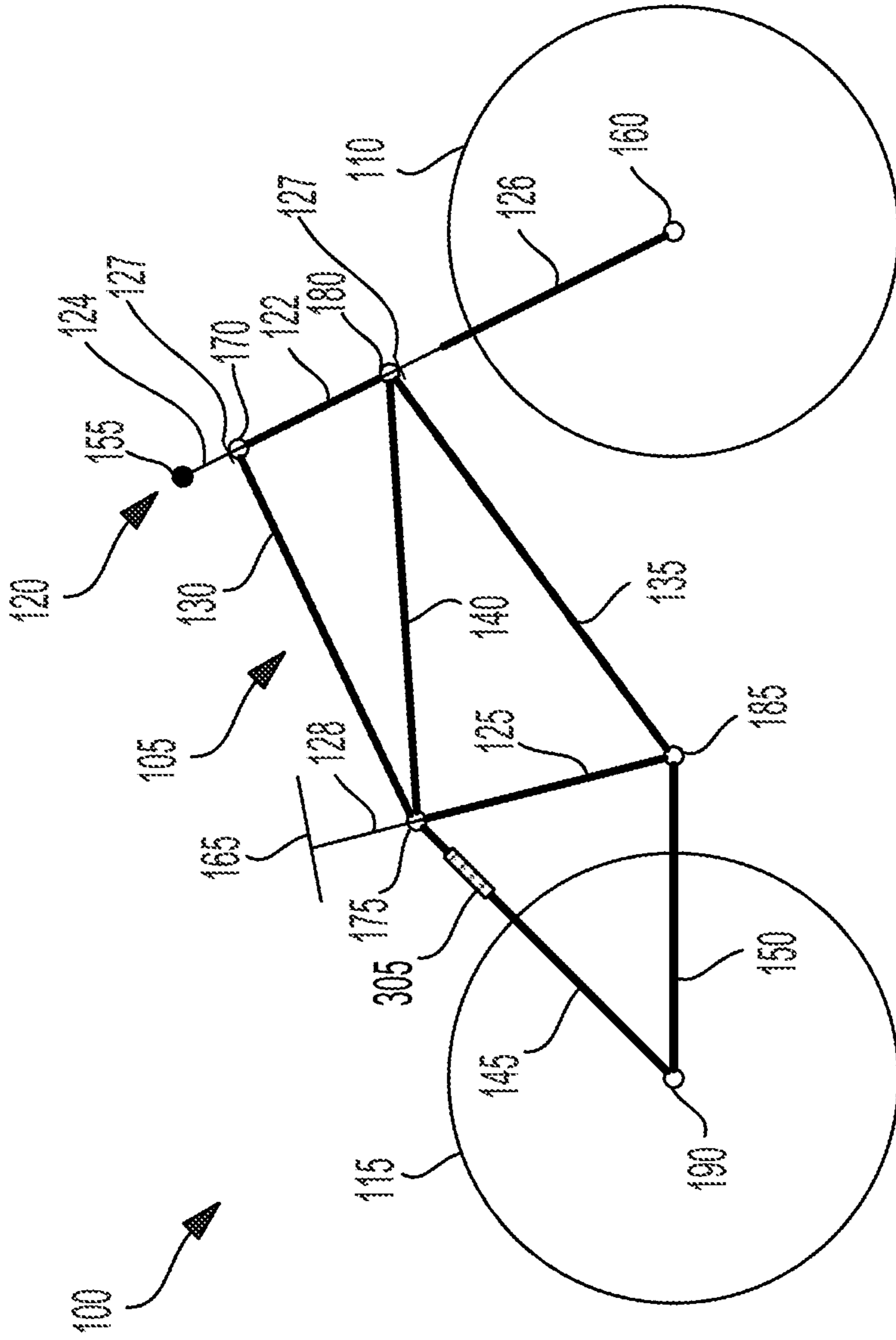


FIG. 3

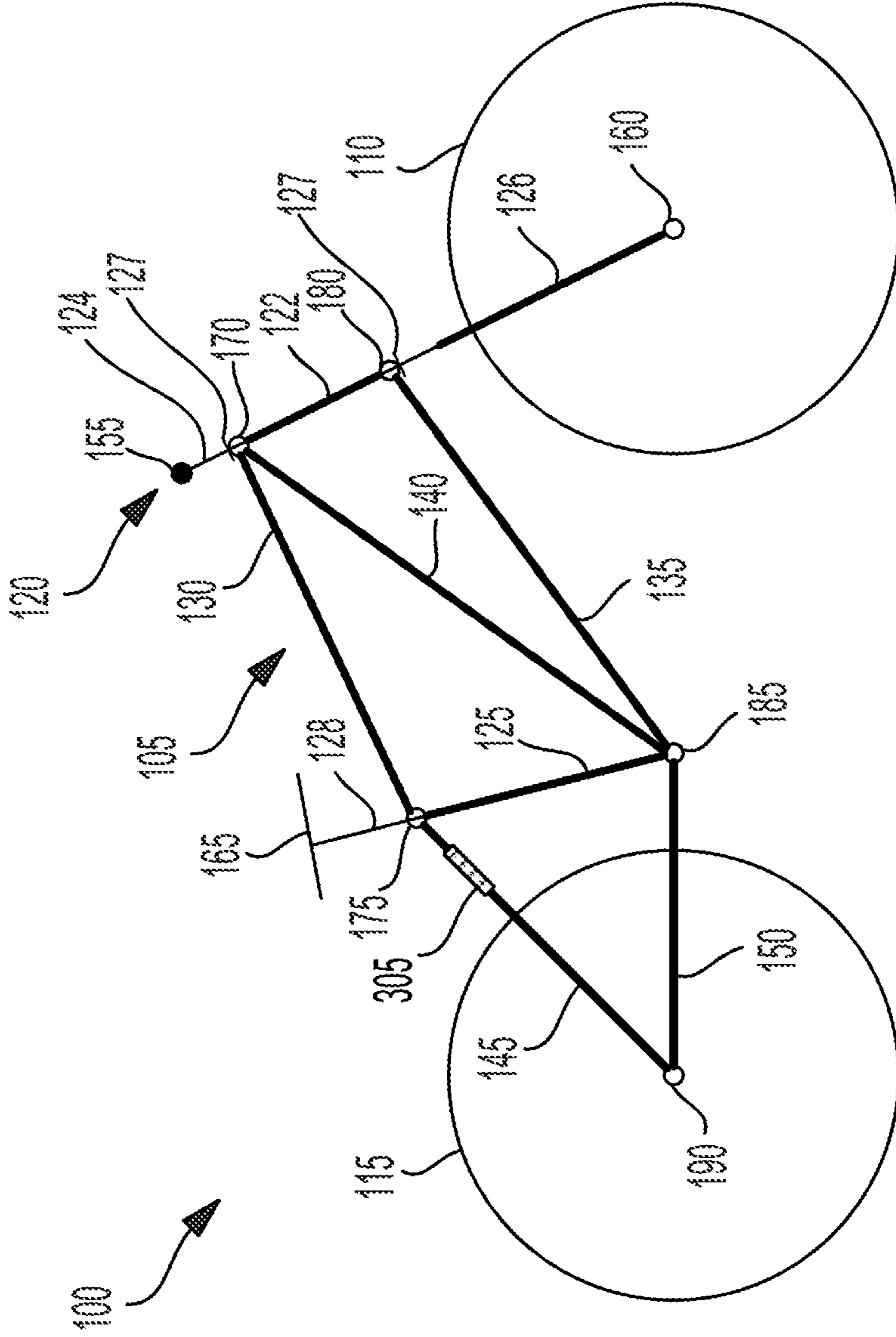


FIG. 4





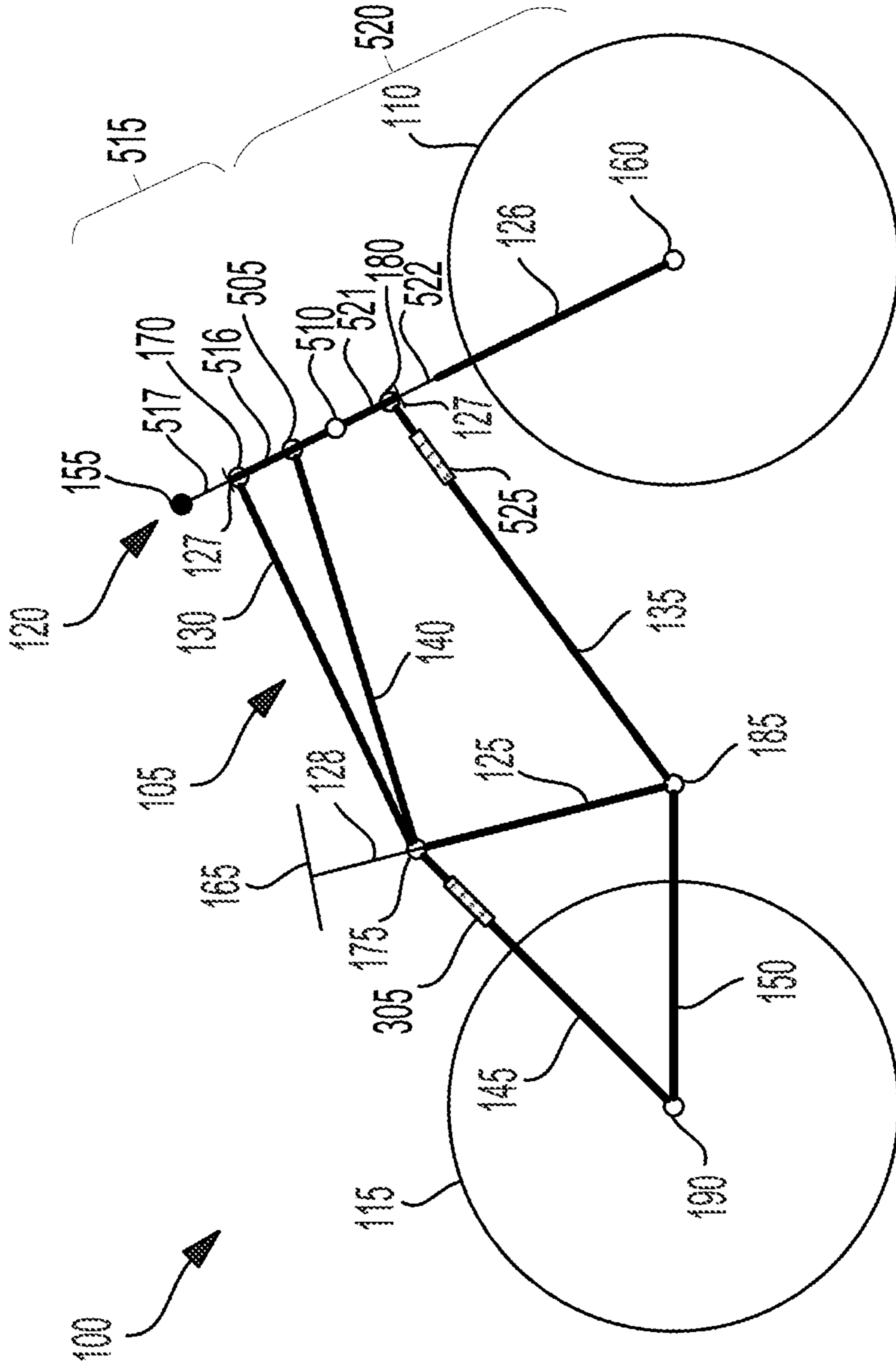


FIG. 7



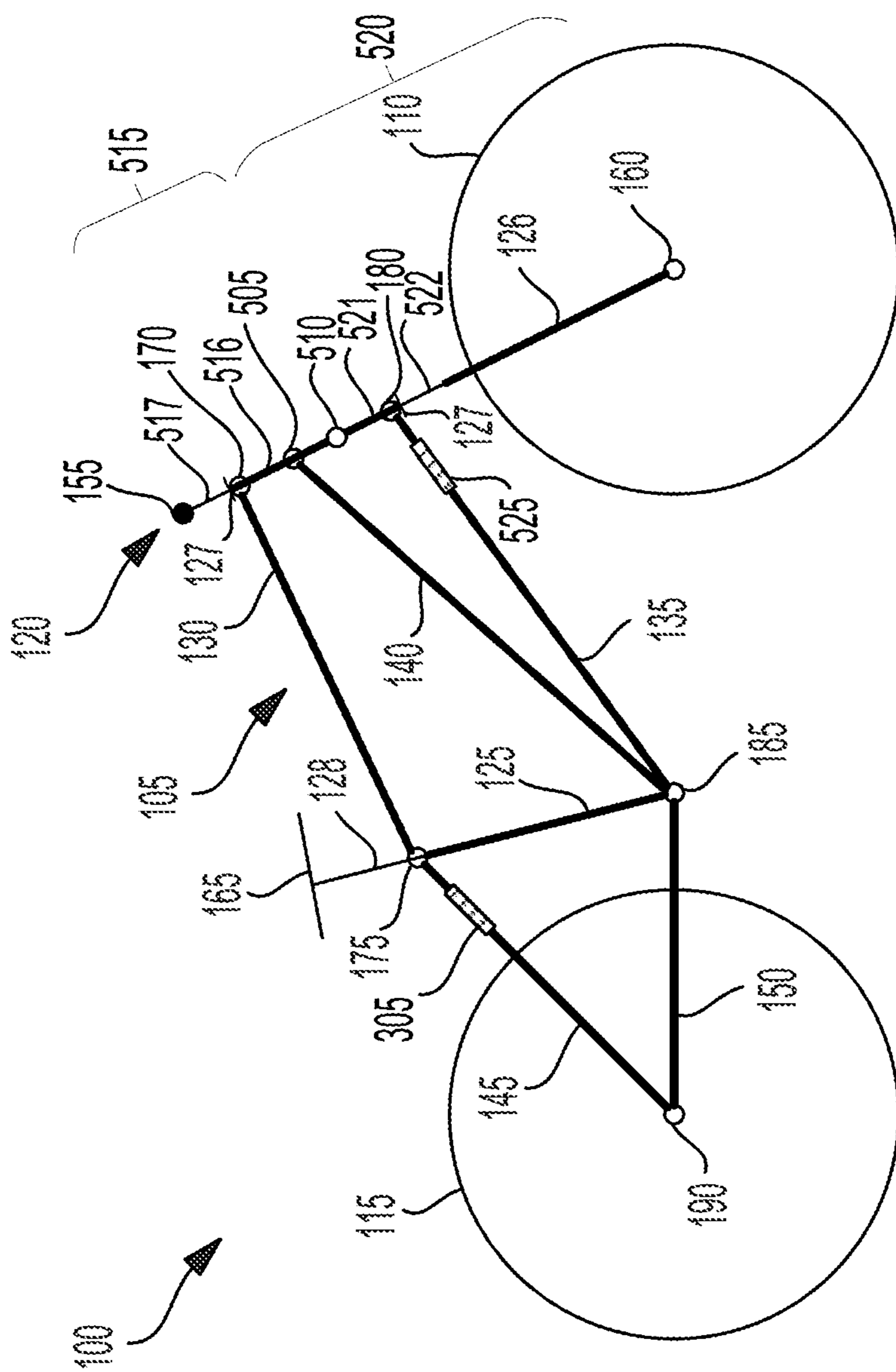


FIG. 8

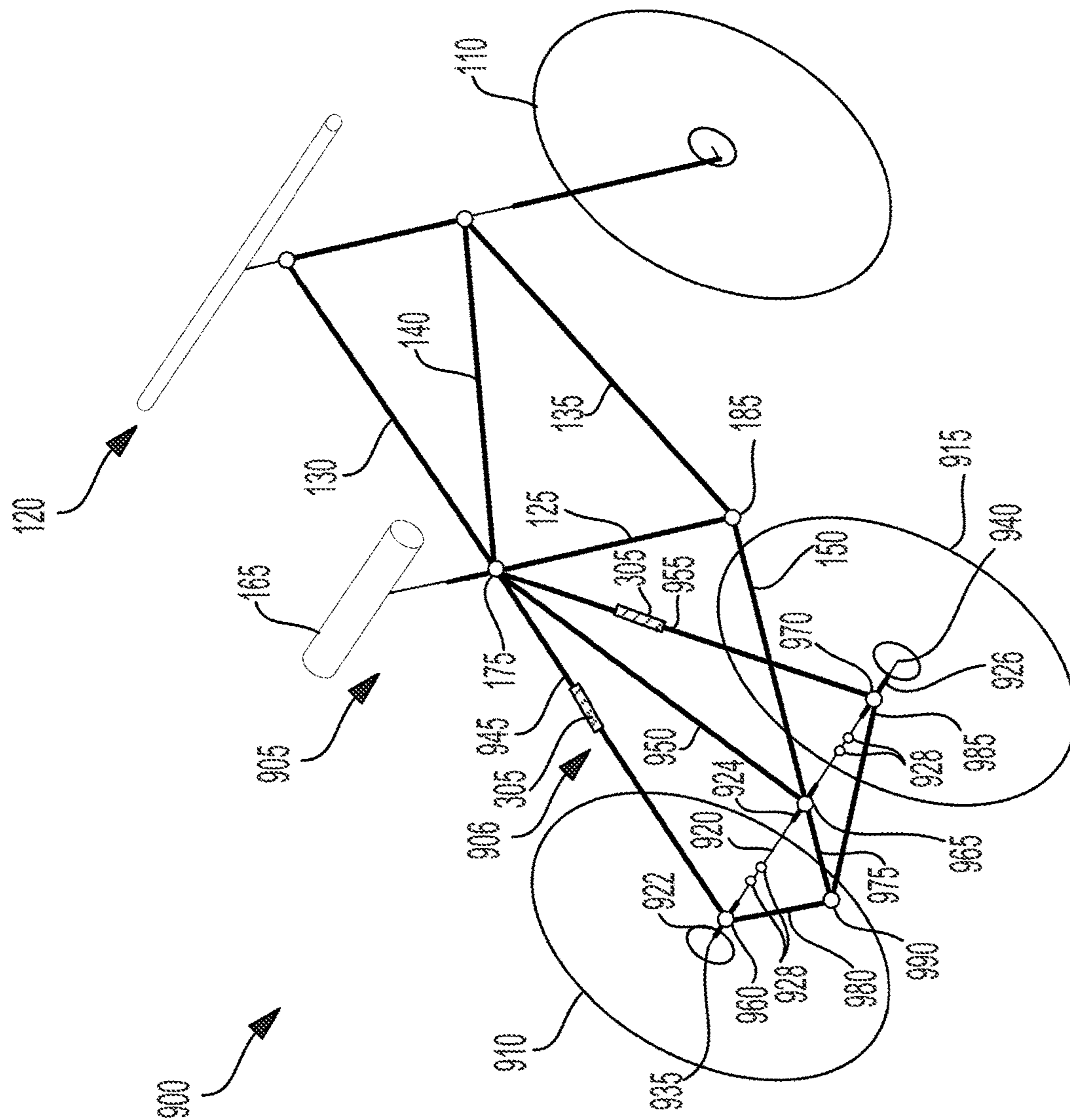


FIG. 9A

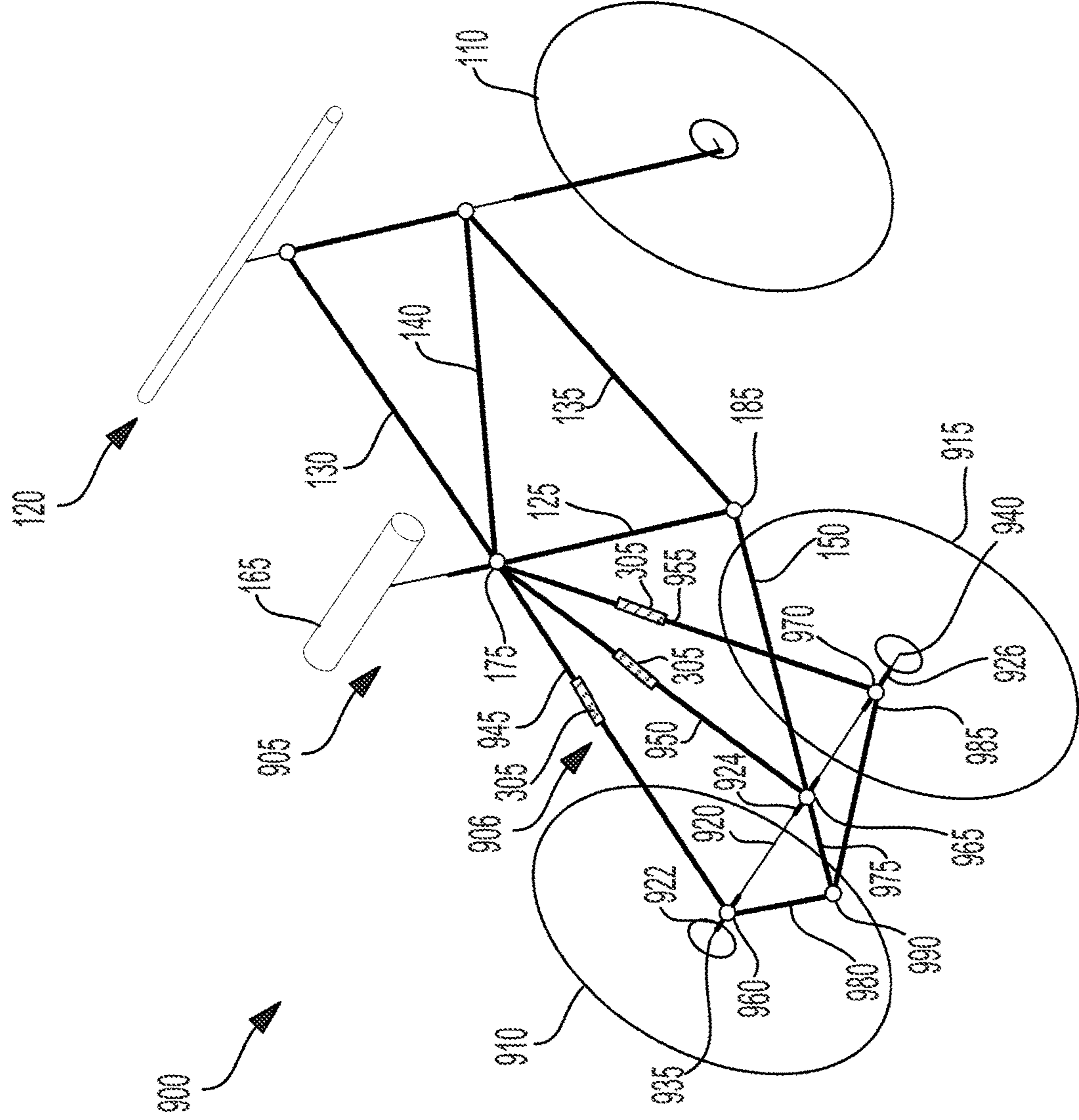


FIG. 9B

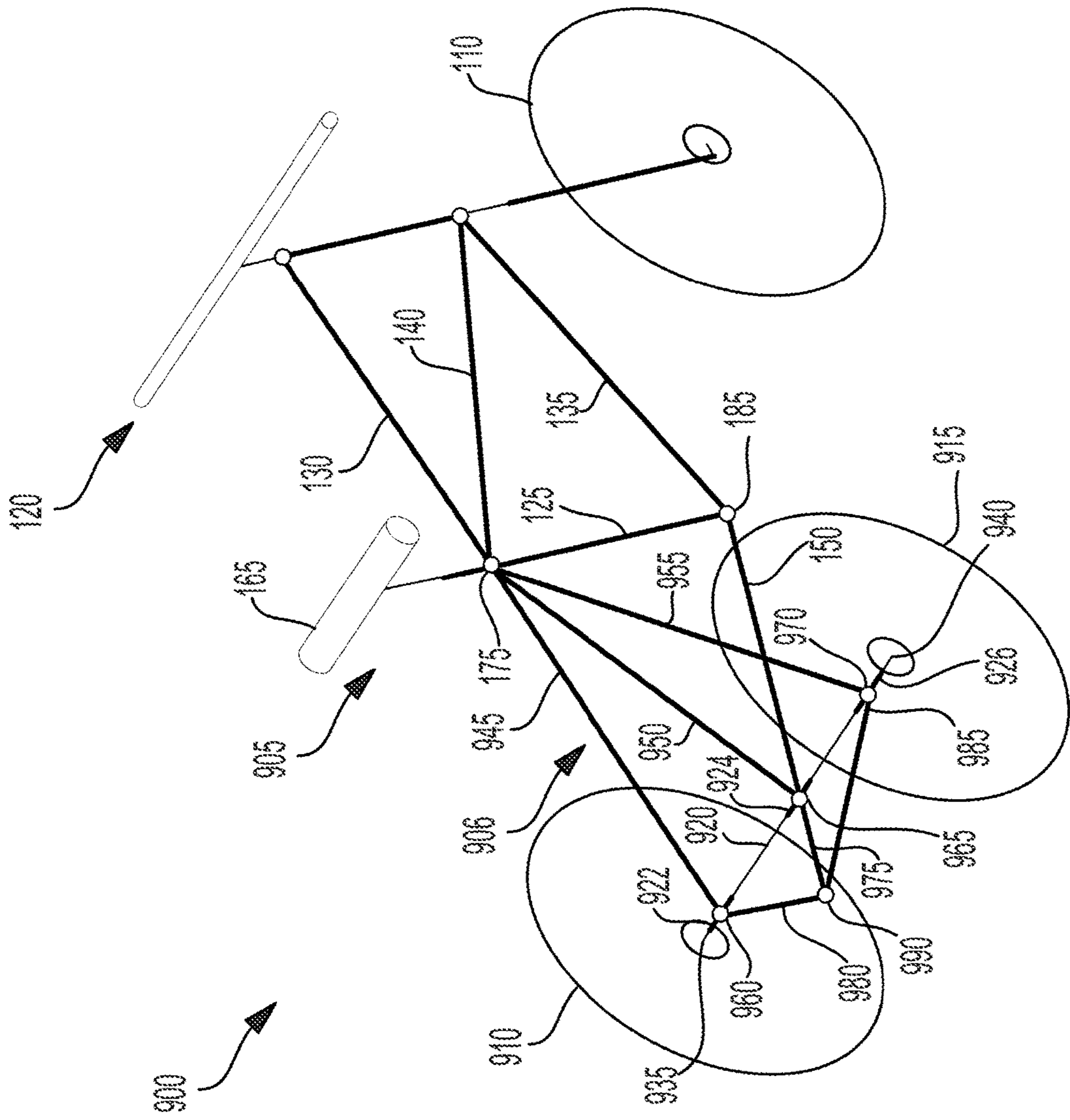


FIG. 9C

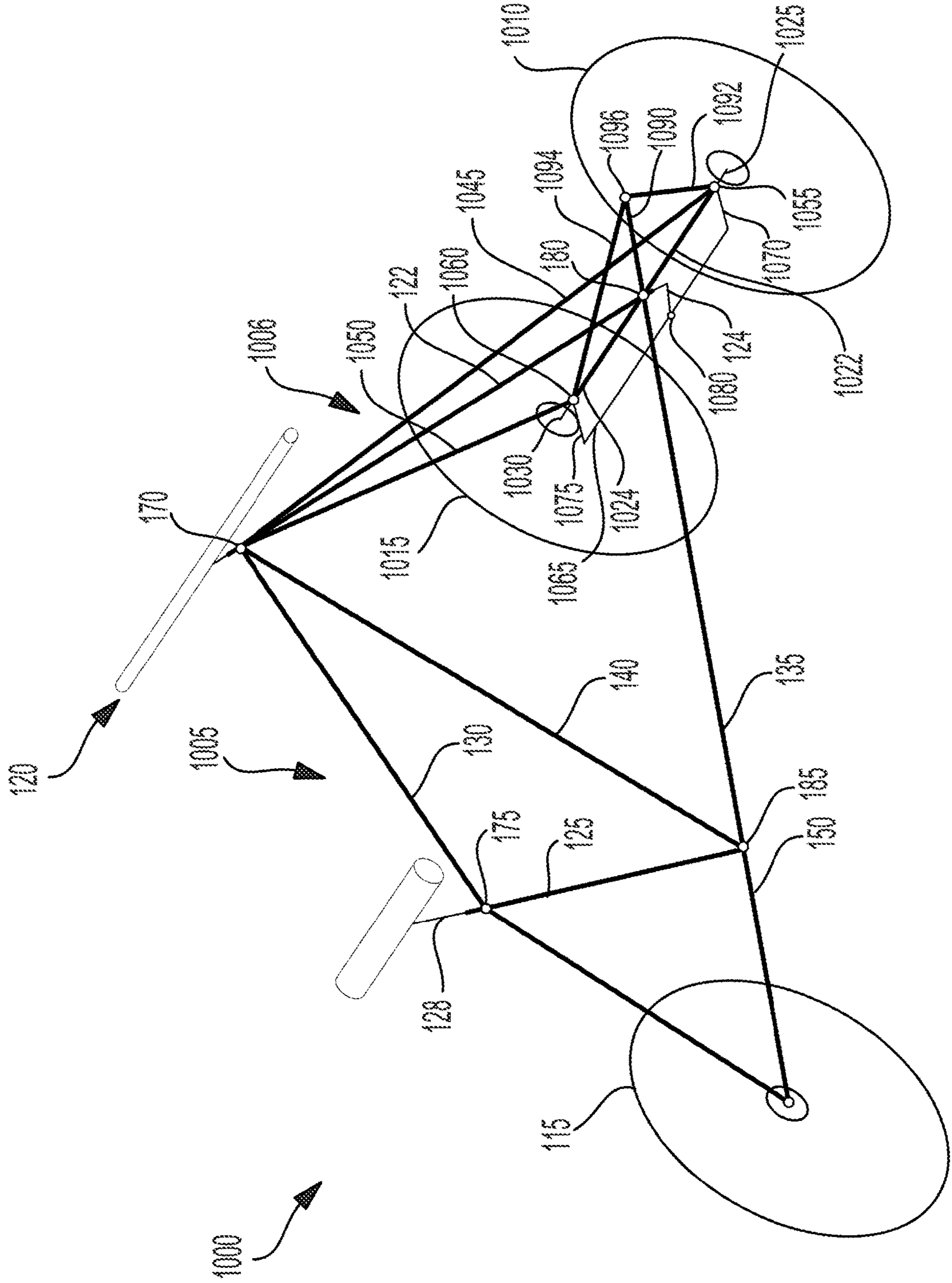


FIG. 10

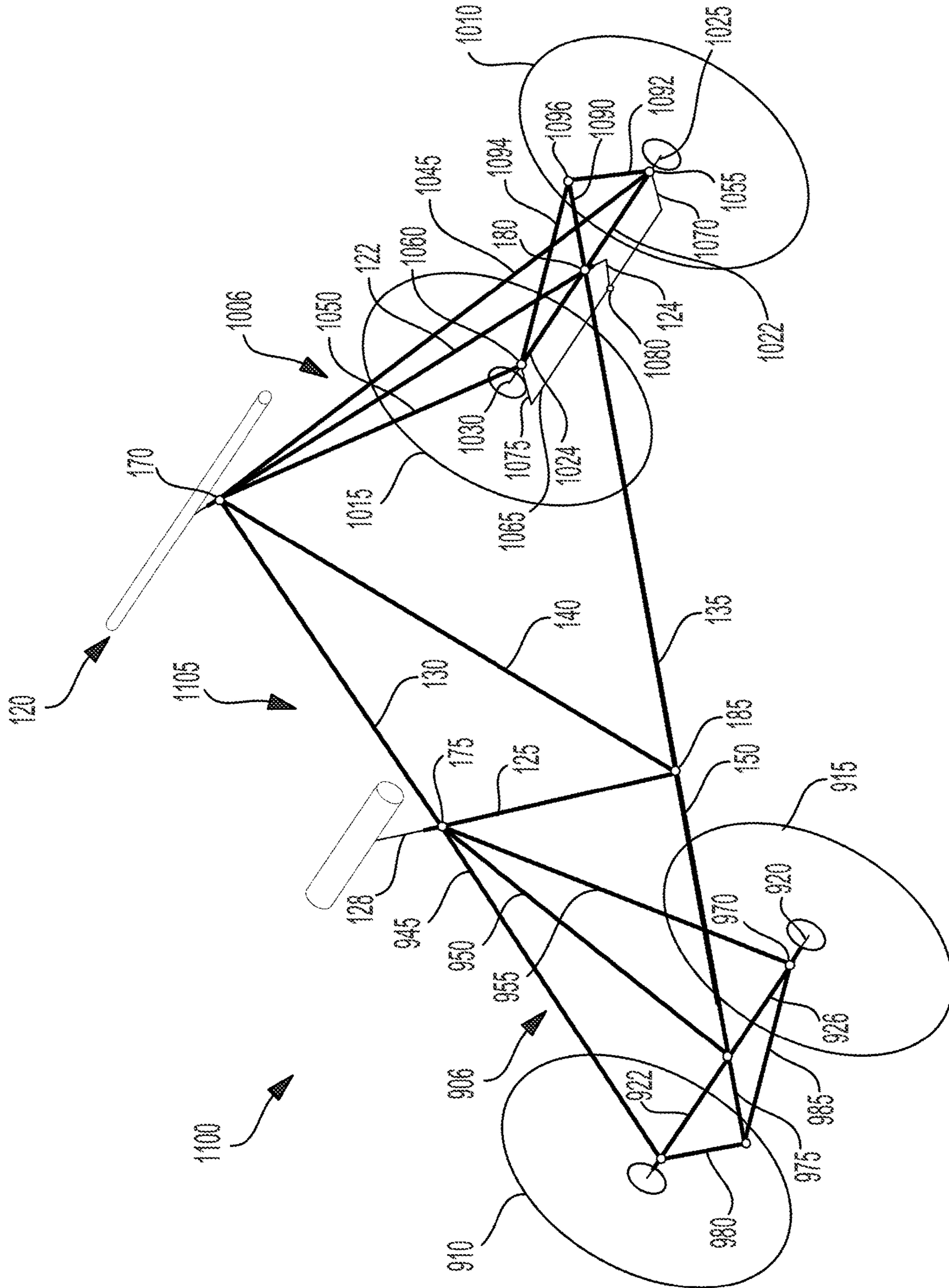


FIG. 11

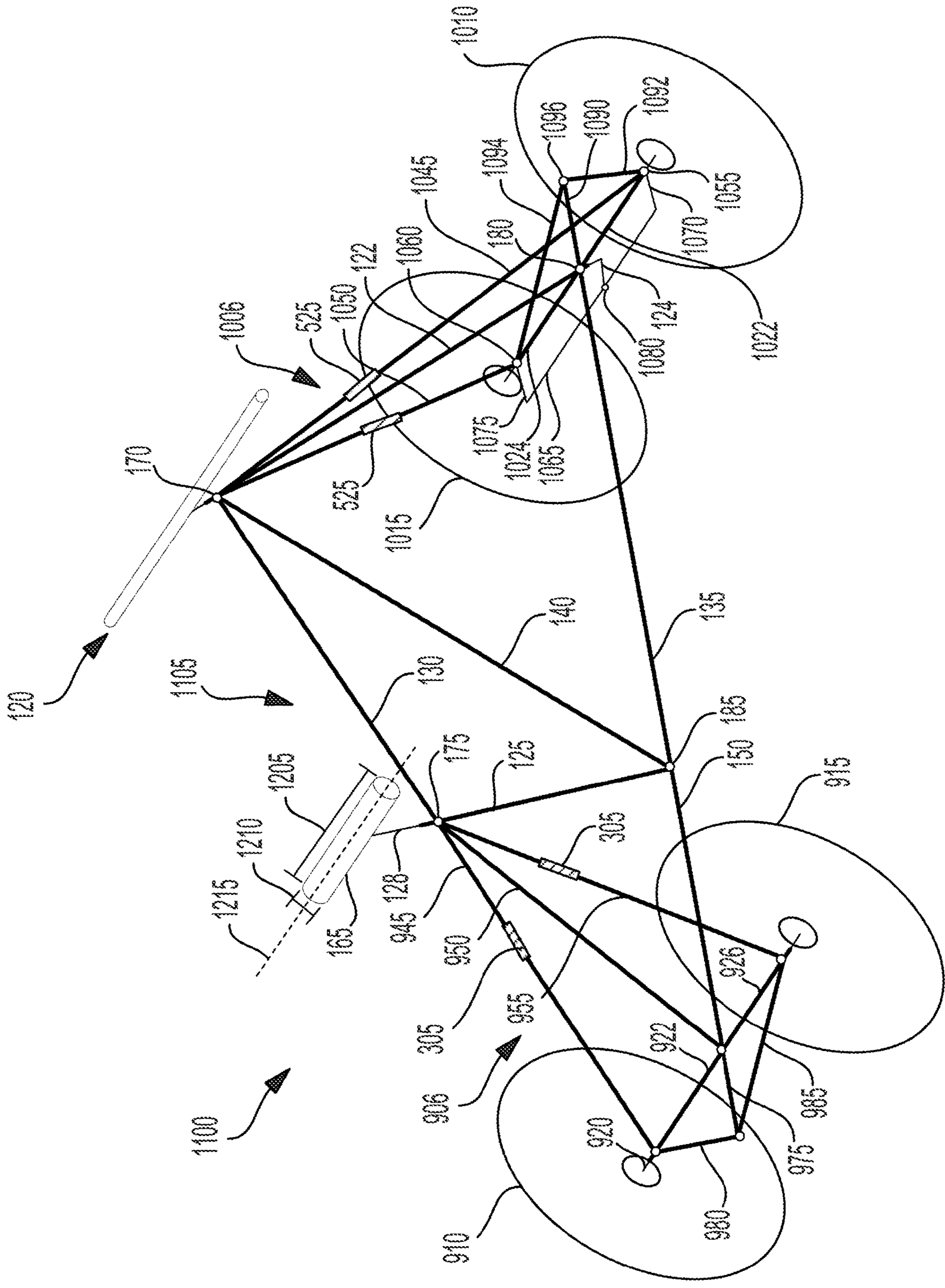


FIG. 12

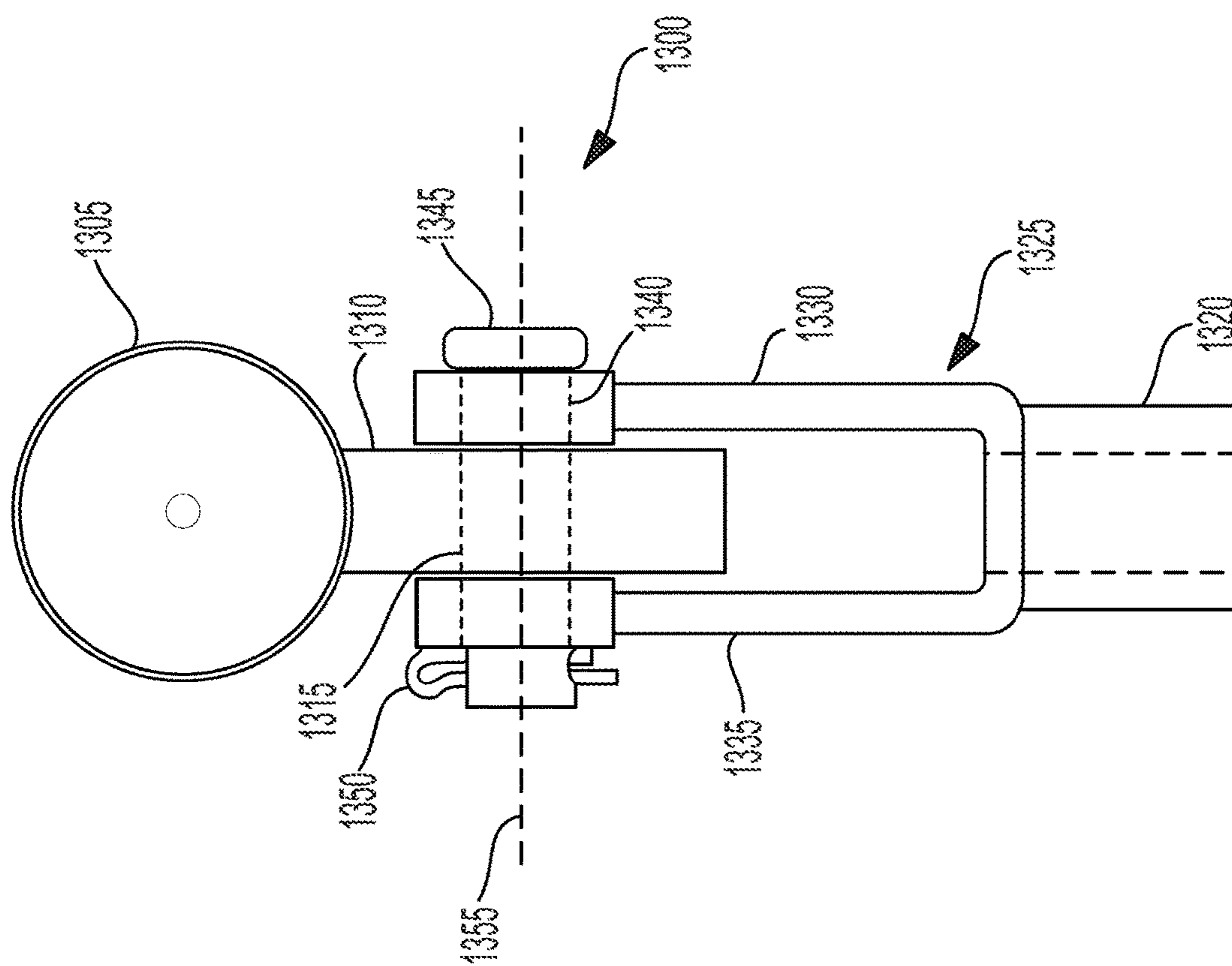


FIG. 13



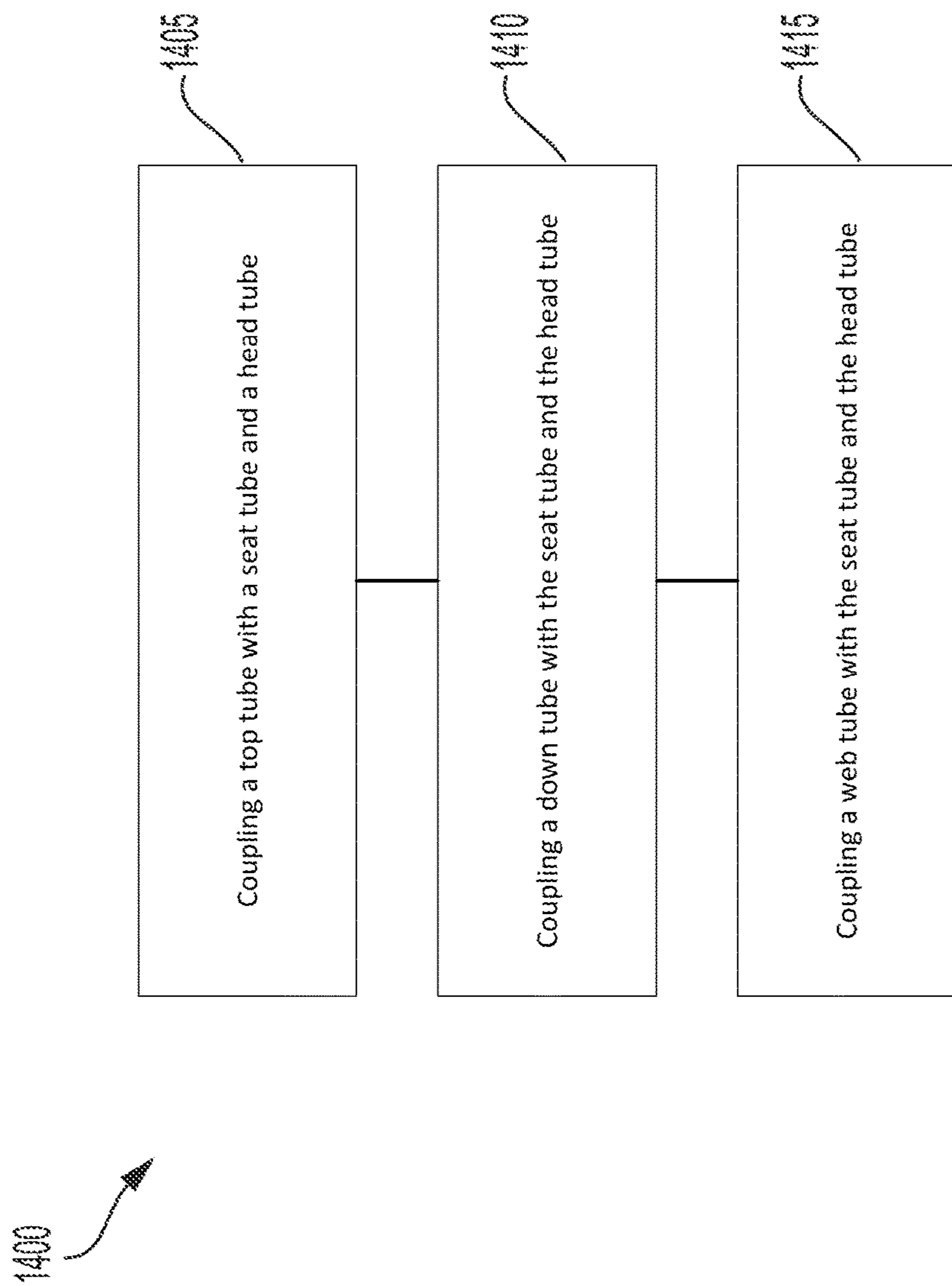


FIG. 14

## FRAME FOR MULTI-WHEELED VEHICLE

### BACKGROUND

[0001] The present invention relates generally to the field of multi-wheeled vehicles, such as bicycles, tricycles, and the like. More specifically, the present invention relates generally to a frame for such vehicles.

### SUMMARY OF THE INVENTION

[0002] One embodiment of the invention relates to a frame for a multi-wheeled vehicle. The frame includes a head tube, a seat tube, a top tube, a brace tube, and a down tube. The seat tube is disposed away from the head tube. The top tube is pivotally coupled with the seat tube and pivotally coupled with the head tube. The brace tube is pivotally coupled with the seat tube and pivotally coupled with the head tube. The down tube is pivotally coupled with the seat tube and pivotally coupled with the head tube.

[0003] Another embodiment relates to a method for assembling a multi-wheeled vehicle. The method includes pivotally coupling a top tube with a seat tube and a head tube. The method includes pivotally coupling a down tube with the seat tube and the head tube. The method includes pivotally coupling a brace tube with the seat tube and the head tube.

[0004] Another embodiment relates to a multi-wheeled vehicle. The multi-wheeled vehicle includes a head tube. The multi-wheeled vehicle includes a seat tube disposed away from the head tube. The multi-wheeled vehicle includes a top tube pivotally coupled to the seat tube and pivotally coupled to the head tube. The multi-wheeled vehicle includes a brace tube pivotally coupled to the seat tube and pivotally coupled to the head tube. The multi-wheeled vehicle includes a down tube pivotally coupled to the seat tube and pivotally coupled to the head tube. The multi-wheeled vehicle includes a seat stay having a first end and a second end. The first end of the seat stay is coupled to the seat tube at a first location. The multi-wheeled vehicle includes a chain stay having a first end and a second end. The first end of the chain stay is coupled to the seat tube at a second location and the second end of the chain stay is coupled to the second end of the seat stay.

[0005] The invention is capable of other embodiments and of being carried out in various ways. Alternative exemplary embodiments relate to other features and combinations of features as may be recited herein.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The disclosure will become more fully understood from the following detailed description, taken in conjunction with the accompanying figures, wherein like reference numerals refer to like elements, in which:

[0007] FIG. 1 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0008] FIG. 2 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0009] FIG. 3 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0010] FIG. 4 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0011] FIG. 5 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0012] FIG. 6 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0013] FIG. 7 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0014] FIG. 8 is a side view of a two-wheeled vehicle or bicycle, according to an exemplary embodiment.

[0015] FIG. 9A is a perspective view of a three-wheeled vehicle or tricycle, according to an exemplary embodiment.

[0016] FIG. 9B is a perspective view of a three-wheeled vehicle or tricycle, according to an exemplary embodiment.

[0017] FIG. 9C is a perspective view of a three-wheeled vehicle or tricycle, according to an exemplary embodiment.

[0018] FIG. 10 is a perspective view of a three-wheeled vehicle or tricycle, according to an exemplary embodiment.

[0019] FIG. 11 is a perspective view of a four-wheeled vehicle or quadricycle, according to an exemplary embodiment.

[0020] FIG. 12 is a perspective view of a four-wheeled vehicle or quadricycle, according to an exemplary embodiment.

[0021] FIG. 13 is a view of a joint or coupling, according to an exemplary embodiment.

[0022] FIG. 14 is a block diagram of a method for assembling a multi-wheeled vehicle frame, according to an exemplary embodiment.

### DETAILED DESCRIPTION

[0023] Before turning to the figures, which illustrate the exemplary embodiments in detail, it should be understood that the present application is not limited to the details or methodology set forth in the description or illustrated in the figures. It should also be understood that the terminology is for the purpose of description only and should not be regarded as limiting.

[0024] According to an exemplary embodiment, a multi-wheeled vehicle frame (e.g., a bicycle frame) can include a plurality of members configured to provide structure to a bicycle. The plurality of members can be arranged in various configurations to couple a front wheel with a rear wheel. The plurality of members can also provide a structure to support a user or rider of the bicycle. A first member of the plurality of members can be a head tube. A second member of the plurality of members can be a steer tube. A first end of the steer tube can couple with a handle of the multi-wheeled vehicle and a second end of the steer tube can couple with the front wheel of the multi-wheeled vehicle via a fork member. A third member of the plurality of members can be a seat tube. A fourth member of the plurality of members can be a seat post. The seat post can provide support for the user of the bicycle. For example, a top of the seat post can couple with a seat for the user.

[0025] Some of the plurality of members can extend between the head tube and the seat tube. For example, a fifth member of the plurality of members can be a top tube. The top tube can extend between the head tube and the seat tube. For example, a front end of the top tube can couple with the head tube. The top tube can couple with the head tube at a first head tube work point. A physical connection point between the top tube and the head tube can be at or adjacent to the work point, as described in more detail herein. A location of a work point may be based on a location of an intersection of a neutral axis (e.g., a central axis of a member with a symmetrical cross-sectional shape) of a first member and a neutral axis of a second member when the frame is

assembled (e.g., when the frame is constructed and oriented to be used). For example, the first head tube work point may be located where a neutral axis of a top tube intersects a neutral axis of the head tube when the frame is assembled. The work point can be located anywhere along the neutral axis of a member between one end of said member and the nearest work point inclusive. For example, the work point between the top tube and the head tube can be located anywhere along the neutral axis of the top tube between the front end of the top tube and the first head tube work point inclusive. A rear end of the top tube can couple with the seat tube. The top tube can couple with the seat tube at a first seat tube work point. A sixth member of the plurality of members can be a down tube. The down tube can also extend between the head tube and the seat tube. For example, a front end of the down tube can couple with the head tube. The down tube can couple with the head tube at a second head tube work point. The second head tube work point can be closer to the second end of the head tube than the first head tube work point. A rear end of the down tube can couple with the seat tube. The down tube can couple with the seat tube at a second seat tube work point. The second seat tube work point can be further away from the seat than the first seat tube work point. A seventh member of the plurality of members can be a brace tube. The brace tube can also extend between the head tube and the seat tube. For example, in some embodiments, a front end of the brace tube can couple with the head tube at the second head tube work point (e.g., the same work point as the down tube) and a rear end of the brace tube can couple with the seat tube at the first seat tube work point (e.g., the same work point as the top tube). In other embodiments, the front end of the brace tube can couple with the head tube at the first head tube work point and the rear end of the brace tube can couple with the seat tube at the second seat tube work point.

[0026] The brace tube reduces the amount of bending forces applied to the head tube, the seat tube, the top tube, and the down tube, and in conjunction with the orientation of all the members—including but not limited to the seat stay and the chain stay—allows all the members to instead rely on compressive and/or tensile strength(s) to maintain the structure of the multi-wheeled frame. Therefore, each end of the top tube, the down tube, the brace tube, the seat stays, and the chain stays can include a loose pinned connection wherein any member, in the absence of all the other members, could move (e.g., pivot, rotate, etc.) around the transverse axis of either of its connections. Compressive and tensile forces alone can prevent the members from rotating around the hinged connections. Relying on compressive and/or tensile strength(s) alone to maintain the structure of the multi-wheeled frame can allow each connection adjacent to a work point to be a pinned connection (e.g., a hinge), and can minimize the cross-sectional dimensions required for each member. For example, each member can be thinner than a similar member of other multi-wheeled frames that apply bending forces on the members. Furthermore, each hinged connection can be made with a removable pin which can facilitate disassembly of the frame, and thereby transportation of the bicycle.

[0027] Referring to FIGS. 1 and 2, a side view of an apparatus, shown as bicycle 100, is shown according to an exemplary embodiment. The apparatus may be the bicycle 100 or other vehicles or devices that have a structure and at least two wheels. The bicycle 100 includes at least one frame

105, at least one front wheel 110, and at least one rear wheel 115. The frame 105 provides structure to the bicycle 100 such that structural members of the bicycle 100 remain substantially stationary with respect to each other during use or operation of the bicycle 100. The frame 105 connects at least one front wheel 110 of the bicycle 100 with at least one rear wheel 115 of the bicycle 100. The frame 105 includes a plurality of (structural) members. For example, the frame 105 includes a first member, shown as head tube assembly 120, a second member, shown as seat tube 125, a third member, shown as top tube 130, a fourth member, shown as down tube 135, a fifth member, shown as brace tube 140, a sixth member, shown as seat stay 145, and a seventh member, shown as chain stay 150. According to various embodiments, the frame 105 may include any combination of members, including some, all, none, or more than the members described herein. The plurality of members of the frame 105 may be coupled with each other via a plurality of work points. The plurality of members may be oriented in any number of configurations.

[0028] The head tube assembly 120 couples a steering mechanism, shown as handle 155, with the front wheel 110 of the bicycle 100. The head tube assembly 120 may be a single member or may comprise of a plurality of members. For example, head tube assembly 120 may include a head tube 122, a steer tube 124 that extends, at least partially, through the head tube 122, and a fork member 126. The head tube assembly 120 may include at least one headset bearing 127. The headset bearing 127 may prevent the steer tube 124 from sliding through the head tube 122. The head tube assembly 120 may include a plurality of headset bearings 127. For example, a first headset bearing may be disposed at a top end of the head tube 122 and a second headset bearing may be disposed at a bottom end of the head tube 122. The steer tube 124 extends between the handle 155 and the fork member 126. The fork member 126 couples with the front wheel 110 via a front wheel work point 160 (e.g., a wheel bearing). The fork member 126 may extend along both sides of the front wheel 110 and couple the head tube assembly 120 with the front wheel work point 160 via both sides of the front wheel 110. The front wheel work point 160 may be a part of a hub of the front wheel 110 or other central structure of the front wheel 110. The front wheel work point 160 may be near or at the center of the front wheel 110.

[0029] The seat tube 125 is disposed away from the head tube assembly 120. The seat tube 125 may be a single member. The seat tube 125 may also comprise a plurality of members. The seat tube 125 is configured to receive a seat post 128. The seat post 128 is configured to extend, at least partially, into the seat tube 125. The seat post 128 is coupled with a support device, shown as seat 165. The seat post 128 provides support for a user of the bicycle 100. For example, a top end of the seat post 128 couples with and provides support for the seat 165 such that the user can sit on the seat 165.

[0030] The frame 105 includes at least one member that extends between the head tube assembly 120 and the seat tube 125. For example, top tube 130 extends between the head tube assembly 120 and the seat tube 125. The top tube 130 may be a single member. For example, the top tube 130 may be a single pipe extending between the head tube assembly 120 and the seat tube 125. In other embodiments, the top tube 130 may comprise a plurality of members. A front end of the top tube 130 couples with the head tube

assembly 120. The top tube 130 couples with the head tube assembly 120 at a first head tube assembly location, shown as first head tube work point 170. The first head tube work point 170 may be closer to the top end of the head tube assembly 120 than the bottom end of the head tube assembly 120. In some embodiments, the first head tube work point 170 is at a top end of the head tube 122.

[0031] A rear end of the top tube 130 couples with the seat tube 125. The top tube 130 couples with the seat tube 125 at a first seat tube location, shown as first seat tube work point 175. The first seat tube work point 175 may be closer to the top end of the seat tube 125 than a bottom end of the seat tube 125. The top tube 130 may be pivotally coupled with the head tube assembly 120. The top tube 130 may be pivotally coupled with the seat tube 125. For example, the top tube 130 couples with the head tube assembly 120 such that the top tube 130 can pivot around a transverse axis at or adjacent to the first head tube work point 170. The top tube 130 couples with the seat tube 125 such that the top tube 130 can pivot around a transverse axis at or adjacent to the first seat tube work point 175. The transverse axis of each connection at or adjacent to the first head tube work point 170 and the first seat tube work point 175 is normal (e.g., perpendicular) to a plane of the frame 105. For example, rotation of the top tube 130 around the transverse axis of its connection at or adjacent to either of the first head tube work point 170 or the first seat tube work point 175 is in the plane of the frame 105. The location of the first seat tube work point 175 can remain fixed with respect to the seat tube 125, and therefore each connection at or adjacent to the first seat tube work point 175 can remain stationary with respect to the seat tube 125. For example, as the seat post 128 retracts into the seat tube 125 or extends out of the seat tube 125, the location of the first seat tube work point 175 remains stationary and does not move with the seat post 128. The location of the first head tube work point 170 remains fixed with respect to the head tube assembly 120, and therefore each connection at or adjacent to the first head tube work point 170 can remain stationary with respect to the head tube assembly 120. For example, as the steer tube 124 rotates around its longitudinal axis through the head tube 122, the location of the first head tube work point 170 remains stationary and does not move with the steer tube 124. As such, any connection point at or adjacent to the work points (e.g., 170, 175) also remain stationary.

[0032] In some embodiments, another member extends between the head tube assembly 120 and the seat tube 125. For example, the down tube 135 extends between the head tube assembly 120 and the seat tube 125. The down tube 135 may be single member. For example, the down tube 135 may be a single pipe extending between the head tube assembly 120 and the seat tube 125. In other embodiments, the down tube 135 comprises a plurality of members. A front end of the down tube 135 couples with the head tube assembly 120. The down tube 135 couples with the head tube assembly 120 at a second head tube location, shown as second head tube work point 180. The second head tube work point 180 may be closer to the bottom end of the head tube assembly 120 than the top end of the head tube assembly 120. For example, the second head tube work point 180 is disposed a first distance from a top end of the head tube assembly 120 and is disposed a second distance from the bottom end of the head tube assembly 120. The first distance is larger than the second distance. In some embodiments, the second head

tube work point 180 is at the bottom end of the head tube 122. The second head tube work point 180 is disposed closer to the bottom end of the head tube assembly 120 than the first head tube work point 170. For example, the first head tube work point 170 is disposed a first distance from the top end of the head tube assembly 120 and the second head tube work point 180 is disposed a second distance from the top end of the head tube assembly 120, wherein the first distance is smaller than the second distance. In some embodiments, the first head tube work point 170 is disposed on an upper head tube and the second head tube work point 180 is disposed on a lower head tube, as described in more detail herein. In some embodiments, both the first and second head tube work points 170, 180 are disposed on the head tube 122.

[0033] A rear end of the down tube 135 couples with the seat tube 125. The down tube 135 couples with the seat tube 125 at a second seat tube location, shown as second seat tube work point 185. The second seat tube work point 185 may be positioned at a location where a bottom bracket shell of the bicycle 100 is located. For example, the down tube 135 may couple with the seat tube 125 at the same location as the bottom bracket shell of the bicycle 100. The second seat tube work point 185 may be closer to the bottom end of the seat tube 125 than the first seat tube work point 175. In some embodiments, the second seat tube work point 185 is at the bottom end of the seat tube 125.

[0034] The down tube 135 is pivotally coupled with the head tube assembly 120. The down tube 135 is pivotally coupled with the seat tube 125. For example, the down tube 135 couples with the head tube assembly 120 such that the down tube 135 can pivot around a transverse axis of its connection at or adjacent to the second head tube work point 180. The down tube 135 couples with the seat tube 125 such that the down tube 135 can pivot around a transverse axis of its connection at or adjacent to the second seat tube work point 175. The transverse axes of the connections at or adjacent to the second head tube work point 180 and the transverse axes of the connections at or adjacent to the second seat tube work point 185 are normal (e.g., perpendicular) to a plane of the frame 105. For example, rotation of the down tube 135 around either the transverse axis of its connection at or adjacent to the second head tube work point 180 and/or the transverse axis of its connection at or adjacent to the second seat tube work point 185 is in the plane of the frame 105. A location of the second seat tube work point 185 remains fixed with respect to the seat tube 125. A location of the second head tube work point 180 remains fixed with respect to the head tube assembly 120. In some embodiments, the second seat tube work point 185 is disposed at a same location as a bottom bracket shell.

[0035] In some embodiments, another member extends between the head tube assembly 120 and the seat tube 125. For example, the brace tube 140 extends between the head tube assembly 120 and the seat tube 125. The brace tube 140 may be single member. For example, the brace tube 140 may be a single pipe extending between the head tube assembly 120 and the seat tube 125. In other embodiments, the brace tube 140 comprises a plurality of members. A front end of the brace tube 140 couples with the head tube assembly 120. The brace tube 140 couples with the head tube assembly 120 at the second head tube work point 180. For example, the brace tube 140 couples with the head tube assembly 120 at the same location as the down tube 135. A rear end of the brace tube 140 couples with the seat tube 125. The brace

tube **140** couples with the seat tube **125** at the first seat tube work point **175**. For example, the brace tube **140** couples with the seat tube **125** at the same location as the top tube **130**.

[0036] As shown in FIG. 2, among others, the brace tube **140** may couple with the head tube assembly **120** and the seat tube **125** at different locations. For example, the brace tube **140** couples with the head tube assembly **120** at the first head tube work point **170**. The brace tube **140** couples with the seat tube **125** at the second seat tube work point **185**. In some embodiments, the brace tube **140** couples with the head tube assembly **120** at other locations. For example, the brace tube **140** couples with the head tube assembly **120** at a third head tube work point. The third head tube work point may be disposed between the first and/or second head tube work points **170**, **180**. The brace tube **140** pivotally couples with the head tube assembly **120**. The brace tube **140** pivotally couples with the seat tube **125**. For example, the brace tube **140** couples with the seat tube **125** such that the brace tube **140** can pivot around a transverse axis of its connection at or adjacent to the first seat tube work point **175**, the second seat tube work point **185**, or any other seat tube work point. The brace tube **140** couples with the head tube assembly **120** such that the brace tube **140** can pivot around a transverse axis of its connection at or adjacent to the first, second, or third head tube work points **170**, **180**, **505**. The transverse axis of each connection at or adjacent to each of the work points **170**, **175**, **180**, **185**, **505** may be normal (e.g., perpendicular) to a plane of the frame **105**. For example, rotation of the brace tube **140** around the transverse axis of either of its connections at or adjacent to any of the work points **170**, **175**, **180**, **185**, **505** may be in the plane of the frame **105**.

[0037] The frame **105** may include the top tube **130**, the down tube **135**, and the brace tube **140** extending between the head tube assembly **120** and the seat tube **125**. The frame **105** may also include more or less members extending between the head tube assembly **120** and the seat tube **125**.

[0038] The frame **105** includes at least one member connecting the seat tube **125** with the rear wheel **115**. For example, the frame **105** includes the seat stay **145**. The seat stay **145** extends between the seat tube **125** and the rear wheel **115**. The seat stay **145** couples with the rear wheel **115** via a rear wheel work point **190**. The rear wheel work point **190** may be a part of a hub of the rear wheel **115** or other central structure of the rear wheel **115**. The rear wheel work point **190** may be near or at the center of the rear wheel **115**. The seat stay **145** couples with the seat tube **125** at the first seat tube work point **175**. For example, the seat stay **145** may couple with the seat tube **125** at the same location as the top tube **130** and/or the brace tube **140**. In some embodiments, the seat stay **145** couples with the seat tube **125** at a different location. The seat stay **145** may be a single member. For example, the seat stay **145** may be a single pipe extending between the seat tube **125** and the rear wheel work point **190**. In some embodiments, the seat stay **145** comprises a plurality of members. For example, the seat stay **145** includes a first member extending on a first side of the rear wheel **115** and coupling with a first side of the rear wheel work point **190** and a second member extending on a second side of the rear wheel **115** and coupling with a second side of the rear wheel work point **190**. The first and second members of the seat stay **145** may couple with the seat tube **125** at the same location or at different locations. For example, the first and

second members of the seat stay **145** may couple with the seat tube **125** at the first seat tube work point **175**. The seat stay **145** may include a fork member (e.g., similar to the head tube assembly **120**) that extends along both sides of the rear wheel **115**.

[0039] The seat stay **145** pivotally couples with the seat tube **125**. The seat stay **145** pivotally couples with the rear wheel **115**. For example, the seat stay **145** couples with the seat tube **125** such that the seat stay **145** can pivot around a transverse axis of its connection at or adjacent to the first seat tube work point **175**. The seat stay **145** couples with the rear wheel **115** such that the seat stay **145** can pivot around a transverse axis of its connection at or adjacent to the rear wheel work point **190**. The transverse axis of each connection at or adjacent to the first seat tube work point **175** and the transverse axis of each connection at or adjacent to the rear wheel work point **190** is normal (e.g., perpendicular) to a plane of the frame **105**. For example, rotation of the seat stay **145** around the transverse axis of its connection at or adjacent to the first seat tube work point **175** or the transverse axis at or adjacent to the rear wheel work point **190** is in the plane of the frame **105**.

[0040] The frame **105** includes a chain stay **150**. The chain stay **150** extends between the seat tube **125** and the rear wheel **115**. The chain stay **150** couples with the rear wheel **115** at the rear wheel work point **190**. The chain stay **150** couples with the seat tube **125** at the second seat tube work point **185**. For example, the chain stay **150** couples with the seat tube **125** at the same location as the down tube **135**. In some embodiments, the chain stay **150** couples with the seat tube **125** at a different location. The chain stay **150** pivotally couples with the seat tube **125**. The chain stay **150** pivotally couples with the rear wheel **115**. For example, the chain stay **150** couples with the seat tube **125** such that the chain stay **150** can pivot around a transverse axis of its connection at or adjacent to the second seat tube work point **185**. The chain stay **150** couples with the rear wheel **115** such that the chain stay **150** can pivot around a transverse axis of its connection at or adjacent to the rear wheel work point **190**. The transverse axis of each connection at or adjacent to the second seat tube work point **185** and the transverse axis of each connection at or adjacent to the rear wheel work point **190** is normal (e.g., perpendicular) to a plane of the frame **105**. For example, rotation of the chain stay **150** around the transverse axis of its connection at or adjacent to the second seat tube work point **185** or the transverse axis of its connection at or adjacent to the rear wheel work point **190** is in the plane of the frame **105**.

[0041] In some embodiments, all of the work points may pivotally couple the members of the frame **105** to each other. For example, each connection at or adjacent to a work point may be a pivot joint (e.g., a pin joint, knuckle joint, revolute joint, hinge joint, cylindrical joint, ball joint, etc.). The pivot joint may provide relative rotation around a single axis and have one degree of freedom. Other pivot joints may provide additional degrees of freedom. For example, the frame **105** includes a first head tube work point **170**, a second head tube work point **180**, a first seat tube work point **175**, a second seat tube work point **185**, a front wheel work point **160**, and a rear wheel work point **190**. Each of the connections at or adjacent to work points **160**, **170**, **175**, **180**, **185**, **190** may be a pivot joint that can be a loose connection. For example, the front end of the top tube **130** may have a loose connection with a transverse axis around which the top tube **130** can

pivot when not held in place by other members of the frame **105** or by external forces. For example, the top tube **130**, when not coupled with the other members, can pivot around the transverse axis of its connection at or adjacent to either the first head tube work point **170** or the first seat tube work point **175**. The transverse axis of a connection at or adjacent to a work point can be normal to a plane of the frame **105** such that rotation around said axis is within the plane of the frame **105**. A pivot joint may have a pin structure with a removable pin that may extend through an end of a member of the frame **105**. The pin can define an axis of rotation around which the member may pivot. Each connection at or adjacent to a work point may be a loose connection. A loose connection, in conjunction with the orientation of all the members of frame **105**, can reduce (e.g., minimize to a negligible value) the bending forces resisted by the members. Provided the cross-sectional dimensions of each member are adequate, resisting tensile and compressive forces alone are enough for the members to maintain the structure of the frame **105**.

[0042] In some embodiments, a subset of the connections at or adjacent to the work points can be loose pivot joints. For example, some of the pivot joints can be loose joints, some can be fixed (i.e. rigid), and some can include a fastener which can be tightened to prevent a member from excessive movement (e.g., vibrating around its neutral axis or moving in a longitudinal or transverse direction) or loosened to allow the connection to become a loose connection. The fastener can also be removable from the connection to facilitate disassembly of the frame **105**. The frame **105** can have any combination of loose and tightened connections. In some embodiments, all of the connections are tightened connections. In other embodiments, all of the connections are fixed.

[0043] The configuration of all the members of frame **105** allows each member to rely almost entirely on its tensile and/or compressive strength(s) to retain the structure of the frame **105** instead of its bending capacity. The configuration can also reduce the required dimensions of the members to retain the structure of the frame. Any material capable of resisting the loads applied to the multi-wheeled frame **105** can be used. For example, the members can be steel pipes. Steel members can, for example, range in diameter from 0.25 inches to 1 inch and in wall thickness from 0.028 inches to 0.058 inches. The members can also be, for example, aluminum pipes. Aluminum members can, for example, range in diameter from 0.25 inches to 1.5 inches and in wall thicknesses from 0.062 inches to 0.094 inches. For example, a steel member can be a pipe with a diameter of 0.5 inches and a wall thickness of 0.028 inches, and an aluminum member can be a pipe with a 0.625 inches diameter and a wall thickness of 0.062 inches. Moreover, the frame **105** does not require other structural features that add unnecessary weight to a bicycle (e.g., welded joints; members with large cross-sectional areas).

[0044] Referring now to FIGS. **3** and **4**, a side view of bicycle **100** is shown, according to exemplary embodiments. Bicycle **100** includes at least one rear suspension mechanism, shown as rear shock absorber **305**. The rear suspension mechanism may be any type of suspension system, including but not limited to a shock absorber, a linkage, and a spring. A frame **105** with any of the member configurations disclosed herein may include a rear shock absorber **305**. The rear shock absorber **305** may be disposed on any member of

the frame **105** disposed in the rear portion of the bicycle **100** (e.g., behind the seat tube **125**). For example, the seat stay **145** includes a rear shock absorber **305**. The rear shock absorber **305** may be disposed at any position along the seat stay **145**. For example, the rear shock absorber **305** is disposed proximate (e.g., within ten inches) to the first seat tube work point **175**. For example, the rear shock absorber **305** can be within six inches of the first seat tube work point **175**. In some embodiments, the rear shock absorber **305** is centered on the seat stay **145** or closer to the rear wheel work point **190**.

[0045] In some embodiments, the frame **105** includes a plurality of seat stays **145**. Each of the plurality of seat stays **145** may have a rear shock absorber **305**.

[0046] Referring now to FIGS. **5** and **6**, a side view of bicycle **100** is shown, according to exemplary embodiments. The frame **105** of the bicycle **100** can have various orientations of the brace tube **140**. For example, the brace tube **140** extends between the head tube assembly **120** and the seat tube **125**. A rear end of the brace tube **140** couples with at least one of the first seat tube work point **175** or the second seat tube work point **185**. In some embodiments, the front end of the brace tube **140** couples with the head tube assembly **120** at a third head tube work point **505**. The third head tube work point **505** may be disposed between the first and second head tube work points **170**, **180**. The third head tube work point **505** may be disposed closer to one of the first or second head tube work points **170**, **180** or disposed between the first and second head tube work points **170**, **180**.

[0047] In some embodiments, the head tube assembly **120** includes a joint **510**. The joint **510** may include a head tube joint and a steer tube joint. The head tube joint and the steer tube joint may be any kind of joint. For example, the head tube joint may be a hinge, and the steer tube joint may be a universal joint or a spherical gear. The combination of the head tube joint and the steer tube joint at joint **510** may facilitate the function of the steer tube **124**. For example, the steer tube joint may allow the steer tube **124** to pivot around an axis of the steer tube joint while the head tube joint prevents the steer tube **124** from pivoting around the steer tube joint outside the plane of the bicycle frame **105**. A boot on the head tube joint can protect the steer tube joint from external elements.

[0048] The joint **510** defines a first portion and a second portion of the head tube assembly **120**. The first portion is shown as upper portion **515** and the second portion is shown as lower portion **520**. The upper portion **515** includes an upper head tube **516** and an upper steer tube **517**. The upper steer tube **517** extends from the handle **155**, through the upper head tube **516** to the steer tube joint of the joint **510**. The lower portion **520** includes a lower head tube **521** and a lower steer tube **522**. The lower steer tube **522** extends from the steer tube joint of the joint **510** through the lower head tube **521** to the fork member **126**. The joint **510** comprising both the head tube joint and the steer tube joint facilitates movement between the upper portion **515** and the lower portion **520**. For example, the combination of the head tube joint and the steer tube joint allows the upper portion **515** to move relative to the lower portion **520**. For example, the upper portion **515** may remain stationary while the lower portion **520** pivots around joint **510** within the plane of the frame **105**. In some embodiments, at least one of the first and third head tube work points **170**, **505** is disposed on the upper portion **515** and the second head tube work point **180**

is disposed on the lower portion 520. The members 130, 135, and 140 may be oriented such that work points 170 and 505 are disposed on the upper portion 515 and work point 180 is disposed on the lower portion 520. The upper portion 515 may be longer than the lower portion 520.

[0049] Bicycle 100 may include at least one front suspension mechanism, shown as front extension spring 525. The front suspension mechanism may be any type of suspension system, including but not limited to an extension spring, a shock absorber, a linkage, etc. A frame 105 with any of the member configurations which include a head tube joint and a steer tube joint may also include a front extension spring 525. The front extension spring 525 may be disposed on any member of the frame 105 disposed in the front portion of the bicycle 100 (e.g., in front of the seat tube 125). For example, the front extension spring 525 is disposed on the down tube 135. The front extension spring 525 may be disposed at any position along the down tube 135. For example, the front extension spring 525 is disposed proximate to the front end of the down tube 135. For example, the front extension spring 525 may be within six inches of the front end of the down tube 135. In some embodiments, the front extension spring 525 is centered on the down tube 135 or closer to the rear end of the down tube 135. The front extension spring 525 may be the same as or different than the rear shock absorber 305. Bicycle 100 may include the front extension spring 525 whether the frame 105 has or does not have a joint 510 disposed along the head tube assembly 120.

[0050] Referring now to FIGS. 7 and 8, a side view of bicycle 100 is shown, according to exemplary embodiments. Bicycle 100 includes a plurality of suspension mechanisms. For example, Bicycle 100 includes a first suspension mechanism, shown as rear shock absorber 305, and a second suspension mechanism, shown as front extension spring 525. The rear shock absorber 305 is disposed on the seat stay 145. In some embodiments, the rear shock absorber 305 is disposed closer to a front end of the seat stay 145 than the rear end of the seat stay 145. The down tube 135 includes a front extension spring 525. In some embodiments, the front extension spring 525 can be disposed closer to a front end of the down tube 135 than a rear end of the down tube 135. For example, the front extension spring 525 is disposed proximate to the second head tube work point 180. For example, the front extension spring 525 may be within six inches of the second head tube work point 180.

[0051] Referring now to FIG. 9A, an isometric view of a three-wheeled vehicle (shown as delta tricycle 900) is shown, according to an exemplary embodiment. The delta tricycle 900 includes a frame 905. Frame 905 may be similar to frame 105. For example, frame 905 includes a head tube assembly 120, a seat tube 125, a top tube 130, a down tube 135, and a brace tube 140. The delta tricycle 900 includes a rear assembly 906. The rear assembly 906 can include the additional members described herein that are disposed, at least partially, behind the seat tube 125 of the delta tricycle 900. The delta tricycle 900 includes the front wheel 110, a first rear wheel, shown as left rear wheel 910, and a second rear wheel, shown as right rear wheel 915. The delta tricycle 900 includes a rear assembly 906. The rear assembly 906 can include additional members of the frame 905 as described herein that are disposed, at least partially, behind the seat tube 125 of the delta tricycle 900. The rear assembly 906 can include the members of the frame 905 that accommodate and control the two rear wheels 910, 915.

[0052] The left rear wheel 910 has an axis, shown as left rear wheel axis 935, and the right rear wheel 915 has an axis, shown as right rear wheel axis 940. The left rear wheel 910 is coupled to the frame 905 via the left rear wheel axis 935 and the right rear wheel 915 is coupled to the frame 905 via the right rear wheel axis 940. For example, the delta tricycle 900 may also include a rear axle 920. The rear axle 920 can extend between the left rear wheel axis 935 and the right rear wheel axis 940. The left rear wheel 910 and the right rear wheel 915 can couple to the frame 905 via the rear axle 920. For example, the left rear wheel 910 can couple to the frame 905 via a first end of the rear axle 920 and the right rear wheel 915 can couple to the frame 905 via a second end of the rear axle 920. The rear axle 920 can extend between the left rear wheel 910 and the right rear wheel 915 through a plurality of rear axle tubes. For example, the frame 905 can include a first rear axle tube, shown as left rear axle tube 922, a second rear axle tube, shown as middle rear axle tube 924, and a third rear axle tube, shown as right rear axle tube 926. The left rear axle tube 922 may include or define a first rear axle work point 960. The middle rear axle tube 924 may include or define a second rear axle work point 965. The right rear axle tube 926 may include or define a third rear axle work point 970. The rear axle 920 can extend through the left rear axle tube 922, the middle rear axle tube 924, and the right rear axle tube 926. In some embodiments, the frame 905 may include only a left rear axle tube 922 and a right rear axle tube 926. For example, the left rear axle tube 922 may extend between the second rear axle work point 965 and the first rear axle work point 960 (and may extend beyond the first rear axle work point 960). The right rear axle tube 926 may extend between the second rear axle work point 965 and the third rear axle work point 970 (and may extend beyond the third rear axle work point 970). As such, the left rear axle tube 922 may couple with the right rear axle tube 926 at the second rear axle work point 965.

[0053] The frame 905 also includes a first leg tube, shown as left leg tube 945, a seat stay, shown as seat stay 950, and a second leg tube, shown as right leg tube 955. A first end of the left leg tube 945 can be coupled to or integral with the left rear axle tube 922 at the first rear axle work point 960. The first rear axle work point 960 can be disposed proximate to a first end of the rear axle 920. A first end of the seat stay 950 can be coupled to or integral with the middle rear axle tube 924 at the second rear axle work point 965. The second rear axle work point 965 can be disposed proximate to a center of the rear axle 920. A first end of the right leg tube 955 can be coupled to or integral with the right rear axle tube 926 at a third rear axle work point 970. The third rear axle work point 970 can be disposed proximate to a second end of the rear axle 920. A second end of the seat stay 950 and a second end of each leg tube 945, 955 can be coupled to or integral with the seat tube 125. For example, the second end of the seat stay 950 and the second end of each leg tube 945, 955 may be coupled to the seat tube 125 via the first seat tube work point 175. The frame 905 further comprises a chain stay 150 that extends between the seat tube 125 and the rear axle. The chain stay 150 can extend between the second seat tube work point 185 and the second rear axle work point 965.

[0054] The frame 905 can further include a tail tube 975. The tail tube 975 is coupled to or integral with one of the left rear axle tube 922 (e.g., when rear gears are on the right side of the frame 905), the middle rear axle tube 924, or the right

rear axle tube **926** (e.g., when rear gears are on the left side of the frame **905**). For example, the tail tube **975** can couple to one of the left rear axle tube **922**, the middle rear axle tube **924**, or the right rear axle tube **926** via the second rear axle work point **965**. The tail tube **975** can extend from one of the left rear axle tube **922**, the middle rear axle tube **924**, or the right rear axle tube **926** in a rearward direction (e.g., away from a front of the delta tricycle **900**). The tail tube **975** can extend parallel to the chain stay **150**. The frame **905** can further include a first tail stay, shown as left tail stay **980**, and a second tail stay, shown as right tail stay **985**. A first end of the left tail stay **980** can couple to or be integral with the left rear axle tube **922**. For example, the first end of the left tail stay **980** can couple to the left rear axle tube **922** via the first rear axle work point **960**. A first end of the right tail stay **985** can couple to or be integral with the right rear axle tube **926**. For example, the first end of the right tail stay **985** can couple to the right rear axle tube **926** via the third rear axle work point **970**. A second end of the left tail stay **980** can couple to or be integral with a second end of the right tail stay **985** at a tail work point **990**. The tail tube **975** can couple to or be integral with the second end of each tail stay **980**, **985**. For example the tail tube **975** can couple to the tail stays **980**, **985** via the tail work point **990**.

[0055] The frame **905** of delta tricycle **900** can incorporate any frame configuration disclosed herein. For example, frame **905** can include any number of suspension mechanisms (e.g., shock absorber **305**, extension spring **525**) and may include the brace tube **140** disposed at any of the various orientations. The frame **905** may include a first rear shock absorber **305** disposed on the left leg tube **945**, a second rear shock absorber **305** disposed on the seat stay **950**, and a third rear shock absorber **305** disposed on the right leg tube **955**. In some embodiments, only the left leg tube **945** and the right leg tube **955** may have a rear shock absorber **305**. Frame **905** may also include a front extension spring **525** disposed on the down tube **135**.

[0056] The frame **905** may include one or more joints **928**. The joint **928** may be similar to the joint **510**. The joint **928** may be a constant velocity joint. The frame **905** may include a first and second joint **928** disposed on the rear axle **920** between the first rear axle work point **960** and the second rear axle work point **965** and a third and fourth joint **928** disposed on the rear axle **920** between the second rear axle work point **965** and the third rear axle work point **970**. The joints **928** may keep each rear wheel **910**, **915** in a substantially vertical position.

[0057] A rear end of the brace tube **140** may be coupled to the seat tube **125** via the first seat tube work point **175** and a front end of the brace tube **140** may be coupled to one of the second or third head tube work points **180**, **505**. In some embodiments, the rear end of the brace tube **140** may be coupled to the seat tube **125** via the second seat tube work point **185** and the front end of the brace tube **140** may be coupled to the first head tube work point **170**. Some or all of the connections between members of the frame **905** can include loose connections, as described herein.

[0058] As shown in FIGS. **9B** and **9C**, in some embodiments, the delta tricycle **900** may have no joints **928**. In some embodiments, a shock absorber **305** may be disposed on the seat stay **950**. The shock absorber **305** on the seat stay **950** can provide the delta tricycle **900** with a dependent suspension system. In some embodiments, the delta tricycle **900** may have no shock absorbers **305**.

[0059] Referring now to FIG. **10**, an isometric view of a three-wheeled vehicle (shown as tadpole tricycle **1000**) is shown, according to an exemplary embodiment. The tadpole tricycle **1000** includes a frame **1005**. Similar to delta tricycle **900**, tadpole tricycle **1000** can incorporate any frame configuration disclosed herein. For example, the frame **1005** may be similar to frame **105**. For example, frame **1005** includes a head tube assembly **120**, a seat tube **125**, a top tube **130**, a down tube **135**, and a brace tube **140**. The tadpole tricycle **1000** includes a first front wheel, shown as right front wheel **1010**, a second front wheel, shown as left front wheel **1015**, and a rear wheel **115**. The tadpole tricycle **1000** includes a front assembly **1006**. The front assembly **1006** can include additional members of the frame **1005** as described herein that are disposed proximate to a front of the tadpole tricycle **1000** (e.g., in front of the seat tube **125** and/or adjacent to the head tube assembly **120**). The front assembly **1006** can include the members of the frame **1005** that accommodate and control the two front wheels **1010**, **1015**.

[0060] The frame **1005** further includes a first front axle tube, shown as right front axle tube **1022**, and a second front axle tube, shown as left front axle tube **1024**. The right front axle tube **1022** may couple with the left front axle tube via the second head tube work point **180**. The right front axle tube **1022** can have a first stub axle, shown as right front stub axle **1025**, disposed at a first end of the right front axle tube **1022** and the left front axle tube **1024** can have a second stub axle, shown as left front stub axle **1030**, disposed at a first end of the left front axle tube **1024**. The right front stub axle **1025** can be coupled to the right front axle tube **1022** and the left front stub axle **1030** can be coupled to the left front axle tube **1024**. The right front wheel **1010** is coupled to the frame **1005** via the right front stub axle **1025**. The left front wheel **1015** is coupled to the frame **1005** via the left front stub axle **1030**.

[0061] The frame **1005** further includes a first arm tube, shown as right arm tube **1045** and a second arm tube, shown as left arm tube **1050**. A first end of the right arm tube **1045** can be coupled to or integral with the right front axle tube **1022** at a first front axle work point, shown as right front axle work point **1055**. The right front axle work point **1055** can be disposed proximate to a first end of the right front axle tube **1022**. A first end of the left arm tube **1050** can be coupled to or integral with the left front axle tube **1024** at a second front axle work point, shown as left front axle work point **1060**. The left front axle work point **1060** can be disposed proximate to a first end of the left front axle tube **1024**. A second end of each of the right arm tube **1045** and the left arm tube **1050** can be coupled to or integral with the head tube assembly **120**. For example, the second end of each arm tube **1045**, **1050** may be coupled to the head tube assembly **120** via the first head tube work point **170**.

[0062] The frame **1005** further includes a nose tube **1090**. The nose tube **1090** is coupled to the head tube **122**. For example, a first end of the nose tube **1090** can couple to the head tube **122** via the second head tube work point **180**. The nose tube **1090** can extend from the head tube **122** in a forward direction (e.g., away from a rear of the quadricycle **1100**). The nose tube **1090** can extend parallel to the down tube **135**. The frame **1105** can further include a first nose tube brace, shown as right nose tube brace **1092**, and a second nose tube brace, shown as left nose tube brace **1094**. The right nose tube brace **1092** can couple to the right front



axle tube **1022**. For example, a first end of the right nose tube brace **1092** can couple to the right front axle tube **1022** via the right front axle work point **1055**. The left nose tube brace **1094** can couple to the left front axle tube **1024**. For example, a first end of the left nose tube brace **1094** can couple to the left front axle tube **1024** via the left front axle work point **1060**. A second end of the nose tube **1090** can couple to or be integral with a second end of the right nose tube brace **1092** and a second end of the left nose tube brace **1094** at a nose tube work point **1096**.

[0063] The frame **1005** further includes a tie rod **1065**. The tie rod **1065** can be disposed behind the right nose tube brace **1092** and the left nose tube brace **1094**. The tie rod **1065** includes a first steer arm, shown as right steer arm **1070**, and a second steer arm, shown as left steer arm **1075**. The right steer arm **1070** can couple to the right front stub axle **1025** at or adjacent to the right front axle work point **1055**. The left steer arm **1075** can couple to the left front stub axle **1030** at or adjacent to the left front axle work point **1060**. A bottom end of the steer tube **124** (or the lower steer tube **522**) can couple to the tie rod **1065** at a tie rod work point **1080**. The tie rod work point **1080** can be disposed proximate to a center of the tie rod **1065**. In some embodiments, the tie rod work point **1080** divides the tie rod **1065** into a first portion and a second portion. The first portion of the tie rod **1065** can be coupled to the second portion of the tie rod **1065** via the tie rod work point **1080**. The steer tube **124**, tie rod **1065**, right steer arm **1070**, left steer arm **1075**, right front stub axle **1025**, and left front stub axle **1030** can facilitate steering of the tadpole tricycle **1000**. The couplings between the steer tube **124**, tie rod **1065**, right steer arm **1070**, left steer arm **1075**, right front stub axle **1025**, and left front stub axle **1030** can be any coupling that facilitates movement between the components to properly steer the tadpole tricycle **1000**. For example, the frame **1005** can include a plurality of ball joints to allow the steer tube **124** to control movement of the right front wheel **1010** and the left front wheel **1015**. A ball joint can be disposed, for example, where the right steer arm **1070** couples to the tie rod **1065**, where the left steer arm **1075** couples to the tie rod **1065**, and on either side of where the steer tube **124** couples to the tie rod **1065**. A hinge may be disposed on the right front stub axle **1025** and the left front stub axle **1030** proximate to the right front axle work point **1055** and the left front axle work point **1060**. The steer tube **124**, the tie rod **1065**, and the tie rod work point **1080** may comprise a rack and pinion steering mechanism such that when the steer tube **124** rotates, the steer tube **124** rotates a pinion, which in turn engages gears of a rack (e.g., the tie rod **1065**) and turns the front wheels **1010**, **1015**. Some or all of the connections between members of the frame **1005** can include loose connections, as described herein.

[0064] Referring now to FIG. **11**, an isometric view of a four-wheeled vehicle (shown as quadricycle **1100**) is shown, according to an exemplary embodiment. The quadricycle **1100** includes a frame **1105**. The frame members of the bicycle **100** and tricycles **900**, **1000** can be combined to create the frame **1105**. For example, the quadricycle **1100** can include a rear assembly **906** and a front assembly **1006**. For example, the quadricycle **1100** can include the two front wheels **1010**, **1015** and the two rear wheels **910**, **915** as well as the accompanying members. For example, the frame **1105** can include the rear axle **920**, the seat stay **950**, the leg tubes **945**, **955**, the tail tube **975**, and the tail stays **980**, **985** to accommodate the rear wheels **910**, **915**. The frame **1105** can

include the right front axle tube **1022** and left front axle tube **1024**, the arm tubes **1045**, **1050**, the tie rod **1065**, the steer arms **1070**, **1075**, the nose tube **1090**, and the nose tube braces **1092**, **1094** to accommodate the front wheels **1010**, **1015**. The frame **1105** can include the head tube assembly **120**, the seat tube **125**, the top tube **130**, the down tube **135**, and the brace tube **140** to connect the front wheels **1010**, **1015** to the rear wheels **910**, **915**.

[0065] Referring now to FIG. **12**, an isometric view of quadricycle **1100** is shown, according to an exemplary embodiment. The frame **1105** of quadricycle **1100** can incorporate any frame configuration disclosed herein. For example, frame **1105** can include any number of suspension mechanisms (e.g., shock absorber **305**, extension spring **525**) and may include the brace tube **140** disposed at any of the various orientations. For example, the frame **1105** may include a first rear shock absorber **305** disposed on the left leg tube **945**, a second rear shock absorber **305** disposed on the seat stay **950**, and a third rear shock absorber **305** disposed on the right leg tube **955**. Frame **1105** may include a first shock absorber **305** disposed on the left arm tube **1050** and a second shock absorber **305** disposed on the right arm tube **1045**. A rear end of the brace tube **140** may be coupled to the seat tube **125** via the first seat tube work point **175** and a front end of the brace tube **140** may be coupled to one of the second or third head tube work points **180**, **505**. In some embodiments, the rear end of the brace tube **140** may be coupled to the seat tube **125** via the second seat tube work point **185** and the front end of the brace tube **140** may be coupled to the first head tube work point **170**. Some or all of the connections between members of the frame **1105** can include loose connections, as described herein.

[0066] Any vehicle, including the vehicles described herein (e.g., bicycle **100**, delta tricycle **900**, tadpole tricycle **1000**, quadricycle **1100**) can include a seat **165**. The seat **165** can be coupled to or integrated with the seat post **128**. As shown in FIG. **12**, among others, the seat **165** can have an elongated shape. For example, the seat **165** can have a (lateral) length **1205** and a (longitudinal) width **1210**. The length **1205** can be longer than the width **1210**. In some embodiments, the length **1205** can be four times as long as the width **1210**. For example, the length **1205** can be approximately 13 inches (+/-1 inch) and the width **1210** can be approximately 3 inches (+/-1 inch). The seat **165** can have any shape. For example, the seat **165** can have a cylindrical shape. Seat **165** can extend along a single central axis **1215**. The seat **165** can extend symmetrically around the central axis **1215**. For example, a cross-sectional shape of the seat **165** can be symmetric with respect to the central axis **1215**. The seat **165** can extend substantially perpendicular (+/-10%) to a plane of the frame. For example, the seat **165** can extend substantially perpendicular to at least one of the top tube **130**, the brace tube, **140**, or the down tube **135**. For example, the length **1205** of the seat **165** can be perpendicular to the top tube **130**.

[0067] Referring now to FIG. **13**, a pivotally coupled work joint **1300** is shown, according to an exemplary embodiment. The pivotally coupled work joint **1300** is an example pivot joint that can be disposed at a work point. Any other pivot joint can also be used to provide the desired pivotable connection points. The pivotally coupled work joint **1300** may be disposed at any of the work points described herein (e.g., first head tube work point **170**, first seat tube work point **175**, etc.). The pivotally coupled work joint **1300**

includes a first frame member **1305** (e.g., the head tube **122**, the seat tube **125**) that has at least one tab plate **1310** that extends away from the first frame member **1305**. The tab plate **1310** has at least one opening **1315** (e.g., a circular hole or aperture) that extends through the tab plate **1310**. A second frame member **1320** has a clevis rod end **1325** configured to extend around the tab plate **1310**. For example, the clevis rod end **1325** can include a first prong **1330** that extends along a first side of the tab plate **1310** and a second prong **1335** that extends along a second side of the tab plate **1310**. The clevis rod end **1325** has an aperture **1340** that extends through both prongs **1330**, **1335**. The aperture **1340** is configured to align with the opening **1315** of the tab plate **1310**. A pin **1345** is configured to extend through the clevis rod end and the tab plate **1310** when the opening **1315** is aligned with the aperture **1340**. For example, the pin **1345** can extend through the aperture **1340** of the first prong **1330**, the opening of the tab plate **1310**, and the aperture **1340** of the second prong **1335** to couple the tab plate **1310** and the clevis rod end **1325** together. A cotter pin **1350** extends through a hole of the pin **1345** perpendicular to an axis **1355** of the pin **1345**, to prevent the pin **1345** from being retracted after insertion through the opening **1315** and the aperture **1340**. The pin **1345** allows for a loose connection point between the frame members. For example, the pin **1345** facilitates rotation of the second frame member **1320** around the axis **1355**. Such rotation can be in the same plane as the first frame member **1305**. The use of a cotter pin **1350** allows for retraction of the pin **1345** from the clevis rod end **1325** to facilitate disassembly of the frame **105**, **905**, **1005** without the use of tools.

[0068] Referring now to FIG. 14, a method **1400** for assembling a multi-wheeled vehicle frame is shown, according to an exemplary embodiment. Method **1400** can be for assembling bicycle **100**, delta tricycle **900**, tadpole tricycle **1000**, and quadricycle **1100**. Method **1400** includes coupling a top tube **130** with a seat tube **125** and a head tube assembly **120** (step **1405**), coupling a down tube **135** with the seat tube **125** and the head tube assembly **120** (step **1410**), and coupling a brace tube **140** with the seat tube **125** and the head tube assembly **120** (step **1415**). Step **1405** may include pivotally coupling the top tube **130** with the seat tube **125** and pivotally coupling the top tube **130** with the head tube assembly **120**. The top tube **130** may be coupled with the head tube assembly **120** at a first head tube work point **170**. The top tube **130** may be coupled with the seat tube **125** at a first seat tube work point **175**.

[0069] Step **1410** may include pivotally coupling the down tube **135** with the seat tube **125** and pivotally coupling the down tube **135** with the head tube assembly **120**. The down tube **135** may be coupled with the head tube assembly **120** at a second head tube work point **180**. The down tube **135** may be coupled with the seat tube **125** at a second seat tube work point **175**.

[0070] Step **1415** may include pivotally coupling the brace tube **140** with the seat tube **125** and pivotally coupling the brace tube **140** with the head tube assembly **120**. The brace tube **140** may couple with the seat tube **125** at one of the first seat tube work point **175** or the second seat tube work point **185**. The brace tube **140** may couple with the head tube assembly **120** at the first head tube work point **170**, the second head tube work point **180**, or at a third head tube work point **505**.

[0071] Method **1400** may also include coupling additional members to the frame **105**. For example, method **1400** may include coupling a seat stay **145** and/or a chain stay **150** with the seat tube **125**. The seat stay **145** and the chain stay **150** may be pivotally coupled with the seat tube **125**.

[0072] Method **1400** may also include providing at least one shock absorber **305** or extension spring **525**. For example, method **1400** may include providing at least one of a shock absorber **305** to the seat stay **145** or an extension spring **525** to the down tube **135**. The shock absorber **305** may be disposed closer to a front end of the seat stay **145** than a rear end of the seat stay **145**. The extension spring **525** may be disposed closer to a front end of the down tube **135** than a rear end of the down tube **135**.

[0073] Method **1400** may also include separating the head tube assembly **120** into a first (e.g., upper) portion **515** and a second (e.g., lower) portion **520** by disposing a joint **510** in the head tube assembly **120**. The joint **510** can be any kind of joint **510** (e.g., a hinge, a universal joint).

[0074] As utilized herein, the terms “approximately,” “about,” “around,” “substantially”, and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the disclosure as recited in the appended claims.

[0075] It should be noted that the term “exemplary” and variations thereof, as used herein to describe various embodiments, are intended to indicate that such embodiments are possible examples, representations, or illustrations of possible embodiments (and such terms are not intended to connote that such embodiments are necessarily extraordinary or superlative examples).

[0076] The term “coupled” and variations thereof, as used herein, means the joining of two members directly or indirectly to one another. Such joining may be stationary (e.g., permanent or fixed) or moveable (e.g., removable or releasable). Such joining may be achieved with the two members coupled directly to each other, with the two members coupled to each other using a separate intervening member and any additional intermediate members coupled with one another, or with the two members coupled to each other using an intervening member that is integrally formed as a single unitary body with one of the two members. If “coupled” or variations thereof are modified by an additional term (e.g., directly coupled), the generic definition of “coupled” provided above is modified by the plain language meaning of the additional term (e.g., “directly coupled” means the joining of two members without any separate intervening member), resulting in a narrower definition than the generic definition of “coupled” provided above. Such coupling may be mechanical, electrical, or fluidic.

[0077] The term “or,” as used herein, is used in its inclusive sense (and not in its exclusive sense) so that when used to connect a list of elements, the term “or” means one, some, or all of the elements in the list. Conjunctive language such as the phrase “at least one of X, Y, and Z,” unless

specifically stated otherwise, is understood to convey that an element may be either X; Y; Z; X and Y; X and Z; Y and Z; or X, Y, and Z (i.e., any combination of X, Y, and Z). Thus, such conjunctive language is not generally intended to imply that certain embodiments require at least one of X, at least one of Y, and at least one of Z to each be present, unless otherwise indicated.

**[0078]** References herein to the positions of elements (e.g., “top,” “bottom,” “in front,” “behind,” “above,” “below”) are merely used to describe the orientation of various elements in the FIGURES. For example, the orientation can be based on a perspective of a user facing a front of the multi-wheeled vehicle. It should be noted that the orientation of various elements may differ according to other exemplary embodiments, and that such variations are intended to be encompassed by the present disclosure.

**[0079]** Although the figures and description may illustrate a specific order of method steps, the order of such steps may differ from what is depicted and described, unless specified differently above. In addition, two or more steps may be performed concurrently or with partial concurrence, unless specified differently above. Such variation may depend, for example, on the software and hardware systems chosen and on designer choice. All such variations are within the scope of the disclosure.

**[0080]** It is important to note that the construction and arrangement of the bicycle **100** and the systems and components thereof as shown in the various exemplary embodiments is illustrative only. Additionally, any element disclosed in one embodiment may be incorporated or utilized with any other embodiment disclosed herein. Although only one example of an element from one embodiment that can be incorporated or utilized in another embodiment has been described above, it should be appreciated that other elements of the various embodiments may be incorporated or utilized with any of the other embodiments disclosed herein.

**1.-20.** (canceled)

**21.** A frame for a multi-wheeled vehicle, the frame comprising:

- a head member;
- a seat member disposed away from the head member;
- a top member pivotally coupled to the seat member and pivotally coupled to the head member;
- a brace member pivotally coupled to the seat member and pivotally coupled to the head member; and
- a down member pivotally coupled to the seat member and pivotally coupled to the head member.

**22.** The frame of claim **21**, wherein:

- the top member is pivotally coupled to the seat member at a first seat member work point and pivotally coupled to the head member at a first head member work point;
- the down member is pivotally coupled to the seat member at a second seat member work point and pivotally coupled to the head member at a second head member work point; and
- the brace member is pivotally coupled to the seat member at the second seat member work point and pivotally coupled to the head member at the first head member work point.

**23.** The frame of claim **21**, wherein the frame defines a plane extending through the head member, the seat member, the top member, and the brace member, the frame further comprising:

a seat post extending into the seat member, wherein the seat post is coupled to a seat, wherein the seat comprises an elongated shape having a first elongated portion extending outwardly from the plane and a second elongated portion extending outwardly from the plane opposite the first elongated portion.

**24.** The frame of claim **21**, wherein:

- the top member is pivotally coupled to the seat member at a first seat member work point and pivotally coupled to the head member at a first head member work point;
- the down member is pivotally coupled to the seat member at a second seat member work point and pivotally coupled to the head member at a second head member work point; and
- the brace member is pivotally coupled to the seat member at the first seat member work point and pivotally coupled to the head member at the second head member work point.

**25.** The frame of claim **24**, further comprising a front assembly, the front assembly comprising:

- a first front axle member pivotally coupled to the head member at the second head member work point;
  - a second front axle member pivotally coupled to the head member at the second head member work point, the second front axle member opposite the first front axle member;
  - a first arm member pivotally coupled to the head member at the first head member work point and pivotally coupled to the first front axle member at a first front axle work point;
  - a second arm member pivotally coupled to the head member at the first head member work point and pivotally coupled to the second front axle member at a second front axle work point;
  - a nose member pivotally coupled to the head member at the second head member work point, wherein the nose member extends away from the down member;
  - a first nose brace member pivotally coupled to the first front axle member at the first front axle work point and pivotally coupled to the nose member at a nose member work point; and
  - a second nose brace member pivotally coupled to the second front axle member at the second front axle work point and pivotally coupled to the nose member at the nose member work point;
- wherein the front assembly couples a plurality of front wheels to the frame.

**26.** The frame of claim **25**, wherein the front assembly further comprises:

- a steer member comprising a first end and a second end, wherein the first end of the steer member is coupled to a handle and the second end of the steer member is coupled to a tie rod, the tie rod comprising a first steer arm and a second steer arm, wherein:
- the first steer arm is coupled to a first front stub axle, wherein the first front stub axle is pivotally coupled to the first front axle member at or adjacent to the first front axle work point; and
- the second steer arm is coupled to a second front stub axle, wherein the second front stub axle is pivotally coupled to the second front axle member at or adjacent to the second front axle work point.

**27.** The frame of claim **21**, wherein:  
the top member is pivotally coupled to the head member at a first head member work point;  
the down member is pivotally coupled to the head member at a second head member work point;  
the head member comprises a first portion and a second portion; and  
the first head member work point and a third head member work point are disposed on the first portion and the second head member work point is disposed on the second portion.

**28.** The frame of claim **27**, wherein:  
the top member is pivotally coupled to the seat member at a first seat member work point;  
the down member is pivotally coupled to the seat member at a second seat member work point; and  
the brace member is pivotally coupled to the seat member at the second seat member work point and pivotally coupled to the head member at the third head member work point.

**29.** The frame of claim **27**, wherein:  
the top member is pivotally coupled to the seat member at a first seat member work point;  
the down member is pivotally coupled to the seat member at a second seat member work point; and  
the brace member is pivotally coupled to the seat member at the first seat member work point and pivotally coupled to the head member at the third head member work point.

**30.** The frame of claim **29**, further comprising a seat stay and a chain stay, the seat stay pivotally coupled to the seat member at the first seat member work point and pivotally coupled to a rear wheel work point, and the chain stay pivotally coupled to the seat member at the second seat member work point and pivotally coupled to the rear wheel work point.

**31.** The frame of claim **30**, further comprising a rear shock absorber coupled to the seat stay.

**32.** The frame of claim **30**, further comprising:  
a fork member; and  
a steer member coupled to the fork member, the steer member comprising:  
an upper steer member coupled to a handle and a joint, the upper steer member extending through an upper head member of the head member; and  
a lower steer member coupled to the joint and the fork member, the lower steer member extending through a lower head member of the head member;

wherein the fork member couples a front wheel to the frame.

**33.** The frame of claim **32**,  
further comprising a front suspension mechanism coupled to the down member.

**34.** The frame of claim **30**, further comprising a rear assembly, the rear assembly comprising:

a plurality of rear axle members comprising a first rear axle member, a second rear axle member, and a third rear axle member;

a plurality of leg members pivotally coupled to the seat member at the first seat member work point and each of the plurality of leg members pivotally coupled to one of the plurality of rear axle members;

a tail member pivotally coupled to the chain stay at a rear axle work point, wherein the tail member extends away from the chain stay;

a first tail brace member pivotally coupled to the second rear axle member and pivotally coupled to the tail member at a tail work point; and

a second tail brace member pivotally coupled to the third rear axle member and pivotally coupled to the tail member at the tail work point;

wherein the rear assembly couples a plurality of rear wheels to the frame.

**35.** The frame of claim **34**,  
further comprising a plurality of pivot joints disposed at or adjacent to at least one of:  
the first or second seat member work points,  
the first, second, or third head member work points,  
a first or second front axle work point,  
a nose member work point,  
the rear wheel work point,  
a first or second rear axle work point, or  
the tail work point;

wherein each of the plurality of pivot joints comprises a pin that defines an axis of rotation for at least one of the top member, the down member, the brace member, a first front axle member, a second front axle member, a first arm member, a second arm member, a nose member, a first nose brace member, a second nose brace member, the first rear axle member, the second rear axle member, the third rear axle member, the plurality of leg members, the tail member, the first tail brace member, or the second tail brace member.

**36.** The frame of claim **35**, wherein the plurality of leg members comprise a first leg member and a second leg member, the frame further comprising: a first shock absorber coupled to the first leg member; and

a second shock absorber coupled to the second leg member.

**37.** A method to assemble a multi-wheeled vehicle, the method comprising:

pivotaly coupling a top member to a seat member and a head member;

pivotaly coupling a down member to the seat member and the head member; and

pivotaly coupling a brace member to the seat member and the head member.

**38.** The method of claim **37**, further comprising:  
pivotaly coupling the top member to the seat member at a first seat member work point;

pivotaly coupling the top member and the brace member to the head member at a first head member work point;

pivotaly coupling the down member to the head member at a second head member work point; and

pivotaly coupling the down member and the brace member to the seat member at a second seat member work point.

**39.** The method of claim **37**, further comprising:

pivotaly coupling the top member and the brace member to the seat member at a first seat member work point;

pivotaly coupling the top member to the head member at a first head member work point;

pivotaly coupling the down member and the brace member to the head member at a second head member work point; and

pivotaly coupling the down member to the seat member at a second seat member work point.

**40.** A multi-wheeled vehicle comprising:  
a head member;  
a seat member disposed away from the head member;  
a top member pivotally coupled to the seat member and  
pivotally coupled to the head member;  
a brace member pivotally coupled to the seat member and  
pivotally coupled to the head member; and  
a down member pivotally coupled to the seat member and  
pivotally coupled to the head member;  
a seat stay having a first end and a second end, the first end  
of the seat stay coupled to the seat member at a first  
location;  
a chain stay having a first end and a second end, the first  
end of the chain stay coupled to the seat member at a  
second location and the second end of the chain stay  
coupled to the second end of the seat stay.

\* \* \* \* \*