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(54) TENSIONER DEVICE TO ACCOUNT FOR VIRTUAL CHAIN GROWTH IN INTERNALLY GEARED HIGH PIVOT POINT REAR SUSPENSION BICYCLES

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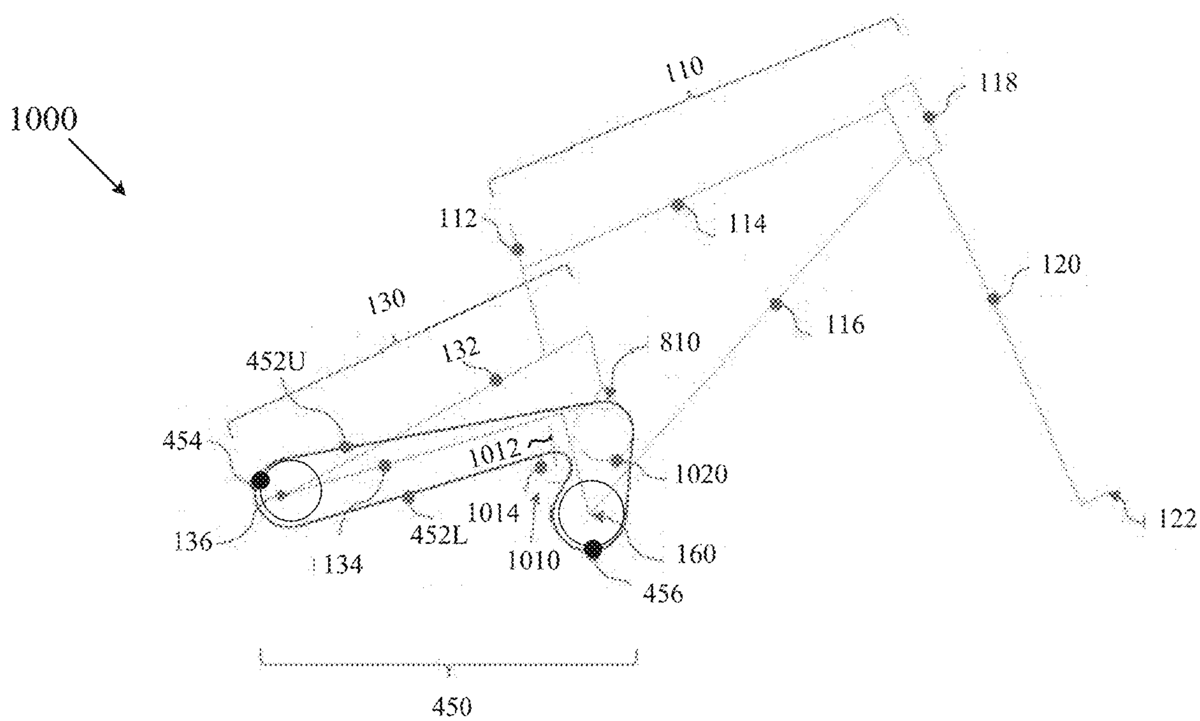
(52) U.S. Cl.
CPC .................................... *B62M 9/16* (2013.01)

(57) **ABSTRACT**

A rear suspension bicycle having a suspension pivot point sufficiently above a crank axis (front sprocket/chainring) to provide predominantly rearward axle path and require an idler pulley to route a drive belt/chain. A tensioner is located between the idler pulley and the front sprocket/chainring to accommodate virtual chain growth and maintain appropriate tension on drive belt/chain. The tensioner includes a pivoting member with a pulley mounted thereto, a spring arm connected to the pivoting member at a defined angle, and a spring located between the spring arm and a frame. The pivoting member/pulley pivot away from the suspension pivot point to accommodate the virtual chain growth created when vertical rear wheel travel of bicycle increases. The pivoting member/pulley pivot back toward the suspension pivot point to maintain appropriate tension when vertical rear wheel travel decreases. A spring returning to its steady state size (e.g., expanding) is used to maintain tension.



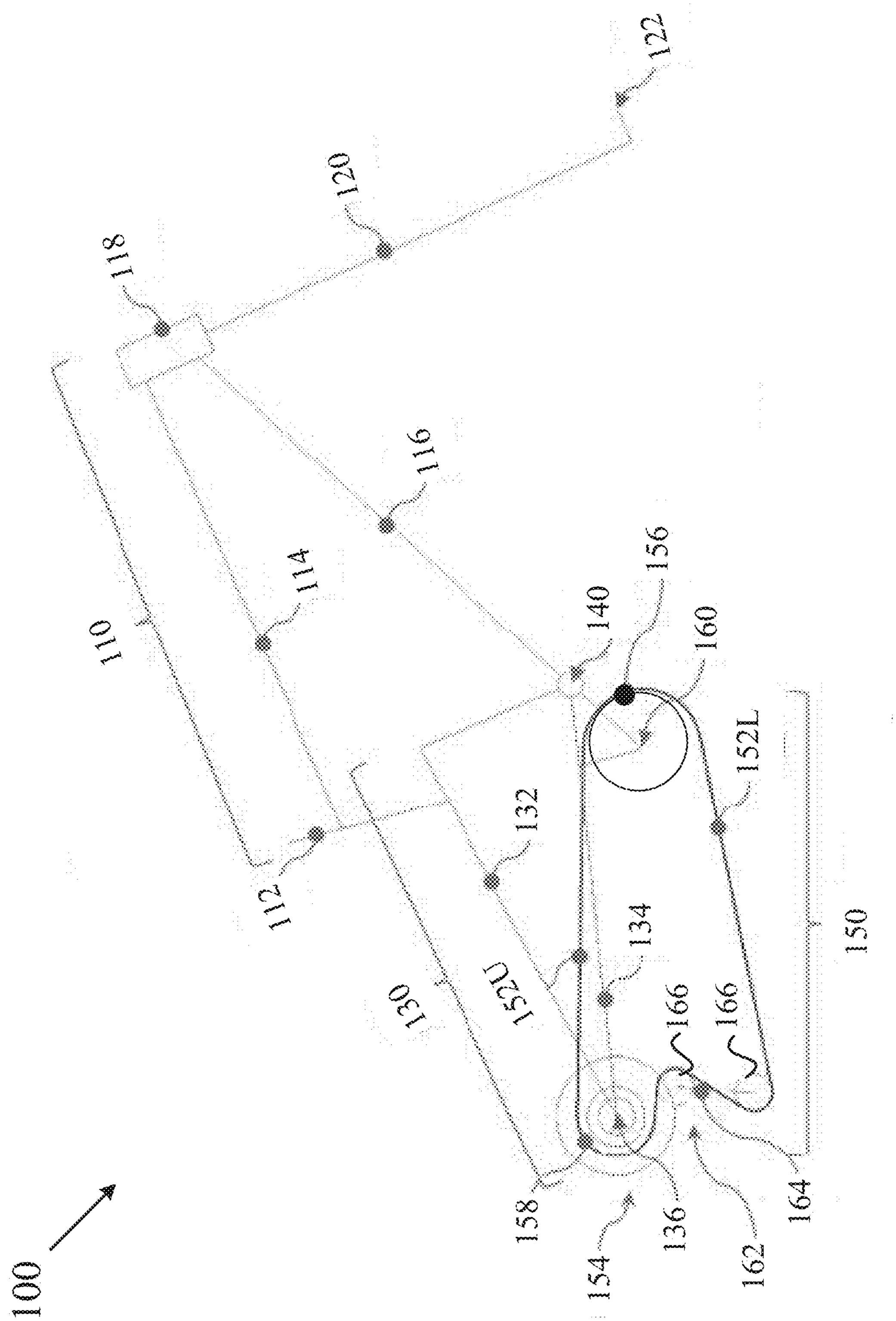



FIG. 1
(Prior Art)

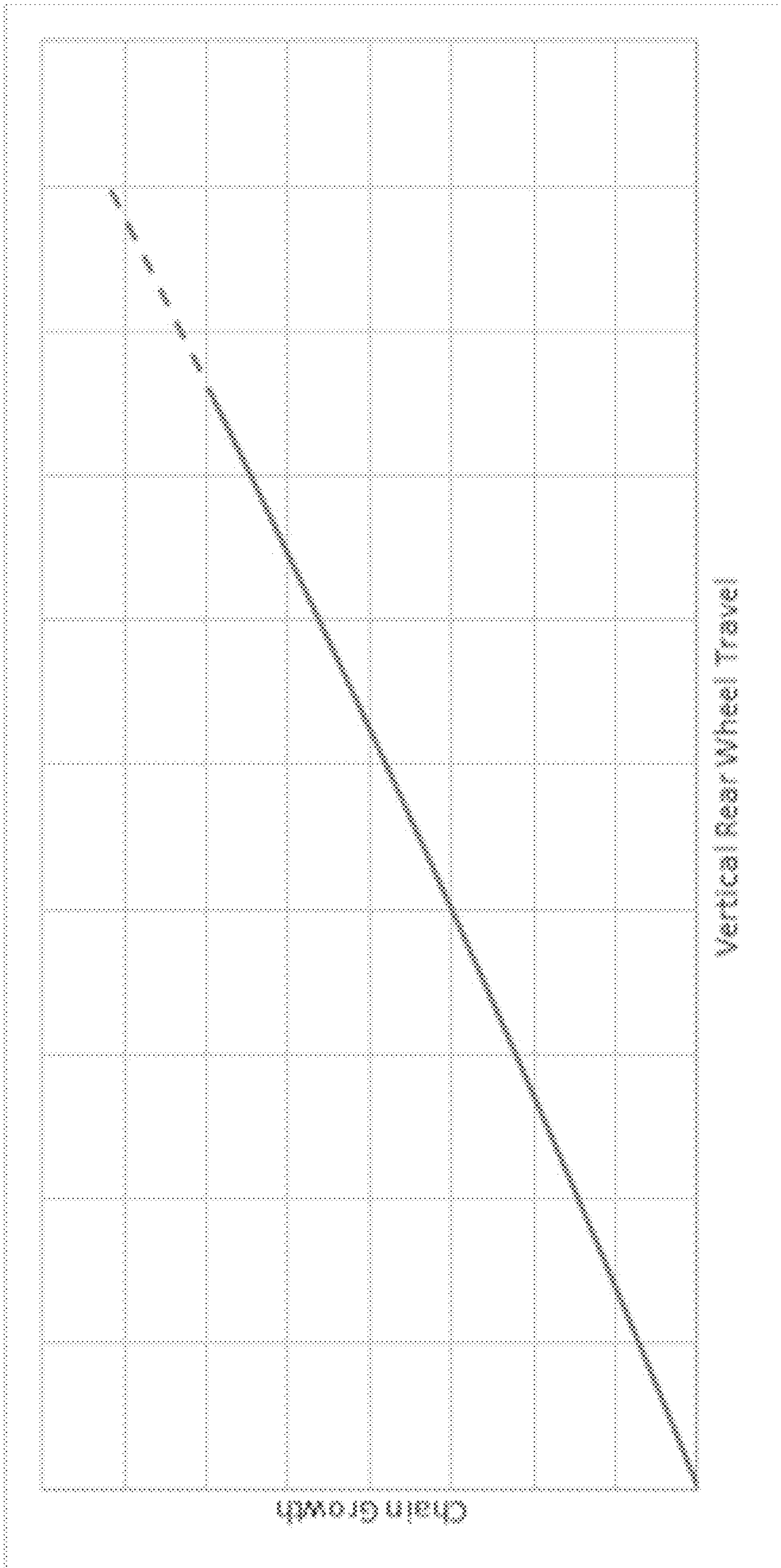



FIG. 2

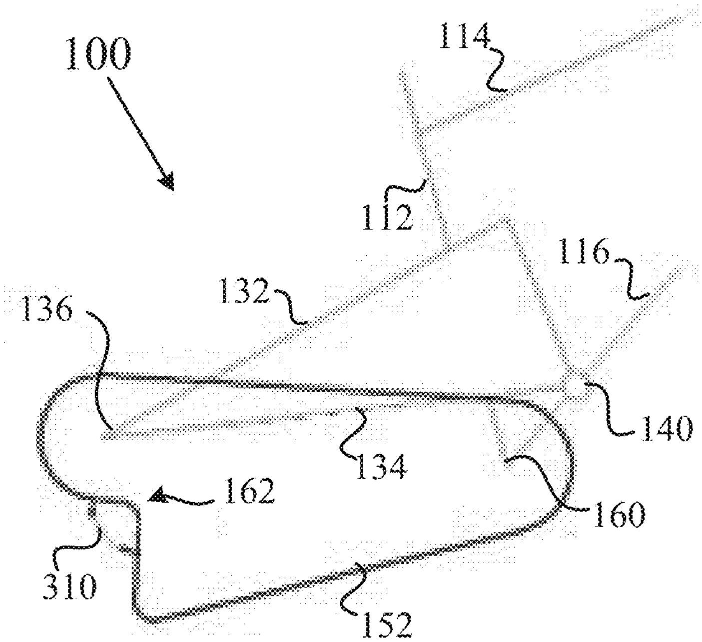



FIG. 3A
(Prior Art)

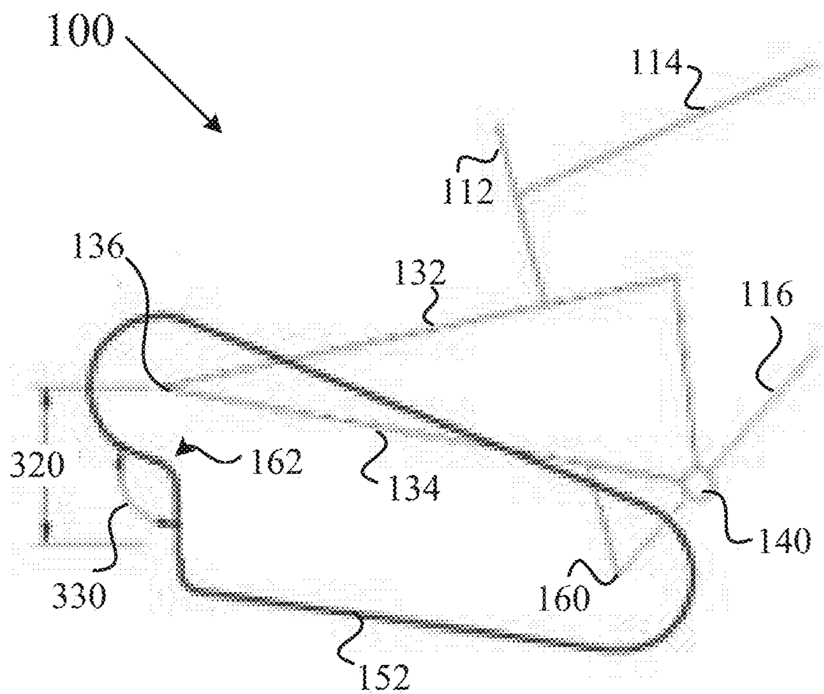



FIG. 3B
(Prior Art)

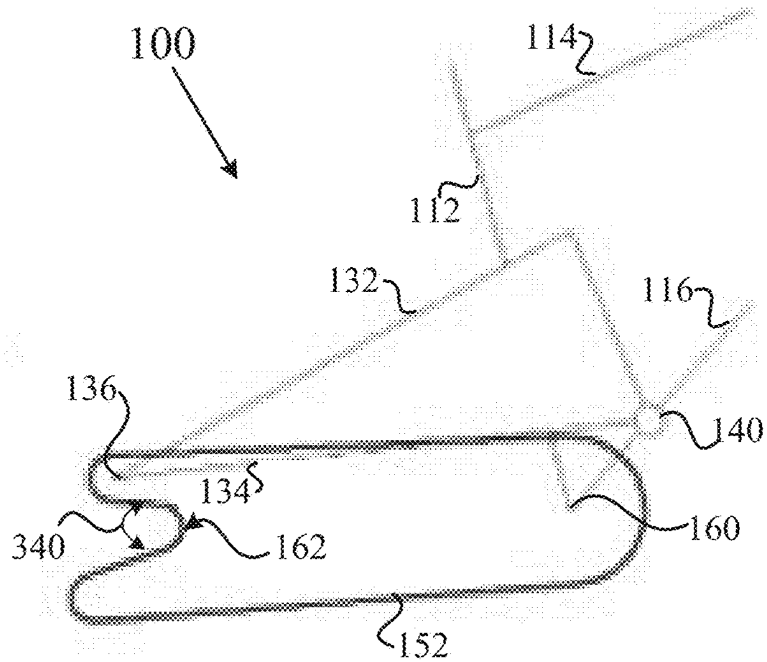



FIG. 3C
(Prior Art)

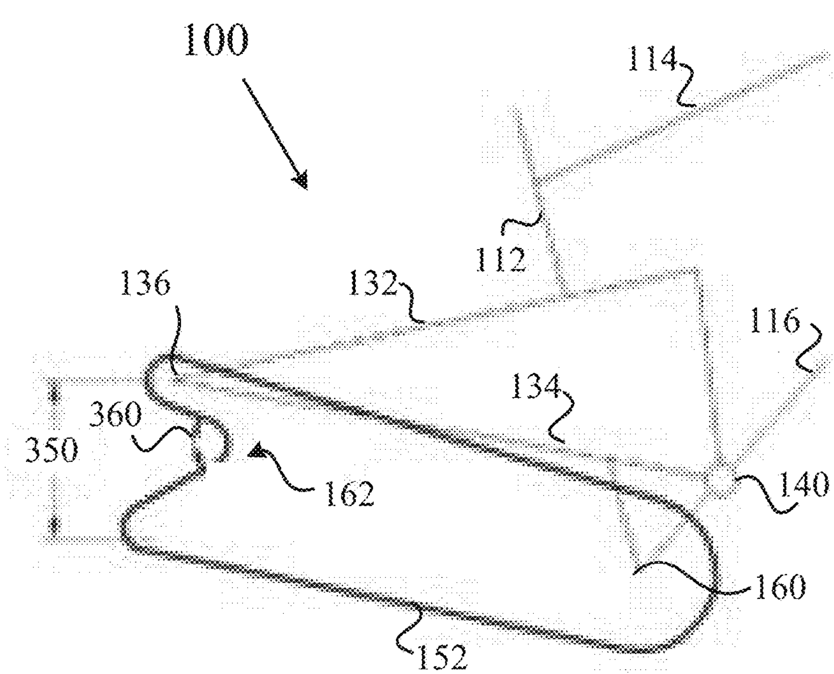



FIG. 3D
(Prior Art)

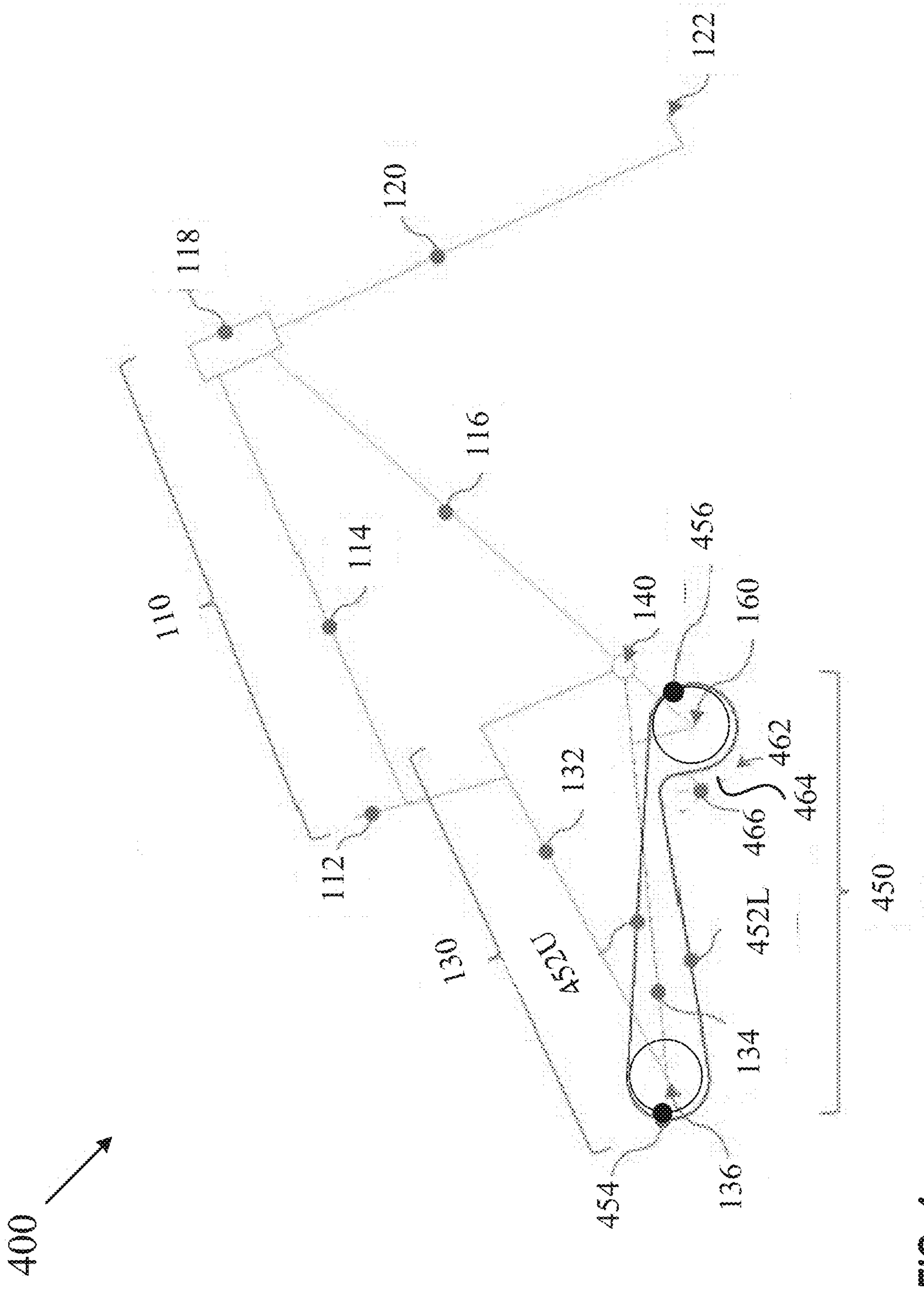



FIG. 4
(Prior Art)

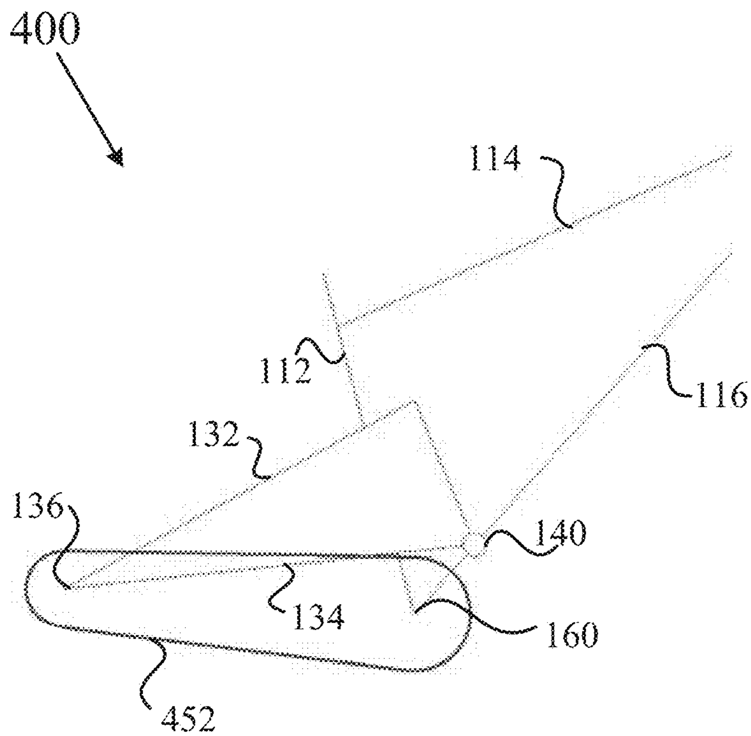



FIG. 5A
(Prior Art)

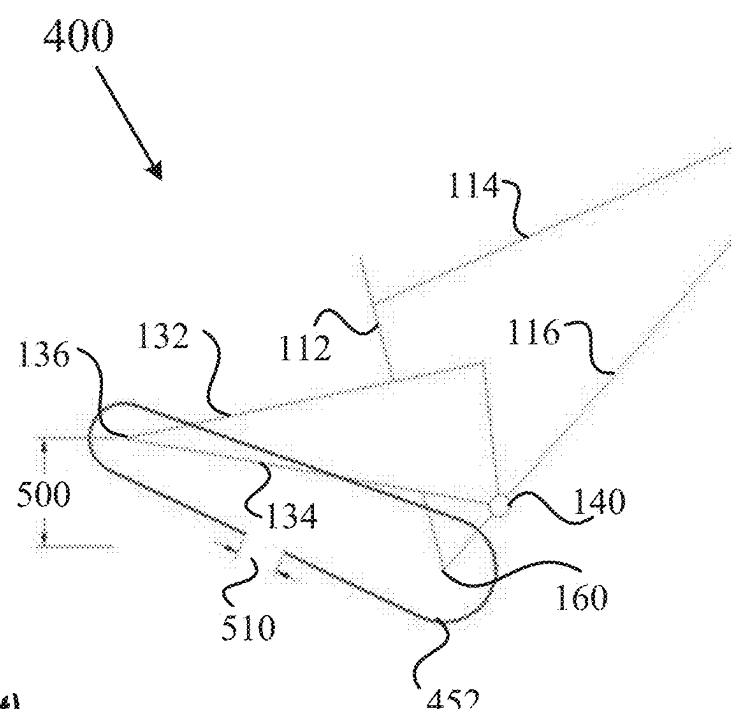



FIG. 5B
(Prior Art)

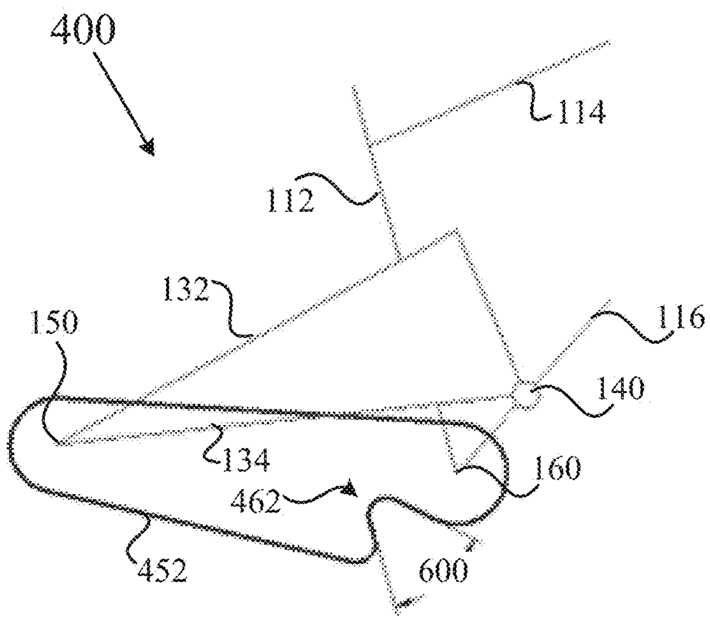



FIG. 6A
(Prior Art)

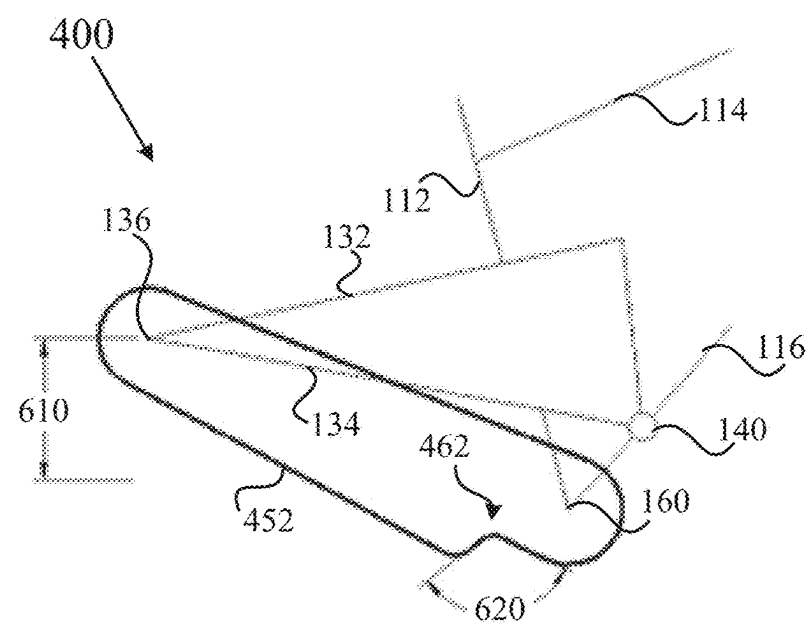



FIG. 6B
(Prior Art)

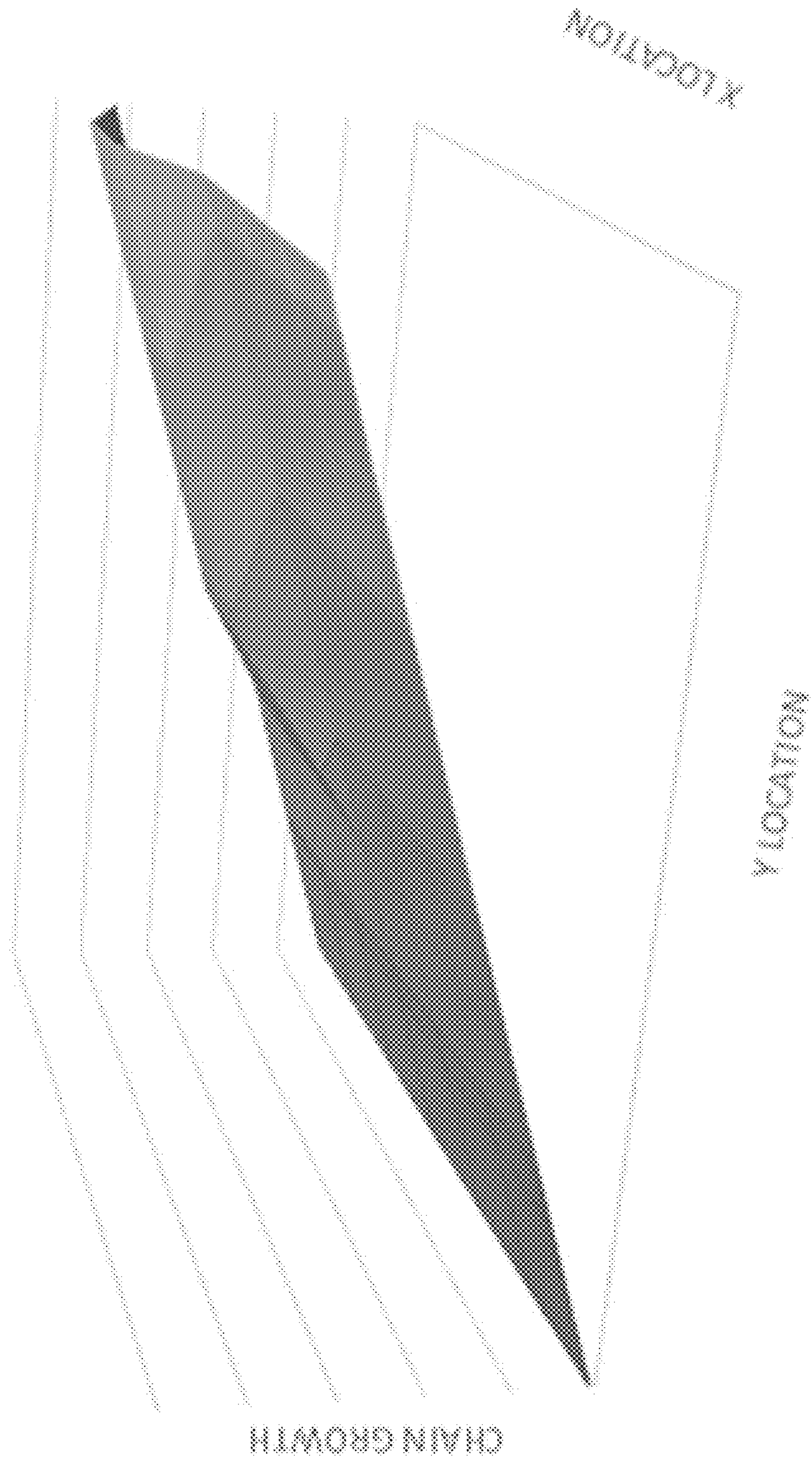



FIG. 7

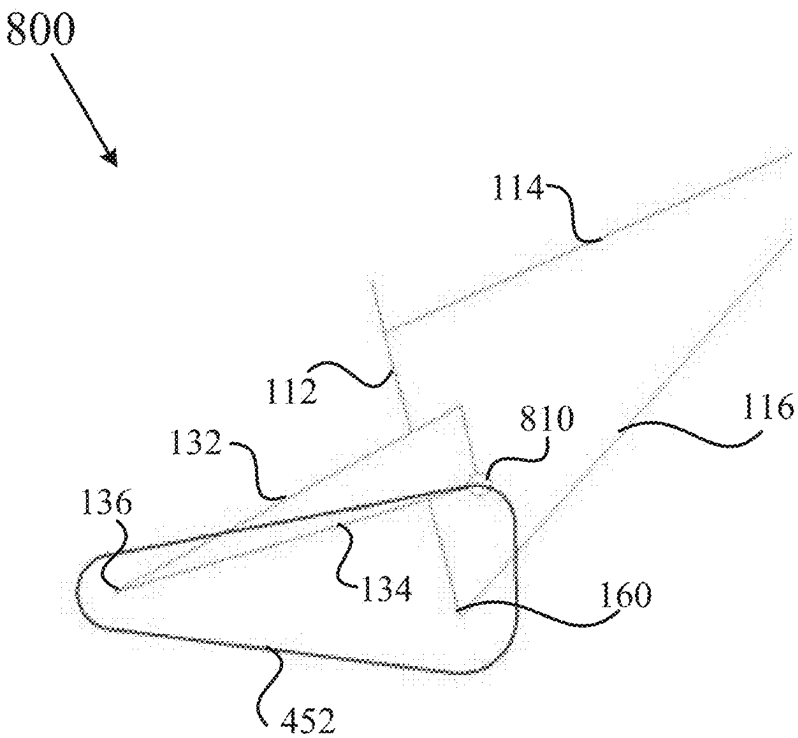

800
114
112
132
810
116
136
134
160
452

FIG. 8A

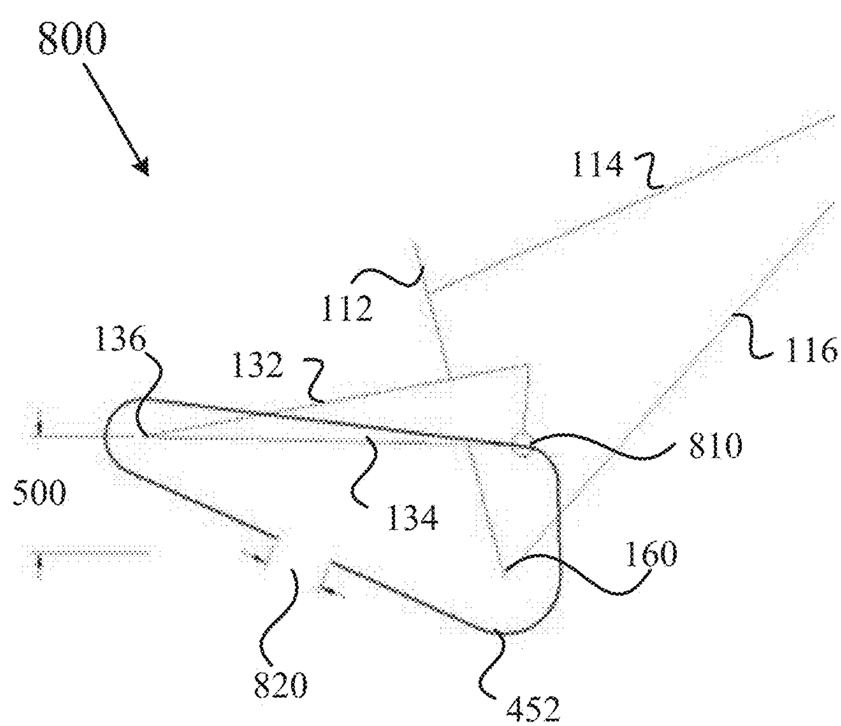

800
114
112
136
132
116
810
500
134
160
820
452

FIG. 8B

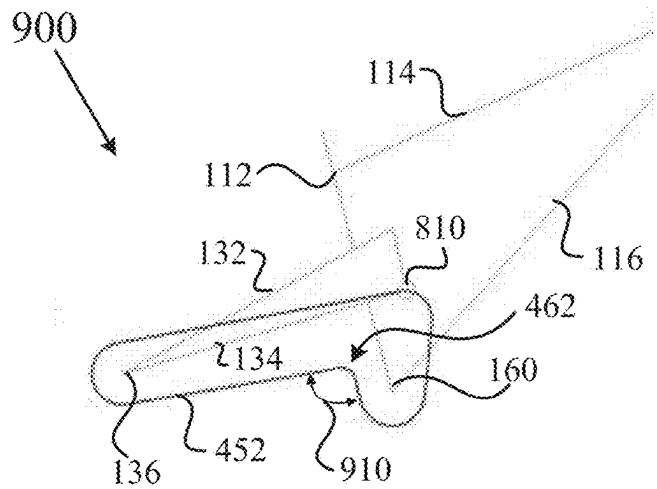



FIG. 9A

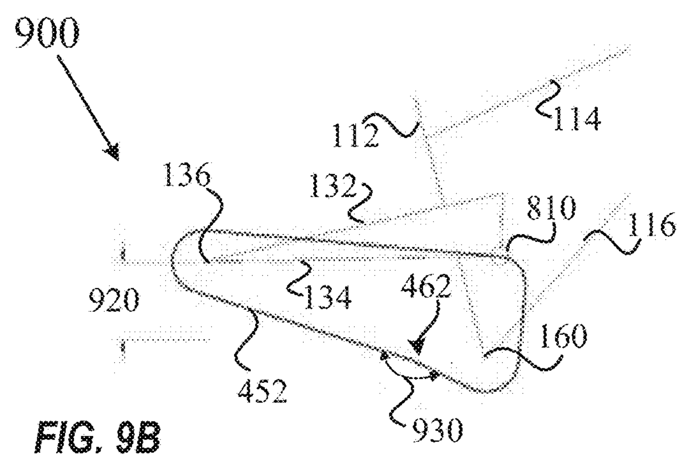



FIG. 9B

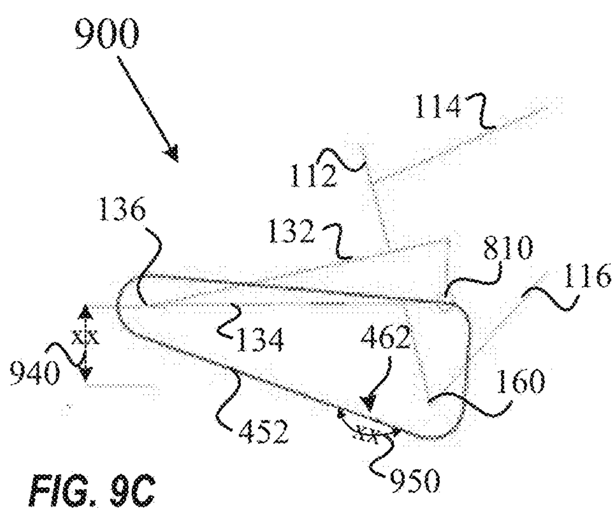



FIG. 9C

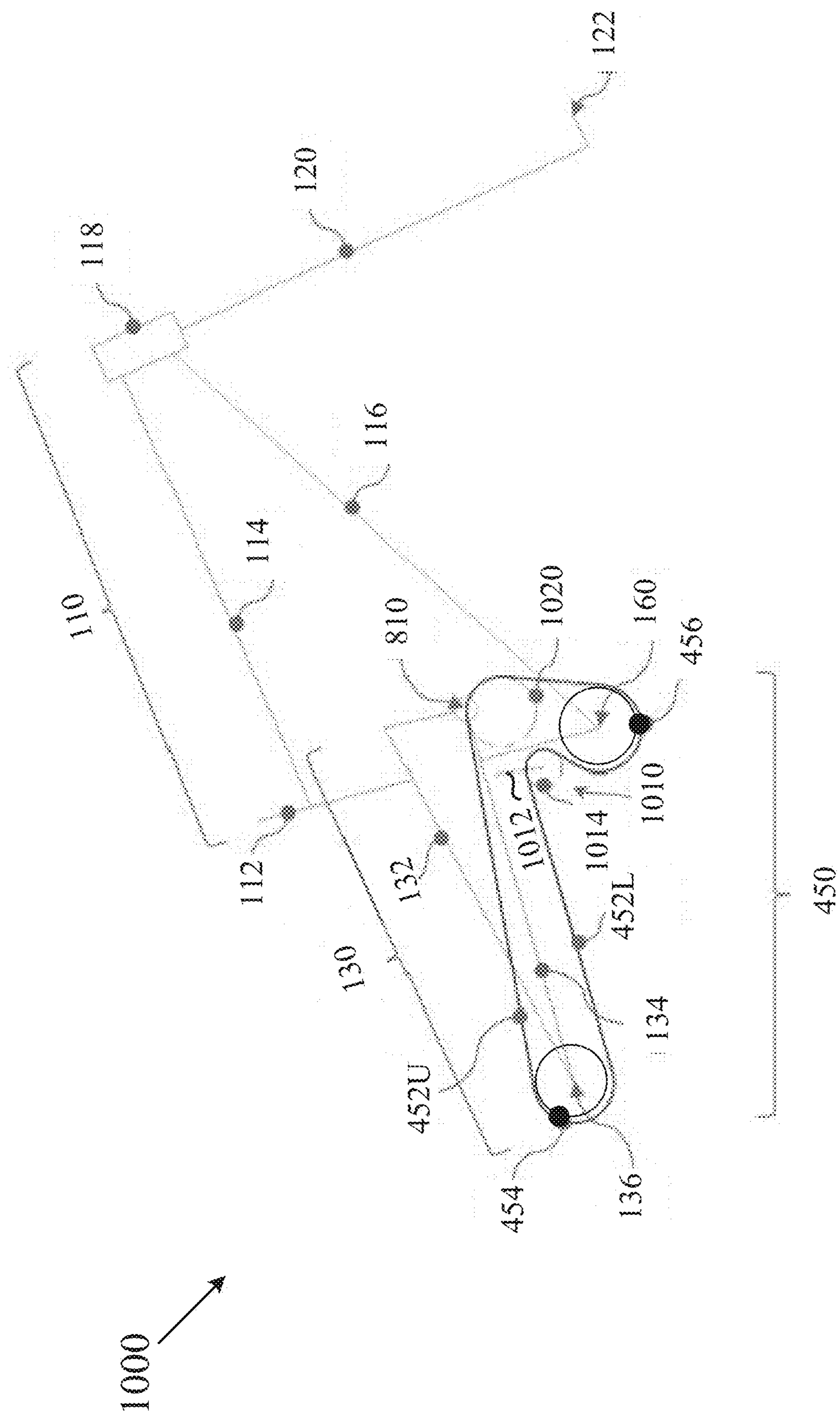

1000
110
112
114
116
118
120
122
130
132
134
136
160
450
452L
452U
454
456
810
1010
1012
1014
1020

FIG. 10

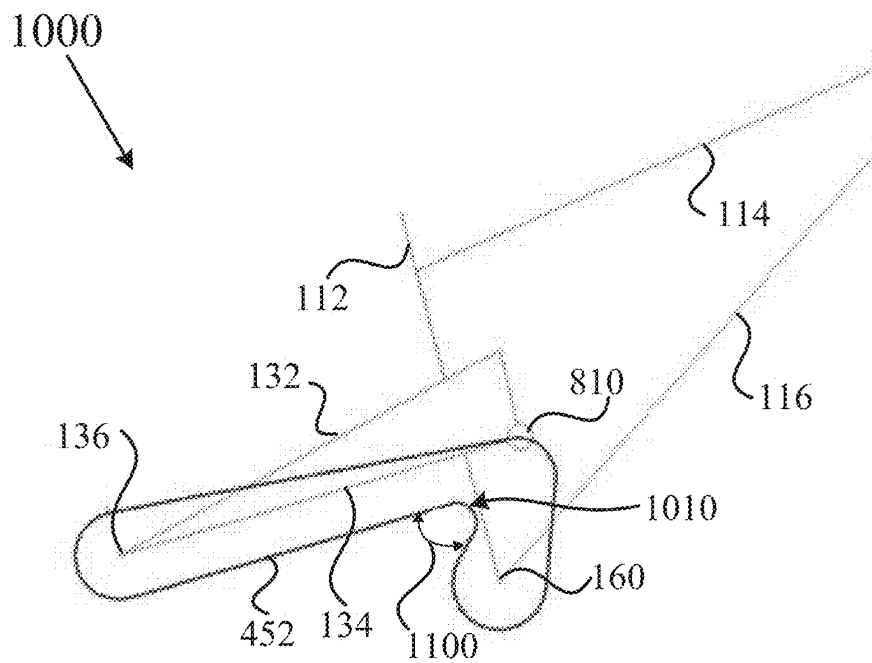



FIG. 11A

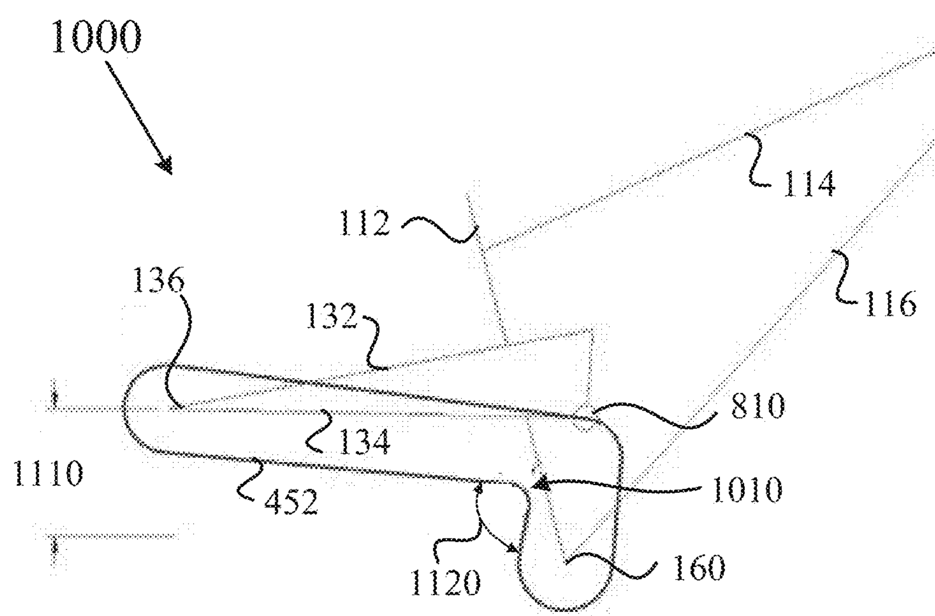



FIG. 11B

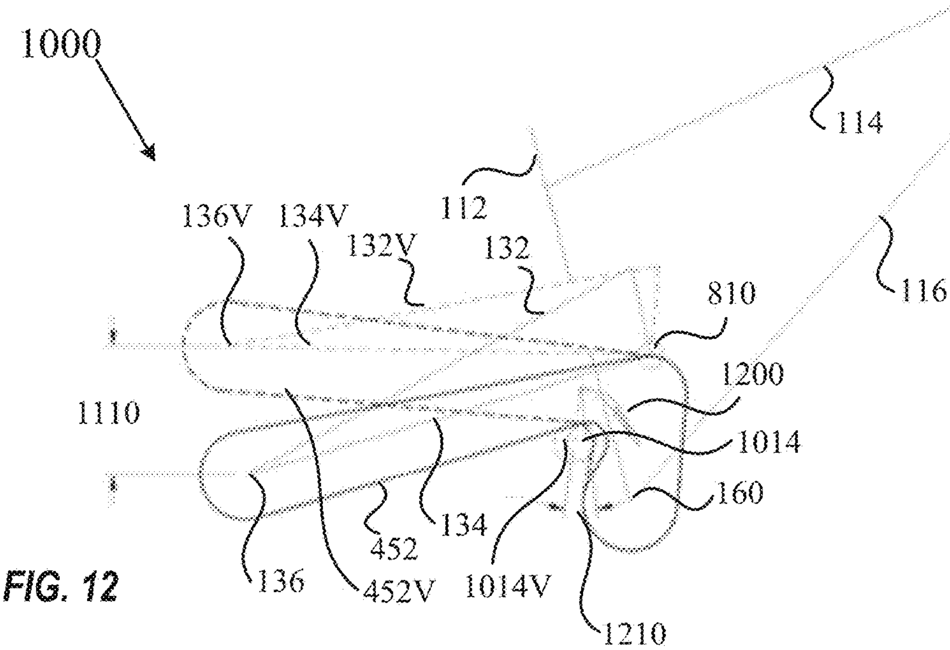



FIG. 12

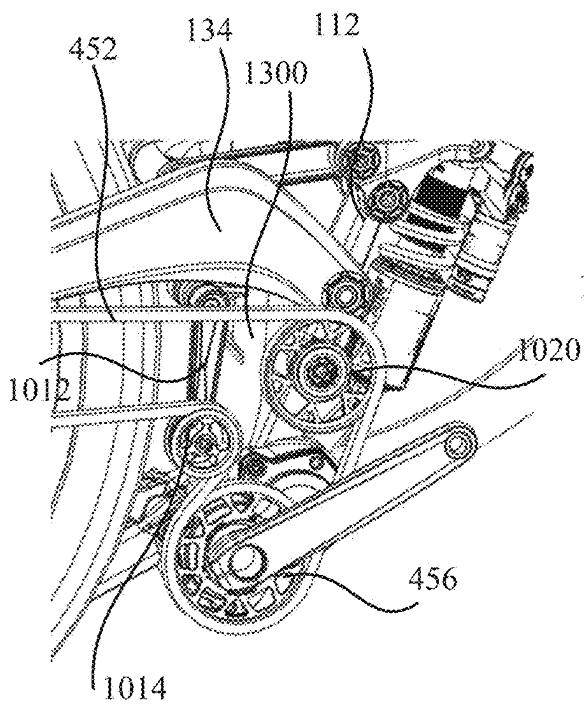



FIG. 13A

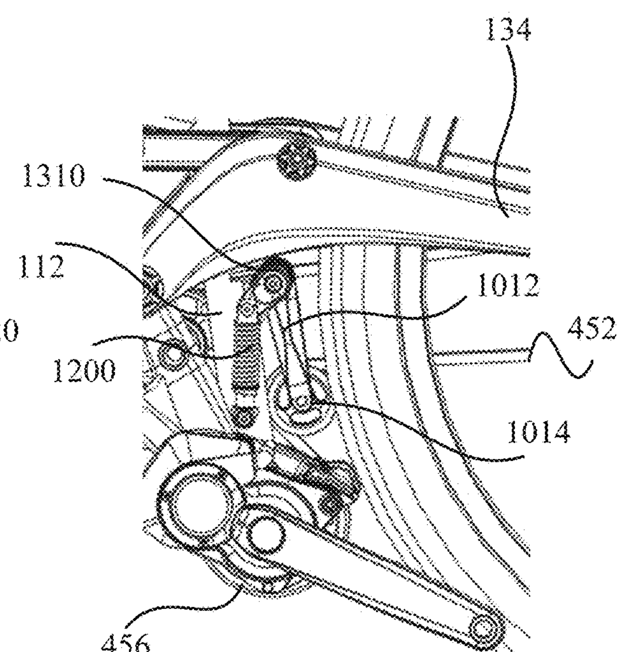



FIG. 13B

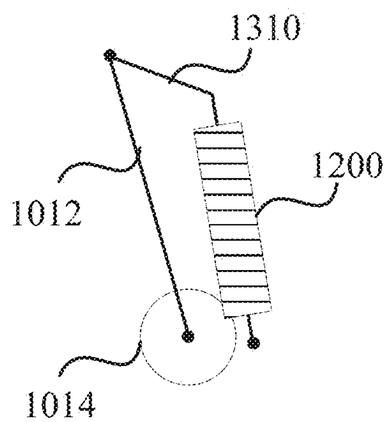



FIG. 14A

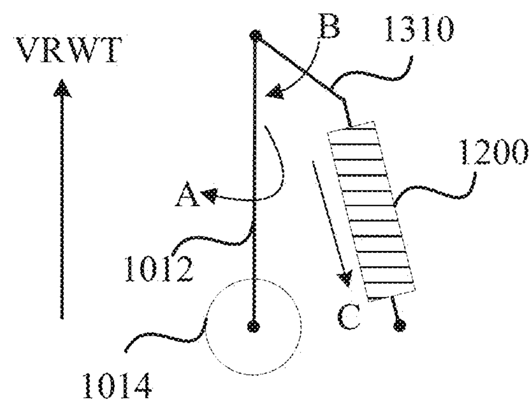



FIG. 14B

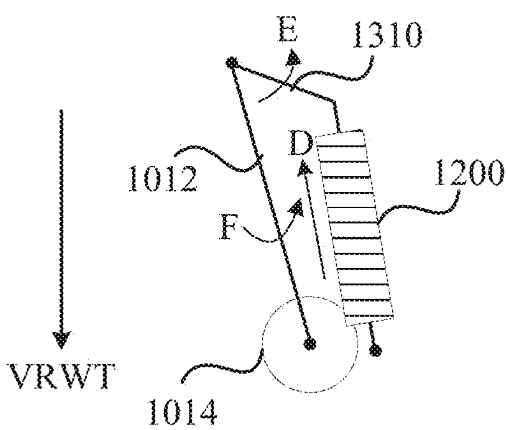



FIG. 14C

# TENSIONER DEVICE TO ACCOUNT FOR VIRTUAL CHAIN GROWTH IN INTERNALLY GEARED HIGH PIVOT POINT REAR SUSPENSION BICYCLES

## BACKGROUND

**[0001]** FIG. **1** illustrates a line diagram of an example chain driven rear suspension bicycle **100**. The bicycle **100** includes a frame made up of a front triangle **110** and a swingarm (rear triangle) **130**. The front triangle **110** includes a seat tube **112**, a top tube **114** and a down tube **116**. The top tube **114** and the down tube **116** are connected to a head tube **118** that connects to handlebars (not illustrated) and a front fork **120** that is used to secure a front wheel (not illustrated) at a front wheel axle (axis) **122**. The seat tube **112** and the down tube **116** are connected to each other via a bottom bracket shell (not separately illustrated, just shown as point of intersection between seat tube **112** and the down tube **116** for ease of illustration). The swingarm **130** may include a seatstay **132** and a chainstay **134**, or a combined chain and seatstay **134** alone in case of a mono-arm bicycle. The seatstay **132** and the chainstay **134** meet to secure a rear wheel (not illustrated) at a rear wheel axle (axis) **136**. For a mono-arm bicycle, simply the combined chain and seatstay **134** would secure the rear wheel.

**[0002]** The swingarm **130** may be connected to the front triangle **100** via a shock absorber or other linkages that are not illustrated for simplicity. The bicycle **100** also includes a rear suspension axis **140** (main pivot point). It should be noted that the rear suspension axis **140** could have a floating or virtual pivot, which may or may not coincide with a physical point on the bicycle frame, where the axis is found at an instant center that varies depending on the rear suspension position. In this case, the rear wheel axle **136** may be connected to either the seatstay **132** or the chainstay **134**. A floating pivot is not illustrated for ease of illustration and simplicity of explaining the basic components.

**[0003]** The bicycle **100** also includes a drive train **150** for providing movement thereof. The drivetrain **150** consists of a chain drive **152**, a rear cassette **154** and a front chain ring **156**. The rear cassette **154** is located on the rear wheel centered around the rear wheel axle **136**. The rear cassette **154** includes a plurality of different sized cogs **158** (to achieve different gear ratios) for receiving and routing the chain drive **152**. The front chain ring **156** is located on the bottom bracket shell. The chain drive **152** routes around the appropriate cog **158** of the rear cassette **154** and the front chainring **156**. An upper portion of the chain drive **152**U moves forward from the rear cassette **154** to the front chainring **156** and a lower portion of the chain drive **152**L moves rearward from the front chainring **156** to the rear cassette **154**. The bottom bracket shell enables a crank set and pedals (not illustrated) to be connected thereto and create a crank axis **160** (simply shown as point of intersection between seat tube **112** and the down tube **116** for ease of illustration). The crank axis **160** enables a user to pedal the bicycle **100** in order to engage the drive train **150** and move the bicycle **100**. The pedaling causes the rotation of the front chain ring **156** which will in turn rotates the chain drive **152** and the appropriate cog **158** of the rear cassette **154** and the rotation of the cog **158** causes rotation of the rear wheel. If the bicycle **100** is an electric bicycle, it will include an electric motor (not illustrated) to provide, or assist with, the movement of the bicycle **100**.

**[0004]** The amount of the chain drive **152** required to route around a larger cog **158** of the rear cassette **154** and the front chainring **156** is more than is required to route the chain drive **152** around a smaller cog **158**. The extra chain drive **152** required is known as virtual chain growth. To account for the chain growth, a derailleur **162** is utilized to take up the slack therein based on the cog **158** that the chain drive **152** is routed around. The derailleur **162** is a rotating member **164** onto which two idler pulleys **166** are mounted. The derailleur **162** is secured to the swingarm **130** in close proximity to the rear cassette **154** and is spring loaded to rotate the rotating member **164** and the idler pulleys **166** based on the rear cog size 158. This allows for virtual chain growth that results from shifting the chain to different sized cogs **158** on the rear cassette **154**.

**[0005]** In addition to the cog **158** utilized affecting chain growth, a vertical distance that the rear wheel axis **136** travels with respect to its resting position (known as vertical rear wheel travel) may result in chain growth. That is, as the rear wheel axis **136** moves upward along a path defined by the rear suspension axis **140**, if the distance between the rear wheel axis **136** and the crank axis **160** increases, it will result in chain growth. As with most mechanical vehicle suspension systems, a bicycle **100** with rear suspension will be designed such that the swingarm **130**, as it moves throughout its range of vertical rear wheel travel, will act upon a shock absorber resulting in a displacement of a spring. This spring displacement (suspension compression) absorbs shock impulses to the bicycle **100** by converting kinetic energy into thermal energy.

**[0006]** FIG. **2** illustrates a simple graph showing that chain growth increases nearly linearly as vertical rear wheel travel increases. The amount of chain growth will depend on the frame and suspension geometry and kinematics, as well as the front and rear sprocket size combination.

**[0007]** FIGS. **3**A-D illustrate simplified line diagrams of the example chain driven rear suspension bicycle **100** of FIG. **1** in different gear ratios and rear suspension positions. FIG. **3**A illustrates the bicycle **100** in a gear associated with the chain drive **152** routing around a larger cog of the rear cassette (not illustrated or identified in simplified drawing). The derailleur **162** provides an angle **310** in the routing of the chain drive **152** (driveline angle **310**) to provide the appropriate tension thereto based on the gear. FIG. **3**B illustrates the bicycle **100** in the same gear as FIG. **3**A but with the bicycle **100** experiencing a vertical rear wheel travel **320**. The vertical rear wheel travel **320** accounts for additional chain growth so that the driveline angle **330** is increased (angle **330** is greater than angle **310**) to provide the appropriate tension thereto based on the gear. The increased driveline angle is the result of the rear wheel axle **136** moving away from the crank axis **160** as the vertical rear wheel travel **320** increases and the fixed length of the chain drive **152**.

**[0008]** FIG. **3**C illustrates the bicycle **100** in a gear associated with the chain drive **152** routing around a smaller cog of the rear cassette (not illustrated or identified in simplified drawing). The derailleur **162** provides a driveline angle **340** in the routing of the chain drive **152** to provide the appropriate tension thereto based on the gear. Note the angle **340** is smaller than the angle **310** since the chain drive **152** has a lesser distance to wrap around the smaller cog of the rear cassette. FIG. **3**D illustrates the bicycle **100** in the same gear as FIG. **3**C but with the bicycle **100** experiencing a vertical rear wheel travel **350**. The vertical rear wheel travel accounts for additional chain growth so that the driveline angle **360** is increased (angle **360** is greater than angle **340**). The increased driveline angle is the result of the rear wheel axle **136** moving away from the crank axis **160**.

**[0009]** As FIGS. **3**A-D clearly illustrate the derailleur **162** fulfills the dual purpose of varying external gear ratio with a cassette as well as accommodating chain growth based on vertical rear wheel travel.

**[0010]** FIG. **4** illustrates a line diagram of an example belt driven rear suspension bicycle **400**. As the bicycle **400** has many of the same components as the bicycle **100**, the same reference numbers are used to identify them and they are not described below to avoid redundancy. The bicycle **400** includes a drive train **450** that consists of a drive belt **452**, a rear sprocket **454** and a front sprocket **456**. The sprockets **454**, **456** simply route the belt drive **452** and do not provide different gear ratios (provides single external gear ratio). Accordingly, the bicycle **400** may provide a gear box (not illustrated) located at the intersection between seat tube **112** and the down tube **116** (e.g., the crank axis **160**) or a geared hub (not illustrated) located at the rear wheel axle **136** to provide internal gear ratios. If used, the gear box is secured to the seat tube **112** and the down tube **116** via a gear box mounting bracket. The rear sprocket **454** is located on the rear wheel centered around the rear wheel axle **136**. The front sprocket **456** is located on the gear box or the bottom bracket shell. The drive belt **452** routes around the rear sprocket **454** and the front sprocket **456** with the upper portion **452**U moving forward from the rear sprocket **454** to the front sprocket **456** and a lower portion **452**L moving rearward from the front sprocket **456** to the rear sprocket **454**. If the gear box is used a crank set and pedals (not illustrated) are connected thereto to create the crank axis **160**. If the geared hub is used the crank set and pedals are connected to the bottom bracket shell as discussed above with respect to FIG. **1**. In either case, the crank axis **160** enables a user to pedal the bicycle **400**. Pedaling causes the rotation of the front sprocket **456** which will in turn rotate the drive belt **452** which in turn will rotate the rear sprocket **454** and the rear wheel.

**[0011]** It should be noted that the bicycle **400** having only a single external gear ratio, is not limited to being a belt driven bicycle. Rather, the bicycle could be a chain driven bicycle and utilize a chain drive and front and rear chain rings instead of the drive belt **452**, the front sprocket **456** and the rear sprocket **454**. If the bicycle **400** is an electric bicycle, it will include an electric motor (not illustrated) to provide, or assist with, the movement of the bicycle **400**.

**[0012]** As the bicycle **400** is a single external gear ratio there is no chain growth (typically called chain growth even when a drive belt **452** is utilized) to account for so there is no need for a derailleur to adjust the tension of the drive belt **452**. However, as with the bicycle **100**, vertical rear wheel travel may result in chain growth. Accordingly, the bicycle **400** includes a tensioner **462** to account for the chain growth resulting from vertical rear wheel travel. The tensioner **462** is a rotating member **464** onto which an idler pulley **466** is mounted. The tensioner **462** may be secured to the front triangle **110** and be located behind the front sprocket **456** (contacts the drive belt **452** behind the front sprocket **456**). The tensioner **462** is spring loaded to rotate the rotating member **464** and the idler pulley **466** to adjust the path of the drive belt **452** based on the vertical rear wheel travel. This allows for virtual chain growth that results from vertical rear wheel travel and appropriate tensioning of the drive belt **452**.

**[0013]** FIGS. **5**A-B illustrate simplified line diagrams of the example belt driven rear suspension bicycle **400** (or any single external gear ratio rear suspension bicycle) showing chain growth based on vertical real wheel travel. FIG. **5**A illustrates the bicycle **400** in an initial position and FIG. **5**B illustrates the bicycle **400** with the rear wheel experiencing a vertical rear wheel travel **500**. At the vertical rear wheel travel **500**, the length of the drive belt **452** required to be routed around the rear wheel axle **136** and the crank axis **160** has increased, resulting in a chain growth **510**.

**[0014]** FIGS. **6**A-B illustrate simplified line diagrams of the example belt driven rear suspension bicycle **400** with the tensioner **462** accounting for chain growth due to vertical rear wheel travel. The actual components (e.g., arm, pulley, springs) of the tensioner **462** are not illustrated for simplicity. Rather, the tensioner **462** is simply illustrated as providing an angle in the routing of the drive belt **452** (driveline angle) to provide the appropriate tension. The more vertical rear wheel travel that the bicycle experiences, the greater the driveline angle. FIG. **6**A illustrates the bicycle **400** in an initial position having a driveline angle **600**. The initial position is prior to the rear wheel experiencing any vertical rear wheel travel (e.g., not engaging the rear suspension). FIG. **6**B illustrates the bicycle **400** experiencing vertical rear wheel travel **610** and having a driveline angle **620**. As the vertical rear wheel travel **610** accounts for additional chain growth the driveline angle **620** increased (angle **620** is greater than angle **600**) to provide the appropriate tension thereto. The increased driveline angle is the result of the rear wheel axle **136** moving away from the crank axis **160** as the vertical rear wheel travel **610** increases and the fixed length of the drive belt **452**.

**[0015]** As chains and belts are inelastic, the maximum vertical rear wheel travel will be restricted by the amount of chain growth that can be accommodated by a derailleur or a tensioner. Furthermore, even if a long enough chain or belt is used to accommodate for chain growth at maximum vertical rear wheel travel, the increased tension of the belt or chain at the extreme end of the vertical rear wheel travel will have the effect of resisting the compression of the shock absorber, thus reducing the efficacy of the suspension at isolating the rider of the bicycle from road surface imperfections. As such, solutions to reduce chain growth are required.

## BRIEF DESCRIPTION OF DRAWINGS

**[0016]** The features and advantages of the various embodiments will become apparent from the following detailed description in which:

**[0017]** FIG. **1** illustrates a line diagram of an example chain driven rear suspension bicycle.

**[0018]** FIG. **2** illustrates a simple graph showing that chain growth increases nearly linearly as vertical rear wheel travel increases.

**[0019]** FIGS. **3**A-D illustrate simplified line diagrams of example chain driven rear suspension bicycle of FIG. **1** in different gear ratios and rear suspension positions.

**[0020]** FIG. **4** illustrates a line diagram of an example belt driven rear suspension bicycle.

**[0021]** FIGS. **5**A-B illustrate simplified line diagrams of the example belt driven rear suspension bicycle of FIG. **4** showing chain growth based on vertical real wheel travel.

**[0022]** FIGS. **6**A-B illustrate simplified line diagrams of the example belt driven rear suspension bicycle of FIG. **4** with the tensioner accounting for chain growth due to vertical rear wheel travel.

**[0023]** FIG. **7** illustrates a graph showing how X location (backwards and forwards) and Y location (up and down) of the suspension pivot affect chain growth.

**[0024]** FIGS. **8**A-B illustrate simple line diagrams of an example internally geared (e.g., belt driven) high pivot point rear suspension bicycle in different rear suspension positions, according to one embodiment.

**[0025]** FIGS. **9**A-C illustrate simple line diagrams of an example internally geared high pivot rear suspension bicycle utilizing a tensioner to account for virtual chain growth due to vertical rear wheel travel, according to one embodiment.

**[0026]** FIG. **10** illustrates a line diagram of an example internally geared (belt driven) high pivot point rear suspension bicycle including a highly placed tensioner, according to one embodiment.

**[0027]** FIGS. **11**A-B illustrate simplified line diagrams of the example belt driven rear suspension bicycle with the tensioner accounting for chain growth due to vertical rear wheel travel, according to one embodiment.

**[0028]** FIG. **12** illustrates the example belt driven rear suspension bicycle of FIGS. **11**A-B overlapping to show the movement of the various parts of the bicycle while experiencing vertical rear wheel travel, according to one embodiment.

**[0029]** FIGS. **13**A-B illustrate detailed front and right views of a portion of a bicycle with an example tensioner, according to one embodiment.

**[0030]** FIGS. **14**A-C illustrate simplified diagrams showing the action of the example tensioner, according to one embodiment.

## DETAILED DESCRIPTION

**[0031]** As illustrated in FIGS. **1** and **4**, most common rear suspension designs have a rear suspension axis (pivot point) **140** near the crank axis **160** and the front chainring **156** or front sprocket **456**. These rear suspension designs provide an axle path that rotates in a circular direction generally towards the front of the bicycle. This generally forward rotation is to the detriment of suspension performance, as the general force vector experienced by a rear wheel when it impacts a road obstacle is in a generally rearward direction. By moving the rear suspension pivot point higher (e.g., further above the crank axis **160** and the front chainring/sprocket **156**, **456**), the axle path of a bicycle becomes more rearward, better matching the direction of the force vector imparted by a rear wheel impact. A high rear suspension pivot point bicycle is one where the rear suspension pivot point is located high enough that an idler pulley is required to route the chain or drive belt **152**, **452** coming from the rear cassette **154** or rear sprocket **454** to the front chainring/sprocket **156**, **456**. Bicycles having high rear suspension pivot points are becoming popular as they provide improved suspension control and a smoother ride in rough terrain.

**[0032]** FIG. **7** illustrates a graph showing how X location (backwards and forwards) and Y location (up and down) of the suspension pivot affect chain growth. As can be seen, the Y location has more impact. The amount of chain growth will depend on the frame and suspension geometry, as well as the front, idler and rear sprocket size combination. As such, high rear suspension pivot points increase the chain growth issue when compared to most other suspension designs.

**[0033]** FIGS. **8**A-B illustrate simple line diagrams of an example internally geared high pivot point rear suspension bicycle **800** (similar to the bicycle **400**) in different rear suspension positions. The bicycle **800** includes a rear suspension axis **810** (main pivot point) that is higher than the rear suspension axis **140** of bicycle **400**. The axle path of the bicycle **800** is accordingly substantially rearward. An idler pulley (not illustrated) is located in close proximity to the high rear suspension axis **810**. The drive belt **452** is routed around the rear sprocket (not illustrated) centered around the rear wheel axle **136**, the idler pulley located in close proximity to the high rear suspension axis **810** and the front sprocket (not illustrated) centered around the crank axis **160**. FIG. **8**A illustrates the bicycle **800** in an initial position and FIG. **8**B illustrates the bicycle **800** with the rear wheel experiencing a vertical rear wheel travel **500** (same as that illustrated in FIG. **5**B). At the vertical rear wheel travel **500**, the length of the drive belt **452** required to be routed around the rear sprocket, the idler pulley, and the front sprocket has increased, resulting in a chain growth **820**. For comparison purposes, with the same vertical rear wheel travel **500** and the same front and rear sprocket sizes, the chain growth **820** for the high rear suspension axis **810** is approximately 22% greater than the chain growth **510** for the rear suspension axis **140**.

**[0034]** Like non-high pivot rear suspension bicycles, high pivot rear suspension bicycles can utilize idler pulleys, tensioners, and derailleurs to adjust the path of the belt or chain and account for changes to the virtual length of the belt/chain (chain growth).

**[0035]** FIGS. **9**A-C illustrate simple line diagrams of an example internally geared high pivot rear suspension bicycle **900** (similar to the bicycle **800**) utilizing the tensioner **462** to account for virtual chain growth due to vertical rear wheel travel. As discussed above, the tensioner **462** is a spring-loaded rotating member onto which an idler pulley is mounted (actual components not illustrated for simplicity) to adjust the tension of the drive belt **452** by adjusting a driveline angle of the drive belt **452**. The more vertical rear wheel travel that the bicycle experiences, the greater the driveline angle. FIG. **9**A illustrates the bicycle **900** prior to the rear wheel experiencing any vertical rear wheel travel (e.g., not engaging the rear suspension). The tensioner **462** provides a driveline angle **910** at this point.

**[0036]** FIG. **9**B illustrates the bicycle **900** experiencing vertical rear wheel travel **930** and having a driveline angle **930** to account therefore. The tensioner **462** may provide a maximum driveline angle which limits the vertical rear wheel travel that can be obtained. For example, if the driveline angle **930** was the maximum driveline angle that can be attained then the vertical rear wheel travel **920** would be the maximum attainable vertical rear wheel travel. FIG. **9**C illustrates the bicycle **900** having a desired vertical rear wheel travel **940** and a driveline angle **950** that would be required to obtain that. As the driveline angle **950** is greater than the maximum driveline angle **930**, the desired vertical rear wheel travel **940** is unattainable as it is greater than the maximum attainable vertical rear wheel travel **920**.

**[0037]** One solution to solve the problem associated with a tensioner angle not being able to accommodate sufficient chain growth to meet a desired vertical rear wheel travel is to locate a tensioner closer to the high rear suspension axis **810** and idler pulley.

**[0038]** FIG. **10** illustrates a line diagram of an example internally geared (belt driven) high pivot point rear suspension bicycle **1000** including a highly placed tensioner **1010**. The bicycle **1000** will use the same reference numbers to identify the same components discussed with regard to previous Figures and will not describe them below to avoid redundancy. An idler pulley **1020** is located in close proximity to the high rear suspension axis **810**. The tensioner **1010** is located between the idler pulley **1020** and the front sprocket **456** (below the idler pulley **1020** and above the front sprocket **456**). The tensioner **1010** includes a pivoting member **1012** with a tensioner pulley **1014** mounted thereto. The pivoting member **1012** may be mounted to the front triangle **110** (e.g., the seat tube **112**). The tensioner **1010** enables the pivoting member **1012** and the tensioner pulley **1014** to pivot away from (e.g., backwards) the high rear suspension axis **810** (and idler pulley **1020** located in close proximity thereto) as well as the front sprocket **456** when experiencing vertical rear wheel travel and thus allow for chain growth in the drive belt **452**. The tensioner **1010** is spring loaded so the pivoting member **1012** and the tensioner pulley **1014** pivot back towards (e.g., forwards) the high rear suspension axis **810** when experiencing less (or no) vertical rear wheel travel in order to keep the drive belt **452** appropriately tensioned. The spring may be secured to the pivoting member **1012** and the front triangle **110** (e.g., the seat tube **112**).

**[0039]** The drive train **450** of the bicycle **1000** includes the drive belt **452**, the rear sprocket **454**, the idler pulley **1020**, the front sprocket **456** and the tensioner **1010**. The drive belt **452** routes around the rear sprocket **454**, the idler pulley **1020**, the front sprocket **456** and the tensioner pulley **1014** (an upper portion of the drive belt **452**U moving forward from the rear sprocket **454** to the idler pulley **1020** and from the idler pulley **1020** to the front sprocket **456**; and a lower portion **452**L moving rearward from the front sprocket **456** to the tensioner pulley **1014** and from the tensioner pulley **1014** to the rear sprocket **454**). Pedaling causes the rotation of the front sprocket **456** which will in turn rotate the drive belt **452** which in turn will rotate the rear sprocket **454** and the rear wheel.

**[0040]** It should be noted that the internally geared bicycle **1000** is not limited to being a belt driven bicycle. Rather, the bicycle could be a chain driven bicycle and utilize a chain drive instead of the drive belt **452** and chainrings instead of sprockets **454**, **456** and pulleys **1014**, **1020**. If the bicycle **1000** is an electric bicycle, it will include an electric motor (not illustrated) to provide, or assist with, the movement thereof.

**[0041]** FIGS. **11**A-B illustrate simplified line diagrams of the example internally geared (e.g., belt driven) rear suspension bicycle **1000** with the tensioner **1010** accounting for chain growth due to vertical rear wheel travel. The actual components of the tensioner **1010** are not illustrated for simplicity. Rather, the tensioner **1010** is simply illustrated as providing a driveline angle that adjusts the path of the drive belt **452** back to the rear sprocket (rear wheel axis **136** identified for simplicity). The more vertical rear wheel travel that the bicycle experiences, the greater the driveline angle. The high mounting of the tensioner **1010** (e.g., in proximity to the high rear suspension axis **810**; between the crank axis **160** and the idler pulley) allows smaller driveline angle changes to account for chain growth which in turn enables more vertical rear wheel travel.

**[0042]** FIG. **11**A illustrates the bicycle **1000** prior to the rear wheel experiencing any vertical rear wheel travel (e.g., not engaging the rear suspension). The tensioner **1010** provides a driveline angle **1100** at this point. The driveline angle **1100** is less than an equivalent driveline angle **910**. FIG. **11**B illustrates the bicycle **1000** experiencing vertical rear wheel travel **1110** and having a driveline angle **1120** to account therefore. The vertical rear wheel travel **1110** is greater than maximum vertical rear wheel travel **920** and the desired vertical rear wheel travel **940** but the driveline angle **1120** is less than either driveline angle **930**, **950** (and possibly even the driveline angle **910**). The change between the initial driveline angle **1100** associated with no vertical rear wheel travel (FIG. **11**A) and the driveline angle **1120** associated with the vertical rear wheel travel **1110** (FIG. **11**B) is substantially less than the change between the initial driveline angle **910** associated with no vertical rear wheel travel (FIG. **9**A) and the driveline angle **930** associated with the vertical rear wheel travel **920** (FIG. **9**B).

**[0043]** FIG. **12** illustrates the example belt driven rear suspension bicycle **1000** of FIGS. **11**A-B overlapping to show the movement of the various parts of the bicycle **1000** while experiencing vertical rear wheel travel **1110**. The parts of the bicycle **1000** associated with FIG. **11**A (prior to the rear wheel experiencing any vertical rear wheel travel) are identified by their associated numbers and the parts of bicycle **1000** associated with FIG. **11**B (experiencing vertical rear wheel travel **1110**) are identified by their associated numbers with a V appended thereto. As can be seen, the various components of the swing arm **130** and the drive train **450** move upward as the bicycle **1000** experiences the vertical rear wheel travel **1110**. The tensioner pulley **1014** and the pivoting member **1012** (not identified for ease) pivot away from the high rear suspension axis **810** (e.g., pivot backwards) as the bicycle **1000** experiences the vertical rear wheel travel **1110**. The amount of pivot of the tensioner (difference between 1014 and 1014V) is indicated by angle **1210**. A spring **1200** is shown secured to the seat tube **112** on one end and the tensioner on the other to provide the tension to have tensioner pivot back towards the high rear suspension axis **810** (e.g., pivot forwards) when not experiencing (or experiencing less) vertical rear wheel travel.

**[0044]** FIGS. **13**A-B illustrate detailed front and right views of a portion of a bicycle with an example tensioner. The tensioner includes a pivoting member **1012**, a tensioner pulley **1014**, a spring (compression spring) **1200** and a spring arm **1310**. The tensioner is mounted to a bracket **1300** that extends backwards from the seat tube **112**. One end of the pivoting member **1012** and one end of the spring arm **1310** are secured to the bracket **1300** (separate sides of the bracket **1300**) so that the two are connected to one another at a defined angle and rotate with relation to each other. A second end of the pivoting member **1012** has the tensioner pulley **1014** mounted thereto. A second end of the spring arm **1310** is secured to one end of the spring **1200** and a second end of the spring **1200** is secured to the seat tube **112**. When the bicycle experiences vertical rear wheel travel, the pivoting member **1012** swings away from the seat tube **112** and the spring arm **1310** rotates in same direction (e.g., swings downwards) providing a force on the spring **1200** and causing the spring **1200** to compress. When the tension caused by the vertical rear wheel travel is reduced, the force on the spring **1200** is reduced so that the spring **1200** extends upwards which pushes the spring arm **1310** upwards (rotate in opposite direction as when experiencing increased vertical rear wheel travel). The rotation (e.g., upward movement) of the spring arm **1310** causes the pivoting member **1012** to pivot back towards the seat tube **112**.

**[0045]** FIGS. **14**A-C illustrate simplified diagrams showing the action of the example tensioner of FIGS. **13**A-B. It should be noted that FIGS. **14**A-C are side views where if the tensioner was located on a bicycle the front triangle would be in front of the tensioner (to the right) and the swingarm would be behind the tensioner (to the left). The pivoting member **1012** and the spring arm **1310** are secured together at a pivot point, the spring arm **1310** is secured to the spring **1200** and the spring **1200** is secured to the bicycle frame. FIG. **14**A illustrates the tensioner prior to the bicycle experiencing any vertical rear wheel travel. The spring **1200** is at its initially configured size (e.g., extended with some preloaded force) which pushes the spring arm **1310** up and pivots the pivoting member **1012** in toward the frame.

**[0046]** FIG. **14**B illustrates the tensioner when the bicycle starts to experience vertical rear wheel travel. The tension on the drive belt caused by the vertical rear wheel travel causes the pivoting member **1012** to pivot away from the high pivot point (e.g., backwards towards the rear wheel) as indicated by A. As illustrated from this side view, the pivoting away is a clockwise rotation of the pivoting member **1012** (would be counterclockwise from opposite side view). However, the pivoting is not limited to a clockwise rotation from this view (e.g., could be counterclockwise rotation). The linkage between the pivoting member **1012** and the spring arm **1310** causes the spring arm **1310** to rotate in same direction as the pivoting member **1012** (e.g., pivot away from the high pivot point) as indicated by B. The pivoting of the spring arm **1310** provides a force on the spring **1200** to change the size of the spring from its initially configured size as indicated by C. As illustrated, the force on the spring **1200** is downwards which results in the compression of the spring **1200**. However, the force is not limited to compressing the spring **1200** (e.g., force could expand the spring).

**[0047]** FIG. **14**C illustrates the tensioner when the vertical rear wheel travel the bicycle is experiencing is reduced or eliminated. The tension on the drive belt is reduced which reduces the force provided on the spring **1200** by the spring arm **1310** which enables the spring **1200** to begin to return (move towards) its initially configured size as indicated by D. As illustrated, the spring **1200** expands as the force is reduced. However, the spring **1200** is not limited to expanding to return to its initially configured size (e.g., could compress). The return of the spring **1200** to its initially configured size (expansion of the spring) causes the spring arm **1310** to rotate in opposite direction as it did when experiencing increased vertical rear wheel travel (e.g., pivot back towards the high pivot point) as indicated by E. As illustrated in this side view, the pivoting is in a counterclockwise rotation of the spring arm **1310**. However, the pivoting is not limited to a counterclockwise rotation from this view (e.g., could be clockwise rotation). The linkage between the pivoting member **1012** and the spring arm **1310** causes the pivoting member **1012** to pivot back towards the high pivot point as indicated by E.

**[0048]** It should be noted that the tensioner is not limited to the configuration and operation disclosed in FIGS. **13**A-B and **14**A-C. Rather other arrangements and configurations that provide the pivoting away from the high suspension point when experiencing increased vertical real wheel travel and pivot back towards the high suspension point when experiencing decreased vertical real wheel travel could be utilized without departing from the scope of the invention. For example, the pivoting member and the spring arm could be a single component having two sides having a defined angle therebetween. The angle between the pivoting member and the spring arm could be such that when the pivoting member pivots away from the high pivot point the spring arm actually pivots towards the high pivot point and vice versa. The pivot point of the pivoting member could be secured to the frame at a lower point than the pulley end such that the tensioner pulley would rotate counterclockwise in the side views of FIGS. **14**A-C. The spring could be located above the spring arm and be an expansion spring where the pivoting of the spring arm expands the spring and when the tension is released the spring compresses back to its initially configured state and pulls the spring arm back. The bracket that the tensioner is secured to, could be located on other tubes of the front triangle. The pivoting member and the spring could be secured to different tubes. One skilled in the art would understand the various manners in which the pivoting necessary could be achieved.

**[0049]** Although the invention has been illustrated by reference to specific embodiments, it will be apparent that the invention is not limited thereto as various changes and modifications may be made thereto without departing from the scope. Reference to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described therein is included in at least one embodiment. Thus, the appearances of the phrase "in one embodiment" or "in an embodiment" appearing in various places throughout the specification are not necessarily all referring to the same embodiment.

**[0050]** The various embodiments are intended to be protected broadly within the spirit and scope of the appended claims.

What is claimed is:

**1**. A high pivot point rear suspension bicycle comprising

a frame including a front triangle and a swingarm;

a rear suspension pivot point between the front triangle and the swingarm, wherein location of the rear suspension pivot point provides a predominantly rearward axle path; and

a drive train including a drive belt, a rear sprocket located at a rear wheel axis, an idler pulley located in close proximity to the rear suspension pivot point, a front sprocket located at a crank axis, and a tensioner located between the idler pulley and the front sprocket, wherein the drive belt traverses from the rear sprocket to the idler pulley, from the idler pulley to the front sprocket, from the front sprocket to the tensioner and from the tensioner back to the rear sprocket, wherein the tensioner is to pivot away from the rear suspension pivot point when vertical rear wheel travel of the bicycle increases to allow for chain growth in the drive belt.

**2**. The bicycle of claim **1**, wherein the tensioner is to pivot back towards the high rear suspension axis when the vertical rear wheel travel of the bicycle decreases in order to keep the drive belt appropriately tensioned.

**3**. The bicycle of claim **1**, wherein the tensioner includes a pivoting member and a pulley mounted to a far end of the pivoting member.

**4**. The bicycle of claim **3**, wherein

the drive belt traverses the pulley; and

the far end of pivoting member and the pulley pivot away from the rear suspension pivot point to adjust a path of the drive belt when the vertical rear wheel travel of the bicycle increases.

**5**. The bicycle of claim **4**, wherein the tensioner further includes a spring to cause the far end of the pivoting member and the pulley to pivot back towards the high rear suspension axis when the vertical rear wheel travel of the bicycle decreases in order to keep the drive belt appropriately tensioned.

**6**. The bicycle of claim **1**, wherein the tensioner includes

a pivoting member having a first end pivotally secured to a first location of the front triangle;

a pulley secured to a second end of the pivoting member;

a spring arm having a first end pivotally secured to the first location of the front triangle and connected to the first end of the pivoting member at a defined angle; and

a spring having a first end secured to a second location of the front triangle and a second end secured to a second end of the spring arm.

**7**. The bicycle of claim **6**, wherein

the second end of the pivoting member and the pulley pivot away from the rear suspension pivot point based on increased tension on the drive belt created when the vertical rear wheel travel of the bicycle increases;

the second end of the spring arm rotates in same direction as the second end of the pivoting member in response to the pivoting of the second end of the pivoting member; and

a force is applied to the spring by the rotation of the second end of the spring arm to change size of the spring away from its initially configured size.

**8**. The bicycle of claim **7**, wherein

the size of the spring moves towards its initially configured size when tension on the drive belt is reduced based on the vertical rear wheel travel decreasing;

the second end of the spring arm rotates in opposite direction in response to the change in the spring size; and

the second end of the pivoting member and the pulley pivots back towards the rear suspension pivot point in response to the rotation of the second end of the spring arm.

**9**. The bicycle of claim **6**, wherein the second location of the front triangle is below the first location of the front triangle.

**10**. The bicycle of claim **6**, wherein

the first location of the front triangle is a bracket extending from a tube of the front triangle; and

the pivoting member and the spring arm are secured to the bracket.

**11**. The bicycle of claim **1**, further comprising a gear box located at the crank axis to provide internal gearing for the bicycle.

**12**. The bicycle of claim **1**, further comprising a geared hub located at the rear axle axis to provide internal gearing for the bicycle.

**13**. The bicycle of claim **1**, further comprising an electric motor.

**14**. A tensioner for use with a high pivot point rear suspension bicycle to allow for chain growth and to maintain appropriate tension, the tensioner comprising:

a pivoting member having a first end pivotally secured to a first location of a front triangle of the bicycle;

a pulley secured to a second end of the pivoting member;

a spring arm having a first end pivotally secured to the first location of the front triangle and connected to the first end of the pivoting member at a defined angle; and

a spring having a first end secured to a second location of the front triangle and a second end secured to a second end of the spring arm.

**15**. The tensioner of claim **14**, wherein

the second end of the pivoting member and the pulley pivot away from a rear suspension pivot point based on increased tension on a drive belt of the bicycle created when the vertical rear wheel travel of the bicycle increases;

the second end of the spring arm rotates in same direction as the second end of the pivoting member in response to the pivoting of the second end of the pivoting member; and

a force is applied to the spring by the rotation of the second end of the spring arm to change size of the spring away from its initially configured size.

**16**. The tensioner of claim **15**, wherein

the size of the spring moves towards its initially configured size when tension on the drive belt is reduced based on the vertical rear wheel travel decreasing;

the second end of the spring arm rotates in opposite direction in response to the change in the spring size; and

the second end of the pivoting member and the pulley pivot back toward the rear suspension pivot point in response to the rotation of the second end of the spring arm.

**17**. The tensioner of claim **14**, wherein the rear suspension bicycle includes

a frame including the front triangle and a swingarm;

a rear suspension pivot point between the front triangle and the swingarm, wherein location of the rear suspension pivot point provides a predominantly rearward axle path; and

a drive train including a drive belt, a rear sprocket located at a rear wheel axis, an idler pulley located in close proximity to the rear suspension pivot point, a front sprocket located at a crank axis, and the tensioner located between the idler pulley and the front sprocket, wherein the drive belt traverses from the rear sprocket to the idler pulley, from the idler pulley to the front sprocket, from the front sprocket to the tensioner and from the tensioner back to the rear sprocket.

**18**. The tensioner of claim **14**, wherein the second location of the front triangle is below the first location of the front triangle.

**19**. The tensioner of claim **14**, wherein

the first location of the front triangle is a bracket extending from a tube of the front triangle; and

the pivoting member and the spring arm are secured to the bracket.

**20**. The tensioner of claim **14**, wherein the spring is a compression spring.

* * * * *