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(54) **BICYCLE FRAME WITH PASSIVE SEAT TUBE PIVOT JOINT**

(2013.01); **B62K 25/04** (2013.01); **B62K 2025/041** (2013.01); **Y10T 29/4984** (2015.01)

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*Primary Examiner* — Kevin Hurley

(57) **ABSTRACT**

A bicycle frame assembly that includes an upper frame member and a lower frame member that each extend between a head tube and a dropout. A seat tube extends between the upper frame member and the lower frame member. The seat tube is preferably connected to a bottom bracket of the lower frame member and is connected by a pivot to the upper frame member so that the seat tube can deflect from a rest position without altering an orientation of a top tube to a bottom tube of the upper and lower frame members, respectively.

**11 Claims, 5 Drawing Sheets**

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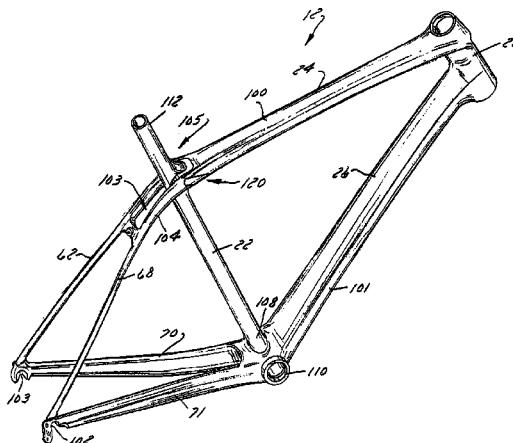
(60) Provisional application No. 61/430,011, filed on Jan. 5, 2011.

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(52) **U.S. Cl.**

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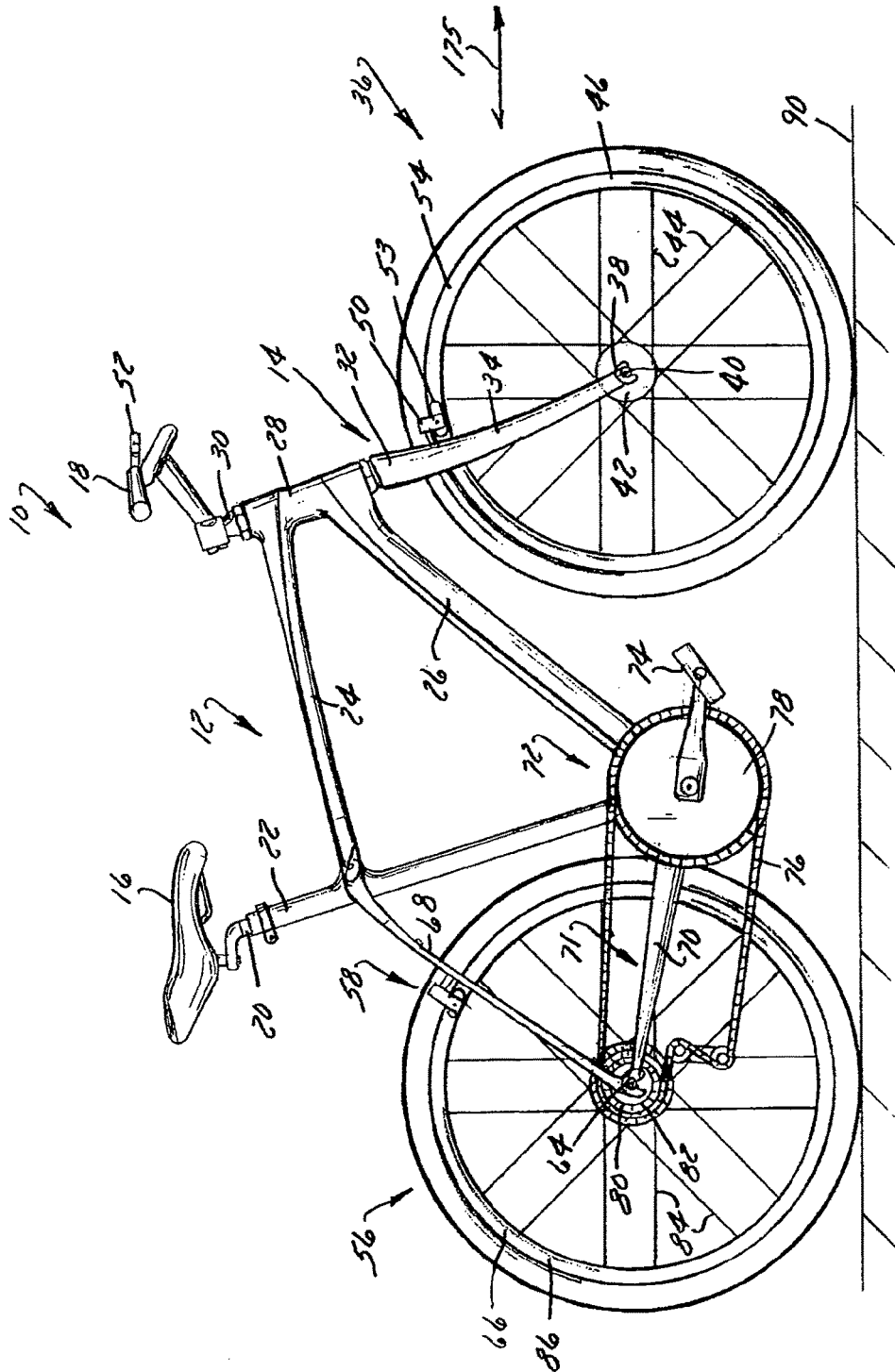


FIG. 1

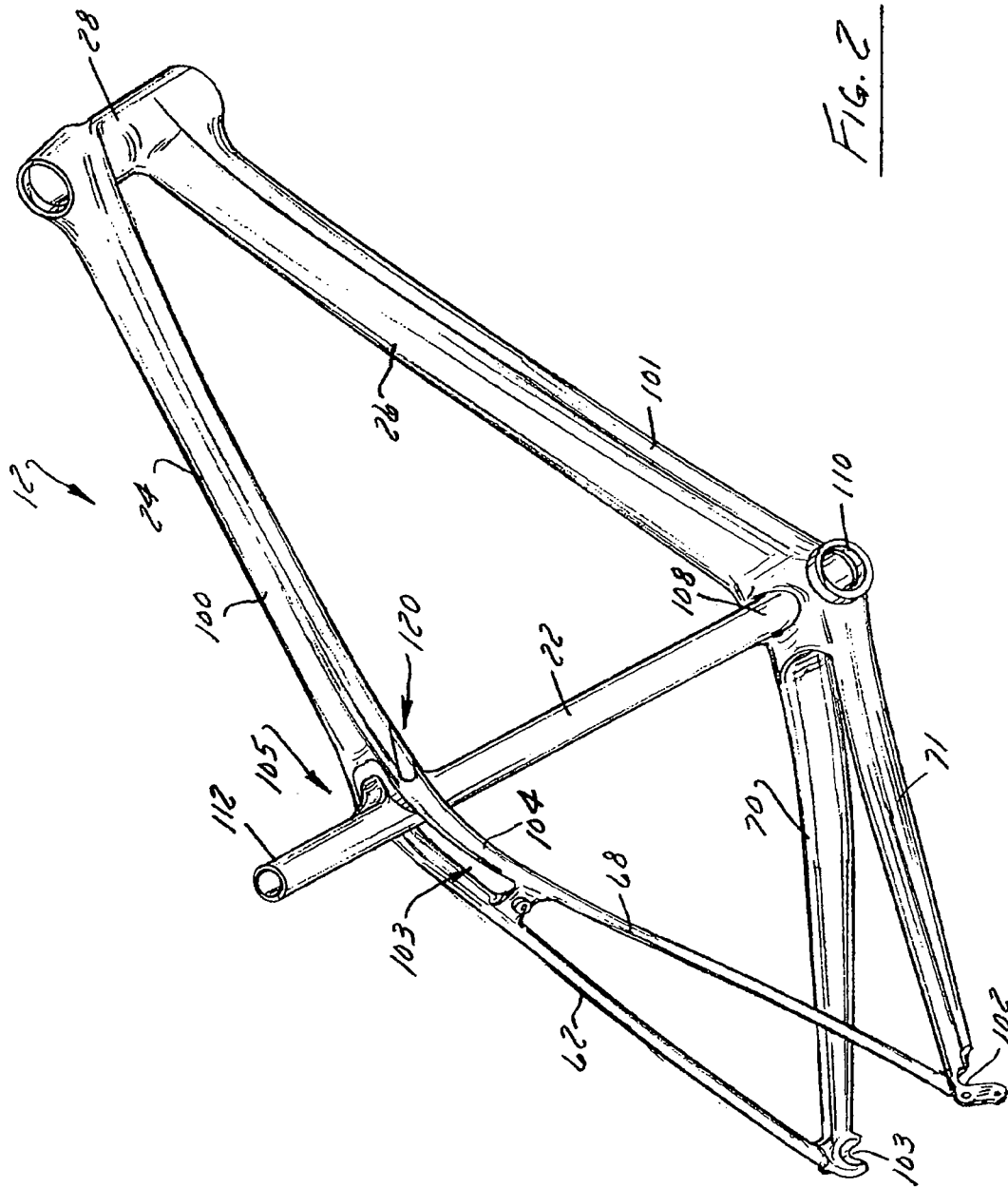
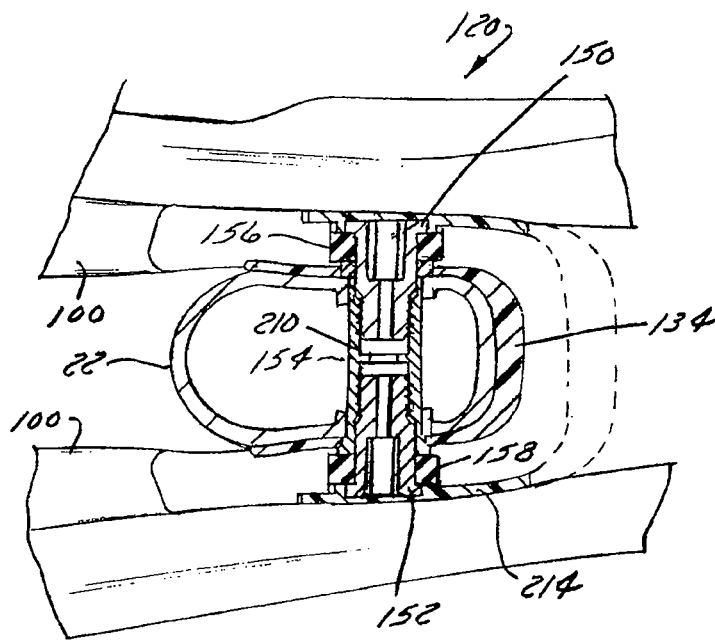
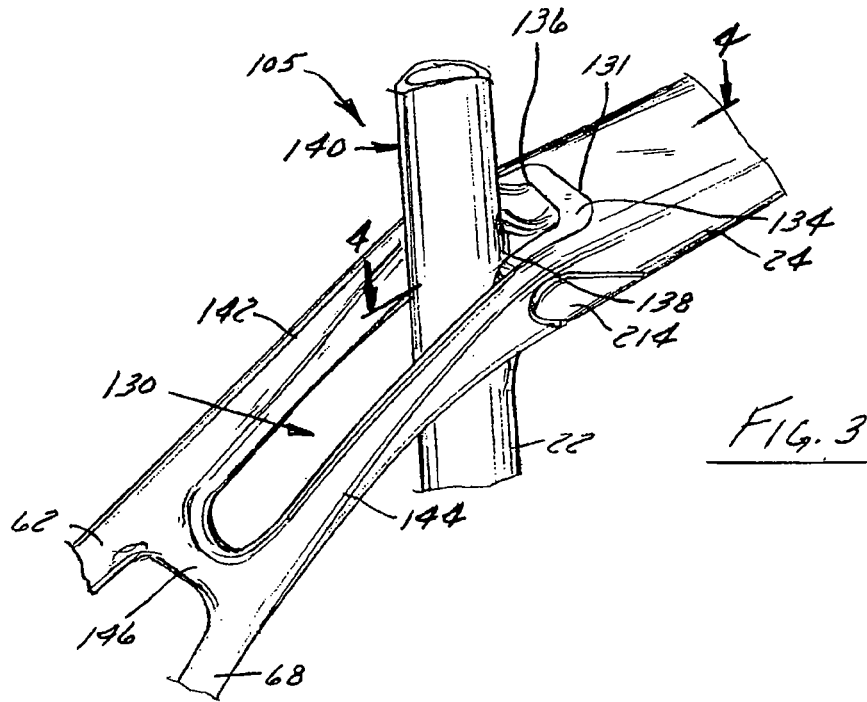


FIG. 2



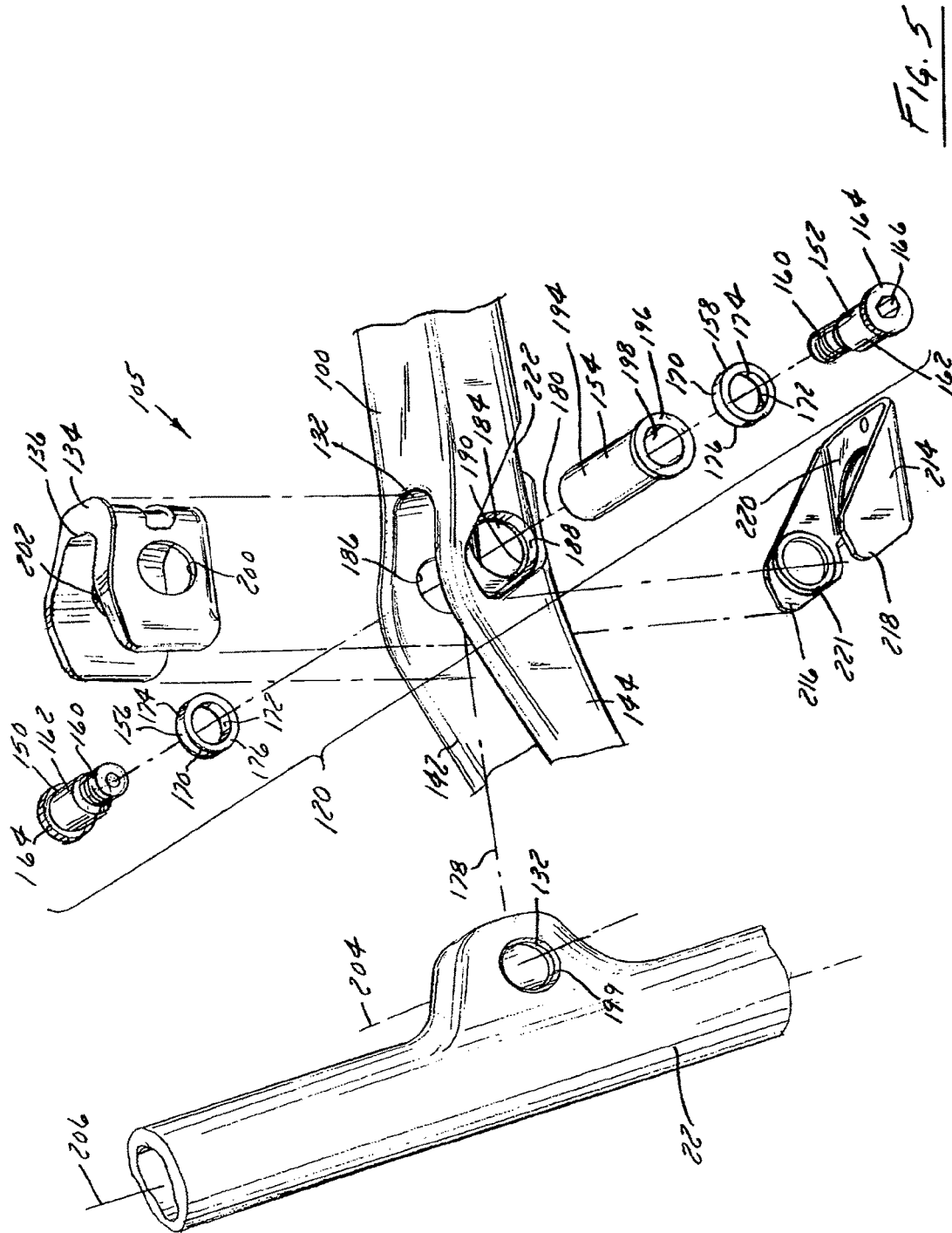
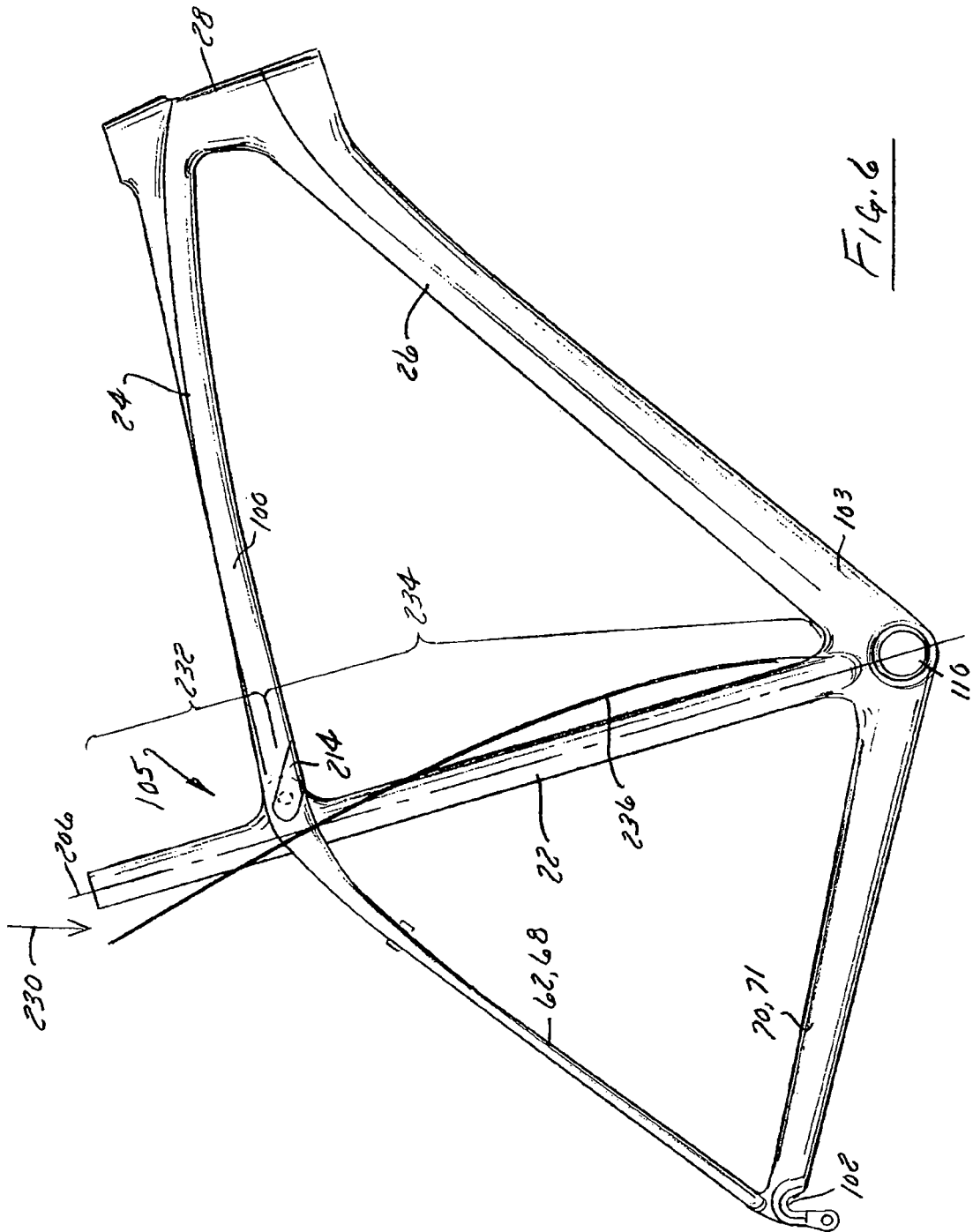


Fig. 5



## BICYCLE FRAME WITH PASSIVE SEAT TUBE PIVOT JOINT

### CROSS-REFERENCE TO RELATED APPLICATIONS

The present invention claims priority to U.S. Provisional Patent Application Ser. No. 61/430,011 filed on Jan. 5, 2011 and the disclosure of which is expressly incorporated herein.

### BACKGROUND OF THE INVENTION

The present invention relates to bicycles and, more particularly, to a bicycle frame assembly wherein the seat tube is connected at an overlapping intersection of a top tube and the seat stays by a passive pivot that allows the seat stay to deflect from a generally linear at-rest orientation to improve the vertical compliance of the bicycle frame.

The primary structural component of a conventional two-wheel bicycle is the frame. On a conventional road bicycle, the frame is typically constructed from a set of tubular members assembled together to form the frame. For many bicycles, the frame is constructed from members commonly referred to as the top tube, down tube, seat tube, seat stays and chain stays, and those members are joined together at intersections commonly referred to as the head tube, seat post, bottom bracket and rear dropout. The top tube usually extends from the head tube rearward to the seat tube. The head tube, sometimes referred to as the neck, is a short tubular structural member at the upper forward portion of the bicycle which supports the handlebar and front steering fork, which has the front wheel on it. The down tube usually extends downwardly and rearward from the head tube to the bottom bracket, the bottom bracket usually comprising a cylindrical member for supporting the pedals and chain drive mechanism which powers the bicycle. The seat tube usually extends from the bottom bracket upwardly to where it is joined to the rear end of the top tube. The seat tube also usually functions to telescopically receive a seat post for supporting a seat or saddle for the bicycle rider to sit on.

The chain stays normally extend rearward from the bottom bracket. The seat stays normally extend downwardly and rearward from the top of the seat tube. The chain stays and seat stays are normally joined together with a rear dropout for supporting the rear axle of the rear wheel. The portion of the frame defined by the head tube, seat post and bottom bracket and the structural members that join those three items together can be referred to as the main front triangular portion of the frame, with the seat stays and chain stays defining a rear triangular portion of the frame. The foregoing description represents the construction of a conventional bicycle frame which of course does not possess a suspension having any shock absorbing characteristics.

Although the increased popularity in recent years of off-road cycling, particularly on mountains and cross-country, has made a shock absorbing system in many instances a biking necessity. An exemplary rear wheel suspension system is disclosed in U.S. Pat. No. 7,837,213. Generally, bicycle suspension systems intended for off-road riding conditions include a number of links that are connected and movable or pivotable to allow the bicycle frame to absorb a portion of the energy associated with aggressive riding over uneven terrain. However, such robust suspension systems do not particularly lend themselves to extended rides over paved terrain. The robust nature of such systems increases the weight attributable to the bicycle assembly. During rides

intended to test rider stamina, endurance, and conditioning, such robust suspension systems would detrimentally affect rider time performance.

Fixed shape forward and rear triangle frame shapes are generally well accepted as the preferred configuration for many road bicycles due to their collective light weight and robust frame. However, even paved surfaces can present discontinuities wherein most riders would prefer some degree of bicycle suspension to limit or reduce the forces communicated to the rider from payment discontinuities. The ever increasing capabilities of bicyclists have created a sub-set of the road bicycle termed an endurance bicycle. Endurance bicycles are generally understood as race-ready road bicycles with added comfort to allow riders to complete rides of ever increasing duration and/or distance. Many endurance bicycles maintain a fixed forward and rear triangle frame and provide impact dampening with suspension seat posts and/or vibration dampening handlebar assemblies.

An alternate approach to an endurance bicycle is disclosed in U.S. Pat. No. 6,932,371. U.S. Pat. No. 6,932,371 discloses a bicycle assembly wherein the seat tube forms a passive suspension element via the elimination of the seat stays and providing a second set of chain stays that are located in closer proximity to the bottom bracket than to the top tube. The frame assembly of U.S. Pat. No. 6,932,371 includes a number of gusset members that are required to provide the desired non-vertical stiffness of the frame assembly. In achieving the desired vertical compliance, the bicycle frame of U.S. Pat. No. 6,932,371 includes a number of supplemental structures that, in improving vertical compliance, detrimentally affect the overall weight of the underlying bicycle assembly.

Accordingly, there is a desire to provide a bicycle frame assembly that includes a passive suspension element but does not appreciably detrimentally affect the weight of the overall bicycle frame assembly.

### BRIEF DESCRIPTION OF THE INVENTION

The present invention provides a bicycle frame assembly having a deflectable seat tube that overcomes one or more of the aforementioned drawbacks. One aspect of the invention discloses a bicycle frame assembly having an upper frame member and a lower frame member. The upper frame member includes a top tube and a pair of seat stays and extends between a dropout and a head tube in a generally continuous manner. The lower frame member includes a bottom tube, a bottom bracket, and a chain stay and extends between the dropout and the head tube. A seat tube extends from the lower frame member toward the upper frame member and passes beyond the top tube. The seat tube is connected to the upper frame member by a pivot so that more of the seat tube is located between the pivot and the bottom bracket than extends beyond the upper frame member. Preferably, an opening is formed through the top tube or a lug that connects the seat stays with the top tube. The seat tube preferably passes through the opening in the upper frame member. Alternatively, the seat tube could be perforated or otherwise contoured to pass generally around the more horizontal structure of the top tube and/or the seat stays. As another alternative, the seat tube could pass rearward relative to the top tube so as to be positioned in the space generally flanked by the seat stays.

Another aspect of the invention that is useable with one or more of the above aspects discloses a bicycle frame assembly that includes a forward frame triangle that includes a top tube and a bottom tube. The top tube includes a first end that



is connected to a head tube and a second end. The bottom tube includes a first end that is connected to the head tube and a second end. A bottom bracket is connected to the second end of the bottom tube. A seat tube extends in an upward direction from the bottom bracket and a pair of seat stays is connected to the top tube and extends in a rearward direction beyond the forward frame triangle. A pivot connects the seat tube to the forward frame triangle proximate the top tube at a location nearer a bicycle seat than the bottom bracket. The pivot allows that portion of the seat tube disposed between the pivot and the bottom bracket to deflect from an at rest position during vertical loading of the seat tube.

Another aspect of the invention that is useable with one or more of the above aspects discloses a bicycle frame assembly having an upper frame member that includes a top tube and a pair of seat stays. The upper frame member extends between a dropout associated with a rear wheel and a head tube. An opening is formed in the upper frame member. A lower frame member that includes a bottom tube, a bottom bracket, and a chain stay extends between the dropout and the head tube. A seat tube extends from the lower frame member toward the upper frame member and passes through the opening in the upper frame member. A pivot connects the seat tube to the upper frame member proximate the opening so that more of the seat tube is located between the pivot and the bottom bracket than extends beyond the upper frame member.

Another aspect of the invention that is useable with one or more of the above aspects discloses a method of allowing deflection of a seat tube. A seat tube is connected to a bottom bracket. The seat tube is connected to an upper frame member with a pivot that is located at an overlapping intersection of the seat tube and the upper frame member so that the seat tube can deflect from alignment along a line between the bottom bracket and the pivot.

These and various other features and advantages of the present invention will be made apparent from the following detailed description and the drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate one preferred embodiment presently contemplated for carrying out the invention.

FIG. 1 is a side elevation view of a bicycle having a bicycle frame assembly according to the present invention;

FIG. 2 is an elevated right hand perspective view of bicycle frame assembly shown in FIG. 1 with the wheels, seat, drive and handlebar assemblies removed therefrom;

FIG. 3 is a view similar to FIG. 2 of an intersection of the seat tube with the upper frame member of the bicycle frame assembly shown in FIG. 1;

FIG. 4 is a cross-section of the intersection of the seat tube with the upper frame member taken along line 4-4 shown in FIG. 3;

FIG. 5 is an exploded view of the assembly associated with the intersection of the seat tube and the upper frame member shown in FIG. 3; and

FIG. 6 is a side elevation view of the bicycle frame assembly shown in FIG. 2 and shows the loaded and loaded configurations of the seat tube associated with use of the bicycle frame assembly.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a bicycle 10 having a frame assembly 12 according to the present invention. Bicycle 10 includes a

seat 16 and handlebars 18 that are attached to frame assembly 12. A seat post 20 is connected to seat 16 and slidably engages a seat tube 22 of frame assembly 12. A top tube 24 and a down tube 26 extend forwardly from seat tube 22 to a head tube 28 of frame 12. Handlebars 18 are connected to a stem or steer tube 30 that passes through head tube 28 and is connected or integrally formed with a fork crown 32. Understandably, handlebar 18 may include a stem that is constructed to slidably engage an interior cavity of steer tube 30. It is appreciated that one or more of the structures of bicycle 10 and frame assembly 12 can be constructed from similar materials, a variety of different materials, and various combinations thereof. Preferably, frame assembly 12 and seat tube 22 are formed of metal-type materials, such as aluminum-type materials, carbon fiber materials, and/or materials that are sufficiently formable and robust enough to support the rider of bicycle 10.

Fork assembly 14 includes a pair of fork blades or fork legs 34 that extend from generally opposite ends of fork crown 32 and are constructed to support a front wheel assembly 36 at an end thereof or dropout 38. Dropouts 38 engage generally opposite sides of an axle 40 constructed to engage a hub 42 of front wheel assembly 36. A number of spokes 44 extend from hub 42 to a rim 46 of front wheel assembly 36. A tire 48 is engaged with rim 46 such that rotation of hub 42 and rim 46, relative to fork legs 34, rotates tire 48.

Bicycle 10 includes a front brake assembly 50 having an actuator 52 attached to handlebars 18 and a pair of brake pads 53 positioned on generally opposite sides of front wheel assembly 36. Brake pads 53 are constructed to engage a brake wall 54 of rim 46 thereby providing a stopping or slowing force to front wheel assembly 36. A rear wheel assembly 56 includes a brake assembly 58 similar to front wheel brake assembly 50 but it is appreciated that one or both of front and rear wheel brake assemblies 50, 58 could be provided in other brake configurations such as a disk brake assembly wherein a rotor and a caliper are positioned proximate one or more of front wheel axle 40 or a rear axle 64, respectively. A rear wheel 66 is positioned generally concentrically about rear axle 64.

A pair of seat stays 62, 68 (FIG. 2) and a pair of chain stays 70, 71 (FIG. 2) extend rearward relative to seat tube 22 and offset rear axle 64 from a crankset 72. Crankset 72 includes a set of pedals 74 that is operationally connected to a flexible drive member such as a chain 76 via one or more variable diameter chain gears or a chain ring or sprocket 78. Rotation of chain 76 communicates a drive force to a gear cluster 80 positioned proximate rear axle 64. Gear cluster 80 is generally concentrically orientated with respect to rear axle 64 and includes a number of variable diameter gears.

Gear cluster 80 is operationally connected to a hub 82 of rear wheel 66. A number of spokes 84 extend radially between hub 82 and a rim 86 of rear wheel 66 of rear wheel assembly 56. As is commonly understood, rider operation of pedals 74 drives chain 76 thereby driving rear wheel 66 which in turn propels bicycle 10. Fork assembly 14 is constructed to support a forward end 88 of bicycle 10 above a ground surface 90. Handlebar 18 is connected to frame 12 and fork assembly 14 such that operator manipulation of handlebar 18 is communicated to fork assembly 14 to facilitate rotation of front wheel assembly 36 relative to frame assembly 12 along a longitudinal axis, indicated by arrow 175, of bicycle 10. As is commonly understood, such manipulation of handlebar 18 steers bicycle 10 during riding.

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Understandably, the construction of bicycle **10** shown in FIG. **1** is merely exemplary of a number of bicycle configurations. That is, whereas bicycle **10** is shown as what is commonly understood as a street or road bike, it is appreciated that the present invention is applicable to a number of bicycle configurations including those bicycles with more aggression suspension systems commonly found in off-road or mountain bike frame configurations, and/or hybrids, cross-over or multi-purpose bicycle frame configurations.

Referring to FIGS. **1** and **2**, top tube **24** and seat stays **68** extend in a fairly continuous manner to form an upper frame member **100** that extends from head tube **28** to a pair of dropouts **102**, **103** that support rear axle **64**. Upper frame member **100** can be formed as one piece and/or assembled from a distinct top tube **24**, seat stays **68**, and/or an optional lug **104** that is disposed between the top tube **24** and the seat stays **68**. It is appreciated that seat stays **62**, **68** and top tube **24** of upper frame member **100** could be formed as a unitary structure, a number of discrete permanently connected elements, or connected to one another via an optional lug **104** associated with an overlap area **105** of seat tube **22** and upper frame member **100**. In a similar manner, it is also appreciated that down tube **26**, bottom bracket **110**, and chain stays **70**, **71**, whose assemblies collectively define a lower frame member that extends from head tube **28** to one or more dropouts **102**, **103** could be formed as a unitary assembly wherein bottom bracket **110** is formed with down tube **26** or chain stays **70**, **71**, or an assembly wherein the chain stays **70**, **71** and down tube **26** can be permanently affixed to a discrete bottom bracket lug or simply bottom bracket **110**. Once assembled, as plainly shown in FIG. **1**, bicycle **10** includes a forward frame triangle that is a generally defined by the triangular shape of the direction of extension of the seat tube, the top tube, and the down tube of frame assembly **12** regardless of the methodology or number of discrete elements used to form the frame assembly.

As shown in FIG. **2**, seat tube **22** includes a first end **108** that is secured to bottom bracket **110** of bicycle frame **12** and a second end **112** that extends in a generally upward direction beyond the location of the lug or overlap area **105** with upper frame member **100**. Preferably, seat post **20** (FIG. **1**) telescopically cooperates with seat tube **22** of frame assembly **12**. A passive pivot assembly **120** connects an upper portion of seat tube **22** to bicycle frame assembly **12** proximate overlap area **105** such that more of seat tube **22** extends between pivot assembly **120** and bottom bracket **110** than extends in an upward direction relative to the intersection of seat tube **22** and upper frame member **100**.

Passive pivot assembly **120** completes the linkage between upper frame member **100**, which includes top tube **24** and the structures associated with seat stays **62**, **68**. A lower end of seat tube **22** is secured to lower frame member **101**, which includes the down tube **26** and bottom bracket **110** and preferably one of more chain stays **70**, **71**. As explained above, seat tube **22**, top tube **24** and down tube **26** collectively generally define the forward triangle of frame assembly **12**. Frame assembly **12** has a fairly robust and stable feel during use but is also constructed to provide impact dampening performance in a manner that does not allow changing of the relative connection points of any of the respective members of the forward frame triangle. As described further below with respect to FIG. **6**, the non-bonded rigid yet pivotable connection of seat tube **22** with upper frame member **100** allows deflection of seat tube **22** in a vertical plane and in a direction along the longitudinal length of the seat tube **22** so as to allow the frame assembly

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**12** to provide a limited degree of suspension performance or vertical compliance without altering the orientation of the connection points of any of the frame members relative to one another.

As shown in FIGS. **3-5**, overlap area **105** includes a passage **130** that is shaped to allow seat tube **22** to pass therethrough. An opening **132** (FIG. **5**) is formed laterally through seat tube **22** and shaped to rotationally cooperate with pivot assembly **120**. As mentioned above, it is envisioned that seat tube **22** merely pass over an axis or longitudinal area associated with one or more of the top tube, the seat stays, and/or a fabrication lug being formed therebetween. It is envisioned that the seat tube could be perforated or otherwise contoured to pass generally around the more horizontal structure of the top tube and/or the seat stays associated with upper frame member **100**. As another alternative, the seat tube could pass rearward relative to the closed structure of top tube **24** so as to be positioned in the space generally flanked by the seat stays. Each configuration allows limited passive pivoting between seat stays **70**, **71** and the adjacent structure of upper frame member **100** of bicycle frame assembly **12**.

As shown in FIG. **3**, passage **130** is bounded on a forward side **131** by an end wall associated with top tube **24** or a portion of the respective frame lug **104**. A first optional gasket **134** is disposed between forward side **131** of overlap area **105** and top tube **24** and generally surrounds a forward side **136**, and opposite lateral sides **138**, **140** of seat tube **22**. Optional gasket **134** prevents moisture and/or dirt and/or debris from entering the pivot area associated with passage **130** and the passage of seat tube **22** therethrough but does not otherwise interfere with the flexion of seat tube **22** during use of bicycle **10** as described further below with respect to FIG. **6**. Passage **130** is bounded on opposite lateral sides by side walls **142**, **144** of upper frame member **100**. An optional rear web wall **146** completes the definition of passage **130** such that upper frame member **100** completely surrounds seat tube **22** with web wall **146** extending laterally between seat stays **62**, **68**.

As shown in FIGS. **4** and **5**, pivot assembly **120** includes a first bolt or other fastener **150**, a second bolt or other fastener **152**, a guide sleeve **154**, and first and second bearings or bushings **156**, **158**. Each of fasteners **150**, **152** includes a threaded portion **160**, a stem portion **162**, and a head portion **164**. The radial diameter of each fastener **150**, **152** gradually increase from the respective threaded portion **160** to the stem portion **162** to the head portion **164**. One or each of head portions **164** includes a drive surface **166** that is shaped to cooperate with a driving tool, such as a hex driver or the like for securing each of first and second fasteners **150**, **152** relative to pivot assembly **120**. Although shown as being formed on an interior radial surface of fasteners **150**, **152**, it is appreciated that drive surface **166** could have any number of shapes and/or be provided on a radial exterior surface of the corresponding fastener **150**, **152**. It is further appreciated that one of fasteners **150**, **152** could formed integrally with sleeve **154** such that operation of one respective fastener secures pivot assembly **120** relative to bicycle frame assembly **12**.

Each bushing **156**, **158** includes an outer radial surface **170**, an inner radial surface **172**, an outboard lateral surface **174**, and an inboard lateral surface **176**. As used herein, the inboard and outboard lateral directions associated with surfaces **174**, **176** of each bushing **156**, **158** refers to the orientation of surfaces **170**, **174** relative to a longitudinal vertical plane that contains longitudinal axis **175** of bicycle **10** and the relative position of the respective surfaces and/or

structures relative to the same. For example, surfaces 176 of bushings 156, 158 are nearer a longitudinal axis, indicated by line 178, of upper frame member 100. Accordingly, surfaces 174 are further outboard and surfaces 176 are further inboard relative to one another and longitudinal axis 178 of upper frame member 100 along a longitudinal axis, indicated by line 180, of pivot assembly 120. As shown in FIG. 5, the longitudinal axis 180 of pivot assembly 120 is oriented in a crossing direction relative to, and is preferably normal to, longitudinal axis 178 of upper frame member 100.

Still referring to FIGS. 4 and 5, a first opening 184 and the second opening 186 are formed in each of the respective sidewalls 142, 144 of upper frame member 100 and centered along axis 180 of pivot assembly 120. A seat 188 extends circumferentially about at least one of openings 184, 186 in the lateral outboard facing surface of the respective sidewall 142, 144. Seat 188 is defined by a lip 190 that extends circumferentially about the corresponding opening 184, 186 and is shaped to cooperate with sleeve 154 and a corresponding bushing 156, 158.

Sleeve 154 includes a stem portion 194, the head portion 196, and an opening 198 formed therethrough. Sleeve 154 is constructed to slidably cooperate with openings 184, 186 in a direction aligned with axis 180. When assembled, head portion 196 of sleeve 154 traverses an overlapping area between opening 184 and a seat 199 associated with opening 132 of seat tube 22 as well as opening 200 associated with optional gasket 134. Optional gasket 134 includes a second opening 202 that, when assembled, is also concentrically oriented with respect axis 180 of pivot assembly 120 and cooperates with the other of fasteners 150, 152. Opening 132 of seat tube 22 circumferentially cooperates with stem portion 194 of sleeve 154 when the longitudinal axis of opening 132 is aligned axis 180 of pivot assembly 120. As explained further below with respect to FIG. 6, the axis of opening 132 of seat tube 22 is formed along a plane, indicated by line 204, that is offset in a forward direction relative to longitudinal axis 175 of bicycle 10 and with respect to a longitudinal axis 206 of seat tube 22.

Threaded portions 160 of each fastener 150, 152 operatively cooperate with a threaded surface 210 (FIG. 4) formed on an inner radial surface of sleeve 154. Bushings 156, 158 rotatably cooperate with stem portion 162 of each of fasteners 150, 152 and cooperate with seats 188 defined by upper frame member 100. As shown in FIGS. 4 and 5, pivot assembly 120 can include another optional gasket 214 that cooperates with the laterally outboard directed sides of pivot assembly 120. Gasket 214 includes a first arm 216 and a second arm 218 that extend in a generally upward direction relative to a web wall 220. The laterally inboard facing side of each arm 216, 218 includes a lip 221 that is shaped to snugly cooperate with a radially outboard directed surface of head portion 164 of a respective fastener 150, 152. Preferably, upper frame member 100 includes a recess 222 that is shaped to mimic the shape of gasket 214 such that when assembled, gasket 214 provides a generally smooth contour along the exterior surface of upper frame member 100 associated with pivot assembly 120.

When assembled, pivot assembly 120 provides a secure connection between upper frame member 100 and seat tube 22 and does so in a manner that prevents lateral, longitudinal, and vertical movement of seat tube 22 relative to upper frame member 100 but allows rotation of seat tube 22 about axis 180 associated with opening 132 which is collinear with pivot assembly 120 relative to upper frame member 100. Such a connection allows only flexion or flexing movement

of seat tube 22 relative to the other structural members of bicycle frame assembly 12 during use of bicycle 10.

As mentioned above, other interactions between seat tube 22 and frame assembly 12 are envisioned that allow similar deflection of the seat tube 22. For instance, seat tube 22 could include a passage like passage 130 or otherwise be contoured so that the seat tube passed around the top tube/seat stays/lug and/or such that the top tube/seat stays/lug pass through the seat tube. Still another alternative includes connecting the seat stays to the upper frame member or top tube at a location forward of the seat tube such that the seat tube would be positioned in an area generally flanked by the seat stays. Referring to FIG. 6, although an axis, indicated by line 180, of pivot assembly 120 is offset in an forward direction relative to the longitudinal axis 206 of seat tube 22, is appreciated that axis 180 could be oriented to intersect axis 206 or offset in a rearward direction relative thereto so as to alter the deflection performance of seat tube 22 and/or to better suit the preferences of a given rider or class of users.

Referring to FIG. 6, during normal use of frame assembly 12, seat tube 22 maintains a generally "at rest" configuration as represented by seat tube 22 shown in FIG. 6. Preferably, seat tube 22 has a fairly linear at rest orientation. Understandably, during normal use, some initial deflection of seat tube 22 may occur depending on the weight and preferred orientation of the rider during normal use over relatively smooth terrain. During an impact event, indicated by arrow 230, a downward and rearward bending moment is imparted to seat tube 22 by the interaction of the rider with the rear portion of a saddle, which is commonly offset to the rear of the longitudinal centerline 206 of seat tube 22. Such loading of the seat tube allows seat tube 22 to pivot in a passive manner about pivot assembly 120 and results in a rearward deflection of an upper portion 232 of seat tube 22 positioned above pivot assembly 120 and a forward deflection of a lower portion 234 of seat tube 22 that is positioned between pivot assembly 120 and bottom bracket 110 relative to the at-rest orientation.

The deflection of seat tube 22 relative to upper frame member 100 and lower frame member 101 is shown graphically in FIG. 6 by line 236. Such a configuration allows near the entirety of seat tube 22 to deflect from an at rest position to a "bent" orientation, represented by line 236 to improve the vertical compliance of frame assembly 12. Supporting an upper end of seat tube 22 proximate the intersection of seat tube 22 with upper frame member 100 provides a fairly rigid feel of frame assembly 12 during all riding conditions but mitigates the communication of undampened travel surface discontinuities to the rider via rider interaction with the bicycle seat. Such performance improves rider comfort and decreases rider discomfort commonly associated with extended rides. Preferably, seat tube 22 deflects no more than 15 degrees from an at rest orientation and more preferably, seat tube 22 deflects no more than 7 degrees from a rest position in response to rider interaction with seat 16. Such a configuration has been shown to provide a desired degree of responsiveness to rider interaction with the bicycle frame and does so in a manner that improves the vertical compliance of the bicycle frame assembly without unduly detracting from the same. However, it is appreciated that any desired range of deflection can be provided. Preferably, the greatest deflection value is associated with a deflection that a rider will tolerate and still feel comfortable on the bicycle during most riding conditions to a near unperceivable deflection during most riding conditions.

As shown in the experimental data below, frame assembly 12 provides greater longitudinal deflection of the seat tube with comparable lateral stiffness for bicycle frames having similar shapes and with nearly negligible contribution to the overall weight of the bicycle frame assembly. It is further envisioned that the forward and/or rearward orientation of the pivot axis relative to the longitudinal axis of the seat tube can be manipulated to satisfy a wide variety of rider performance preferences and/or to alter the deflection performance of the seat tube. It is further appreciated that the construction of the seat tube can be manipulated to further alter the vertical compliance of the frame assembly while providing a robust bicycle frame assembly.

Description	Size	Frame Sample #	Weight (gram)	Full Frame Torsional Stiffness (inches)	Head Tube Stiffness N * m per degree	BB horizontal deflection (2) inches	Vertical Compliance (inches)
6SRS Baseline	56 H3	2011-5428	850	0.1885	78	56	0.86
6SRS Pivot	56 H3	2011-5697	898	0.186	79*	54	1.38

As shown in the data provided above, configuring a bicycle frame with the passive pivot connection between the seat tube and the upper frame member provides improved vertical compliance of the seat tube of approximately 60% with an increase in frame assembly weight of approximately 48 grams or only approximate 5% of the overall weight of the frame assembly. Accordingly, bicycle frame assembly 12 provides a bicycle frame have acceptable frame responsiveness with improved vertical compliance for improving rider comfort.

Therefore, one embodiment of the invention includes a bicycle frame assembly having a forward frame triangle that includes a top tube and a bottom tube. The top tube includes a first end that is connected to a head tube and a second end. The bottom tube includes a first end that is connected to the head tube and a second end. A bottom bracket is connected to the second end of the bottom tube. A seat tube extends in an upward direction from the bottom bracket. A pair of seat stays are connected to the top tube and extend in a rearward direction beyond the forward frame triangle. A pivot connects the seat tube to the forward frame triangle proximate the top tube at a location nearer a bicycle seat than the bottom bracket.

Another embodiment of the invention that includes one or more features combinable with the above embodiment includes a bicycle frame assembly having an upper frame member that includes a top tube and a pair of seat stays. The upper frame member extends between a dropout associated with a rear wheel and a head tube. An opening is formed in the upper frame member. A lower frame member that includes a bottom tube, a bottom bracket, and a chain stay extends between the dropout and the head tube. A seat tube extends from the lower frame member toward the upper frame member and passes through the opening in the upper frame member. A pivot connects the seat tube to the upper frame member proximate the opening so that more of the seat tube is located between the pivot and the bottom bracket than extends beyond the upper frame member.

Another embodiment of the invention that is useable with one or more of the aspects of the above embodiments discloses a method of allowing deflection of a seat tube. A seat tube is connected to a bottom bracket. The seat tube is connected to an upper frame member with a pivot that is located at an overlapping intersection of the seat tube and the upper frame member so that the seat tube can deflect from alignment along a line between the bottom bracket and the pivot.

The present invention has been described in terms of the preferred embodiment, and it is recognized that equivalents, alternatives, and modifications, aside from those expressly stated, are possible and within the scope of the appending claims.

What is claimed is:

1. A bicycle frame assembly comprising:
  - a forward frame triangle comprising:
    - a top tube having a first end connected to a head tube and a second end;
    - a bottom tube having a first end connected to the head tube and a second end;
    - a bottom bracket connected to the second end of the bottom tube; and
    - a flexible, unitary seat tube extending in an upward direction from the bottom bracket;
    - a pair of seat stays connected to the top tube and extending in a rearward direction beyond the forward frame triangle; and
    - a coupling connecting the seat tube to the forward frame triangle proximate the top tube at a location nearer a bicycle seat than the bottom bracket.
  2. The bicycle frame assembly of claim 1, further comprising a passage formed proximate an intersection of the seat stays and the top tube and shaped to accommodate the seat tube passing therethrough.
  3. The bicycle frame assembly of claim 2, wherein an axis of the coupling is oriented normal to an axis of the passage.
  4. The bicycle frame assembly of claim 1, wherein the flexible, unitary seat tube is made of a fiber reinforced plastic.
  5. The bicycle frame assembly of claim 1, wherein the seat tube can rotate at least 7 degrees about the coupling allowing the seat tube to deflect from an at rest shape.
  6. The bicycle frame assembly of claim 1, wherein a longitudinal axis of the coupling is one of positioned forward of a longitudinal axis of the seat tube, aligned with the longitudinal axis of the seat tube, or positioned rearward the longitudinal axis of the seat tube.
  7. A bicycle frame assembly comprising:
    - an upper frame member that includes a top tube and a pair of seat stays and that extends between a dropout and a head tube;

- an opening formed in the upper frame member;
- a lower frame member that includes a bottom tube, a bottom bracket, and a chain stay, and that extends between the dropout and the head tube;
- a flexible, unitary seat tube extending from the lower frame member toward the upper frame member and passing through the opening in the upper frame member; and
- a coupling connecting the seat tube to the upper frame member proximate the opening so that more of the seat tube is located between the coupling and the bottom bracket than extends beyond the upper frame member.
8. The bicycle frame assembly of claim 7, wherein the coupling is oriented either forward or rearward relative to a longitudinal center-line of seat tube.
9. The bicycle frame assembly of claim 7, further comprising a bridge that extends between the pair of seat stays and defines a rear wall of the opening.
10. The bicycle frame assembly of claim 7, wherein the flexible, unitary seat tube is made of a fiber reinforced plastic.
11. The bicycle frame assembly of claim 7, wherein the coupling includes a first portion and a second portion located on opposite sides of the flexible, unitary seat tube.

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