



(43) International Publication Date
27 December 2013 (27.12.2013)

- (51) International Patent Classification:
B62K 25/00 (2006.01)
- (21) International Application Number:
PCT/US2013/047392
- (22) International Filing Date:
24 June 2013 (24.06.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/663,559 23 June 2012 (23.06.2012) US
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- (81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

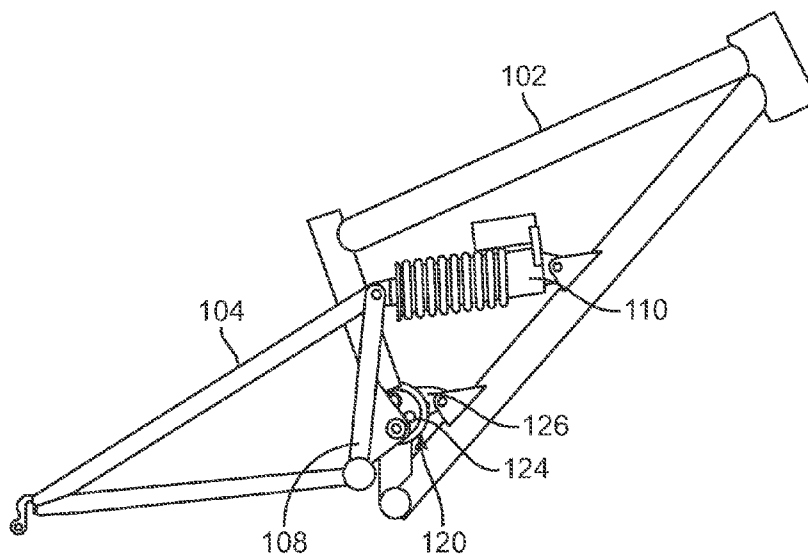
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
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SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: BICYCLE REAR SUSPENSION WITH A TWO AXIS WHEEL PATH



(57) **Abstract:** Disclosed herein are rear suspension systems for bicycles that couple the rear wheel of a bicycle to a bicycle frame through a swing arm assembly. The structures disclosed herein allow for independent movement of the swing arm assembly in both vertical and horizontal directions. The rear suspension system includes a first deflection device coupling the swing arm assembly to a main frame assembly at a first coupled location, where the first deflection device is configured to allow relative motion between the swing arm assembly and the main frame. A second deflection device is also provided coupling the swing arm assembly to the main frame assembly at a second coupled location.



BICYCLE REAR SUSPENSION WITH A TWO AXIS WHEEL PATH

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional of U.S. Provisional Application No. 61/663,559 filed June 23, 2012 the content of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] High-end bicycles, especially those used for off-road riding, typically have both rear and front suspension systems to assist in traversing uneven or rough terrain. Downhill mountain racing bikes, freeride bikes, trail bikes and recreational bikes can be subjected to high speeds where the bumpier terrain can increase the chance that the rider can lose control. The combination of the terrain and speed conditions can result in rear wheel movement vectors including rearward direction impact vectors in addition to vertical direction vectors.

[0003] Many rear suspension systems designed for freeriding and other biking applications are known by those skilled in the art. Such systems generally include a rear suspension permitting a limited degree of travel of the rear wheel relative to the bicycle frame and a rear shock absorber that absorbs or dampens suspension forces acting on the wheel. The range of rear wheel travel permitted by existing suspension systems varies, but is typically within the range of about 5 to 12 inches measured vertically (although some designs permit travel outside this range).

[0004] The dramatic growth of rear wheel suspension on such bicycles is partially due to the fact that rear suspension systems not only increases rider comfort, since the suspension dampens jarring forces from rough terrain, but also prevents the forces or movement vectors from being directly transferred to the rider's seat. The growth of these suspensions can also be attributed to the need for increase traction and control when the rear wheel suspension acts to keep the rear wheel in better contact with the trail surface after encountering the rough terrain.

[0005] There is a need for improved suspensions for the rear wheel of bicycles and/or two-wheeled vehicle. More particularly, a need remains for suspensions that are adapted or configured for off-road two wheel vehicles (hereafter referred to as bicycles or bikes, including motorized as well as manual powered). The need includes suspensions that allow the rear

wheel to move in two axes, or degrees-of-freedom (DOF) relative to the remainder of the frame of the bike.

BRIEF SUMMARY OF THE INVENTION

[0006] This invention relates to the rear suspension of bicycles or motor driven cycles. The present invention comprises improvements to a bicycle suspension system with a two-axis rear wheel path for rearward compliance in addition to the main vertical compliance for improved control in bumpy, steep, high-speed off road terrain conditions. The following examples illustrate simple, light and compact improvements that can optionally be manufactured for less expense.

[0007] The present disclosure includes an improved a bicycle suspension system for use with bicycle having a main frame assembly and a swing arm assembly, the system allowing improved movement of a wheel coupled to the swing arm assembly.

[0008] In one example, the improved bicycle suspension system includes a first deflection device coupling the swing arm assembly to the main frame assembly at a first coupled location, where the first deflection device is configured to allow relative motion between the swing arm assembly and the main frame; a second deflection device coupling the swing arm assembly to the main assembly at a second coupled location; where a frame end of the first deflection device is pivotally coupled to the main frame assembly and a swing arm end of the first deflection device is pivotally coupled to the swing arm assembly; and where a frame portion of the second deflection device is coupled to the main frame assembly and a swing arm portion of the second deflection device is coupled to the swing arm assembly such that the second deflection device permits relative movement between the swing arm assembly and the main assembly independently in either a horizontal direction or a vertical direction. The term assembly and portion with regard to the main frame and swing arm are intended to be used interchangeably and include additional features or structures that can be incorporated to the respective part of the bicycle.

[0009] The horizontal direction can optionally comprise a horizontal arcing direction and/or the vertical direction can optionally comprise a vertical arcing direction.

[0010] In one variation, the second deflection device comprises at least a first pivot bearing located at the swing arm portion of the second delivery device, where the first pivot

bearing allows movement of the swing arm assembly in the vertical direction upon rotation of the swing arm assembly about an axis of the first pivot bearing.

[0011] Variations of the suspension also includes where the second deflection device comprises a shock member coupled to the main frame assembly at the frame portion of the second deflection device, where deflection of the shock member results in movement of the swing arm in the horizontal direction.

[0012] In certain variations of the second deflection device includes a first pivot bearing is mechanically coupled to a portion of the shock member. In some cases the second deflection device includes a second pivot bearing coupling the first pivot bearing to the portion of the shock member, where rotation of the second pivot bearing is driven by torsion of the portion of the shock member, where the rotation of the second pivot bearing and rotation of the first pivot bearing permits movement of the swing arm in the horizontal direction.

[0013] One or more a pivot bosses can be coupled to the shock member the pivot boss also being coupled to the second pivot bearing such that deflection of the shock member causes movement of the second pivot bearing. In additional variations, a frame plate is coupled to the main frame assembly at the frame portion of the second deflection device, where the frame plate comprises defines an opening that limits movement of the pivot boss or second pivot bearing to limit movement of the shock member. For example, the opening can be any opening that provides desired restraint or movement of the shock member. For instance, the opening can comprise a shape selected from an ellipse, a circular opening, and a slot.

[0014] The suspensions described herein can include shock members where a first portion of the shock member comprises at least one opening or cavity that increases deflection of at least a second portion of the shock member.

[0015] The first deflection device can comprise a shock absorber or damper. Such structures can include structures selected from the group consisting of a hydraulic, pneumatic, coil sprung, non-spring based, elastomeric structures.

[0016] The present disclosure also includes a bicycle comprising: a main frame assembly; a swing arm assembly, the swing arm assembly having a rear wheel axis portion for affixing a rear wheel thereto; a first deflection device mechanically coupling the swing arm assembly to the main frame assembly at a first location; a second deflection device mechanically coupling the swing arm assembly to the main assembly at a second location; where a frame end of the

first deflection device is pivotally coupled to the main frame assembly and a swing arm end of the first deflection device is pivotally coupled to the swing arm assembly, where the frame end and swing arm end of the first deflection device are moveable relative to each other; where a frame portion of the second deflection device is coupled to the main frame assembly and a swing portion of the second deflection device assembly is coupled to the swing arm assembly such that the second deflection assembly permits relative movement between the swing arm assembly and the main assembly independently in either a horizontal direction or a vertical direction.

[0017] Another variation of the invention includes a bicycle suspension component for use with a bicycle having a main frame assembly and a swing arm assembly and a linear damper device pivotally coupling to both the swing arm assembly and the main frame assembly. One example of such a suspension component includes a frame portion for affixing to the frame assembly; a swing arm portion for affixing to the swing arm assembly, where the swing arm assembly includes a rear axle; and where when the frame portion is affixed to the main frame assembly and the swing arm portion is affixed to the swing arm assembly the main frame assembly and the swing arm assembly are able to move independently in either a horizontal direction or a vertical direction.

[0018] The bicycle, bicycle component, and/or bicycle suspension system disclosed or discussed herein are examples of the invention described herein. It is contemplated that combinations of aspects of specific embodiments or combinations of the specific embodiments themselves are within the scope of this disclosure.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0019] FIG. 1 illustrates an exemplary bicycle with one variation of a dual suspension configuration as disclosed herein.

[0020] FIG. 2A illustrates a side view of a main frame and a swing arm of a bicycle of coupled by a first displacement device and a second displacement device.

[0021] FIGS. 2B and 2C show respective top and front views of the bicycle structures shown in FIG. 2A.

[0022] FIGS. 3A to 3D illustrate four positions of rear wheel axle movement and depicted curve to demonstrate movement of a rear axle of a dual suspension bicycle using the principles disclosed herein.

[0023] FIG. 4A illustrates an exploded view of a variation of the second deflection device.

[0024] FIG. 4B illustrates relative movement of bearings used in the second deflection assembly.

[0025] FIG. 4C shows a side view of the second deflection assembly of FIG. 4A.

[0026] FIG. 4D shows a sectional view of the second deflection assembly taken long lines 4D-4D of FIG. 4C.

[0027] FIGS. 5A and 5B illustrates a partial sectional view of the second deflection device showing displacement of the shock member as movement A2 deforms the shock member.

[0028] FIG. 6A shows another variation of a dual suspension configuration having a first deflection device and a second deflection device.

[0029] FIG. 6B shows an exploded assembly view of the second deflection device depicted in FIG. 6A.

[0030] FIG. 6C shows a side view of the displacement device of FIG. 6B.

[0031] FIG. 6D shows a cross sectional view of the displacement device taken along line 6D-6D of FIG. 6C.

[0032] FIG. 6E illustrates one example of displacement of the shock member, pivot boss, and pivot bearing as a result of movement A3.

[0033] Fig. 6F is intended to illustrate the displacement of a shock member.

[0034] FIGS. 7A to 7D illustrate a path of movement or curve of a rear axle through four extreme positions depending on the displacement of the various displacement devices.

[0035] FIG. 8 illustrates yet another variation of a suspension system for providing the benefits as discussed herein.

[0036] FIGS. 9A and 9B illustrate oblique views of additional variations of a displacement device according to the present disclosure.

[0037] FIGS. 10A and 10B illustrate yet another variation of a suspension assembly.

[0038] FIG. 10C shows an exploded view of the variation shown in FIG. 10A.

DETAILED DESCRIPTION OF THE INVENTION

[0039] FIG. 1 illustrates an exemplary bicycle **100** having a dual suspension configuration as disclosed herein. While the bicycle **100** is illustrated as a variation of a mountain bike configuration, it should be noted that the suspension design and other improvements discussed herein can be applied to any two wheel vehicle, including, motorized bicycles, manual bicycles, or other such vehicles where dual suspension is desired.

[0040] FIG. 1 shows the bicycle **100** including dual suspension assembly having certain features, aspects and advantages of preferred embodiments of the present invention. The overall bicycle **100** is described in general detail to assist in the understanding of certain features and advantages of the illustrated variation of the suspension design. Details of the bicycle **100** that are not described herein may be assumed to be of a conventional construction or a suitable alternative construction, such as those readily known by one of skill in the art. For example, the bicycle shown in FIG. 1 includes three main sections, a main frame assembly or portion **102** having a swing arm assembly **104** coupled thereto and a front fork assembly **108** located on an opposite side of the swing arm assembly **104**. The front fork assembly **108** can include a steering bar and wheel.

[0041] As shown, the main frame portion or assembly **102** of the illustrated bicycle **100** couples to a swing arm assembly **104**. The swing arm assembly **104** is also known as a rear frame assembly and is moveable relative to the main frame portion **102** due to the suspension system discussed below.

[0042] The swing arm assembly **104** supports a wheel **106** (in most cases a rear wheel). As noted herein, the illustrated configuration includes a dual suspension system that allows for relative movement between the main frame portion **102** and the swing arm assembly **104** especially in view of movement of the wheel **106**. In this particular variation, the dual

suspension comprises a first deflection device **110** and a second deflection device **120** each coupling the swing arm assembly **104** to the main frame portion **102** at different locations. In this example, the first deflection device **110** comprises a shock absorber assembly that travels along a first axis (i.e., the stroke of the shock absorber). As shown, the first deflection device **110** couples the main frame portion **102** to the swing arm assembly **104** at a first location. However, the location of the coupling can be varied as needed where the illustrated first location is shown for convenience only.

[0043] In the illustrated example, the second deflection device **120** permits relative movement between the swing arm assembly **104** and the main frame portion **102** independently in either a horizontal or vertical direction as shown by FX and FY. The independent movement in either the FX (horizontal) or FY (vertical) movement means that the second deflection device allows movement of the portion of the swing arm assembly coupled to the second deflection device **120** in either the FX or FY directions regardless of where the first deflection device **110** is in its stroke along the first axis.

[0044] FIG. 1 also illustrates two directions of wheel **106** movement encountered when the bicycle **100** is ridden under the conditions described herein. Direction A1 corresponds to the vertical path movement along the FY direction. Direction A2 corresponds to a relatively smaller amount of rear travel along the FX direction. FIG. 100 also illustrates an additional movement direction of A4, which occurs as a result of independent front wheel movement in response to forces acting on the wheel.

[0045] FIG. 2A illustrates a side view of the main frame **102** and swing arm **104** of the bicycle of FIG. 1 with various assemblies removed for purposes of illustration. As shown, the main frame portion **102** is coupled to the swing arm **104** via the dual suspension configuration including a shock absorber **110** coupled between the main frame **102** and swing arm **104**. The coupling points can include any number of bearings at either end to permit movement of the shock absorber **110** along its stroke axis. The swing arm **104** is also coupled to the main frame **102** using a second deflection device **120**. While variations of the second deflection device **120** are described below, the illustrated variation depicts the lower portion **108** of the swing arm **104** coupled to a link **124** that provides a rotational mount on the deflection device **120** so that the swing arm **104** is rotably joined to the deflection device **120**. Accordingly, one or more bearings can be used when fastening the swing arm **104** to the deflection device **120**.

FIG. 2A also shows a deflection portion or shock member **126** of the second deflection device **120**. The deflection portion can comprise an elastomer or similar material that permits deflection in both axial and horizontal directions as described above as well as providing a damping function. In one variation, the elastomers allow for wide tuning options, simplicity, light weight, and no stiction from seals, and short lengths without custom shocks. One example of such an elastomer is polyurethane.

[0046] FIGS. 3A to 3D illustrate four positions of rear wheel axle **107** movement, depicted by curve **10** (having positions **2**, **4**, **6**, and **8**) when using a variation of the dual suspension configuration disclosed herein. It is noted that the maximum displacements of each deflection device affect the shape of curve **10**. It is understood by those skilled in the relevant art that displacement of the rear wheel or axle **107** can be adjusted by varying the stroke of the each displacement device. Such adjustments affect the shape of curve **10**.

[0047] FIG. 3A represents an initial position **2** as a base for illustrating the deflection of the deflection devices. FIG. 3B illustrates the movement of axle **107** from position **2** to position **4** in response to displacement **A1** (see also **A1** from FIG. 1). As noted previously, **A1** depicts vertical movement of the wheel or axle **107** in response to riding conditions. As shown in FIG. 3B moving rear axle **107** upwards to position **4**. FIG. 3C illustrates an additional movement **A2** acting on rear wheel or axle **107**, which in turn causes deflection of the second deflection device **120** in a rearward direction along **FX** (see FIG. 1). This deflection of rear axle **107**, while still under the influence of **A1** causes rear axle **107** to move to position **6**. However, movement of the second deflection device **120** can also occur independently of movement of the first deflection device **110**.

[0048] FIG. 3D shows movement of rear axle **107** as force or deflection **A1** is removed causing the rear axle **107** to move from position **6** to position **8**. It is noted that, FIG. 3D shows second deflection device **120** in the same or similar position as that shown in FIG. 3BC.

[0049] Again, the dual suspension configuration permits fore and aft movement independent of up and down movement of the rear wheel axis **107** / rear wheel **106**. The ability to have such independent movement improves the shock absorbing and pivoting of the bicycle.

[0050] FIG. 4A illustrates an exploded view of a variation of the second deflection device **120**, where FIG. 4B illustrates relative movement of bearings used in the second deflection

assembly. Any of the bearings described herein can include conventional cartridge ball bearings or plane bearings. FIG. 4C shows a side view of the second deflection assembly and FIG. 4D shows a sectional view of the second deflection assembly taken along lines 4D-4D of FIG. 4C.

[0051] As shown, the second deflection device 120 can include a shock member 126 that physically couples the main frame portion 102 via any number of connection points. In the illustrated variation, the shock member 126 fastens to the main frame portion 102 via use of a fastener 50 positioned through opening 58. It should be noted that any number of bushings or spacers 54 can be used. The shock member 126 can be constructed from an elastomeric material where thickness, durometer, number of mounting points 58, as well as through holes 60 can be varied as needed to tune spring and damping rates to meet the desired performance characteristics of the suspension assembly. As previously discussed, the second deflection assembly 120 is also rotationally coupled to the swing arm 104. In this variation, the swing arm 104 is directly coupled to the second deflection device 120 using a first pivot bearing 128 that allows movement of the swing arm upon reaction of the rear wheel to direction A1 as previously discussed. FIG. 4B illustrates the direction of movement of swing arm 104 in response to movement A1. The first pivot bearing 128 is fastened to the second deflection device 124 via fastener 52 though any number of fasteners can be used.

[0052] FIG. 4A also shows fastener 52 and first pivot bearing coupled to a link plate 124. Link plate 124 is seated within a second pivot bearing 130 and secured thereto using fasteners 50 that extend through shock member 126. Movement A2 by the swing arm 102 in the FX direction causes rotation of second pivot bearing as shown in FIG. 4B. This rotation causes deflection of shock member 126 allowing for the rear frame assembly 104 to move as described above. It is noted that FIG. 4B illustrates the state depicted in FIG. 3C where the swing arm assembly is subject to movement A1 and A2. However, as noted above, the second deflection device can move in response to either A1 or A2. FIG. 4B also illustrates deformation of through-hole 60 as shock member 126 is deformed as a result of the movement of the swing arm 104. As noted above, the suspension system can be adjusted or tuned by varying the parameters of the shock member 126. Furthermore, movement of the swing arm 104 in either a horizontal directional arc or a vertical directional arc is accomplished by the ability of the second deflection device 120 to move in response to either A1 or A2.

[0053] FIGS. 5A and 5B illustrates a partial sectional view of the second deflection device showing the shock member 126 as movement A2 deforms shock member 125 and allows movement of the swing arm 104 relative to the main frame 102. FIG. 5A illustrates the state of the shock member 126 prior to movement as well as distances X1 and X2 which represent the distance between mounting points 56 of the transfer plate and the mounting point 58 to the main frame 102. As movement along A2 occurs via link plate (not shown in FIGS. 5A and 5B), F1 places a portion of the shock member 126 in compression while F2 places another portion of the shock member 126 in tension. The result is that the shock member 126 undergoes a torsion to cause a radial dimension of as measured by B1 to decrease to that of B1' as shown in FIG. 5B. The resulting forces also cause distance X1 to decrease to X1', which corresponds to the portion of the shock member 126 placed in compression. Distance X2 increases to X2', which corresponds to the portion of the shock member 126 placed in tension.

[0054] Again, FIGS. 5A and 5B show a single variation of a second deflection device having a shock member. Any number of modifications to the shock member can be made to adjust the spring and damping rates of the second displacement device. For example, such changes include, but are not limited to, the thickness of the shock member, the durometer of the elastomer material, the number of mounting bolts 52, and the size, location, and number of holes 60, pockets, or other surface or body features.

[0055] FIG. 6A shows another variation of a dual suspension configuration having a first deflection device 110 and a second deflection device 120 to function similar to that described above for coupling a main frame portion 102 with a swing arm assembly 104. However, in this example, the second deflection member 120 comprises a flexible elastomeric structure that is capable of providing both a shock absorbing function and a displacement function. In this variation, the second deflection device 120 does not necessarily require a second bearing. However, alternate variations of the deflection device can easily incorporate a bearing if so required.

[0056] FIG. 6B shows an exploded assembly view of the second deflection device 120 depicted in FIG. 6A. In this variation, the deflection device 120 includes a first pivot bearing 128 for coupling the swing arm 104 in a manner similar to that described above. The first pivot bearing 128 can be mounted in any number of ways as is understood by those skilled in

the art. In the illustrated variation, the first pivot bearing is mounted using a pivot boss 62 on each side with a spacer 54. The second displacement device can also include any number of housing components 130 or similar structures that retain or house the remaining components of the displacement device. In this example, the housing component 130 comprises a plate, ring or collar structure that contains a clearance area 132 to limit motion of the pivot boss 62 as it moves when the swing arm assembly 104 causes deflection of the shock member 126. Accordingly, the clearance area 132 can also optionally limit displacement of the shock member 126.

[0057] This variation of the displacement device includes a shock member 126 that functions as a damper and displacement mechanism as well as eliminates the need for a torsional bearing. In this variation, the shock member 126 is coupled to the main frame portion 102 by being housed within a portion 112 of the main frame 102 and forms the frame end of the second deflection device. The swing arm assembly 104 couples to one of the first pivot bearings 128 that are coupled to either side of this variation of the second deflection device 120. Accordingly, the pivot bearings 128 and fasteners 52 form the swing arm end of the second deflection device 120. This variation of the second deflection device can also include an optional spacer 54 located through a central opening 56 of the shock member 126. In addition, the shock member 126 can include one or more through holes 60 as described above to achieve the desired performance characteristics. Any of the shock members described herein can include any number of through-holes, pockets, or other features that promotes desired deflection, torsion, compression, or tension of the shock member. In addition, the shock member can be tuned by selecting a particular the thickness, the durometer of the elastomer material, the number of mounting bolts 52, and the size, location, and number of holes 60, pockets, or other surface or body features.

[0058] FIG. 6C shows a side view of the displacement device of FIG. 6B and FIG. 6D shows a cross sectional view of the displacement device taken along line 6D-6D of FIG. 6C. FIG. 6C shows the displacement device 120 in a neutral position without significant lateral displacement of the shock member 126. As illustrated, the housing ring or plate 130 includes a clearance area 132 that can limit movement of the pivot boss 62. Clearly, the displacement of the deflection device 120 can be tuned by any number of factors, including but not limited to, modification of the clearance area 132 (via size, shape, etc.), modification of the size and/or

shape of the pivot boss 62, as well as by the use of any spacers or other adjustments readily apparent by those skilled in the art.

[0059] FIG. 6E illustrates one example of displacement of the shock member 126, pivot boss 62, and pivot bearing 128 as a result of movement A3. As noted similarly above, movement A3 acts on the rear wheel and is transferred by the swing arm 104 to the first pivot bearing 128. In this illustration, the bracket of the swing arm 104 used to couple the swing arm 104 to the deflection device 120 is not shown for purposes of clarity. As A3 causes rearward movement (or any lateral movement), the shock member 126 displaces until clearance area 132 limits the movement of the pivot boss 62. In additional variations, the deflection device 120 does not require a clearance area, instead the shock member 126 can be used to limit movement. Alternatively, any number of stops can be incorporated into shock assembly 126 where the stops can be used to limit movement of the shock assembly 126 against a housing plate 130 or other portion of the bicycle.

[0060] FIG. 6E also represents that vertical movement A1 of the swing arm can occur independently as a result of the first pivot bearing 128. Clearly, such vertical and lateral movement can occur independently.

[0061] Fig. 6F is intended to illustrate the displacement of the shock member. For sake of clarity, the shock member 126 and first pivot bearing 128 without the housing plate or bracket of the swing arm are omitted from the view. FIG. 6F shows displacement of the shock member 126 as a result of movement A3 that is transmitted through the connection of the swing arm coupling (not shown) at the first pivot bearing 128. Displacement of the shock member 126 causes the through-hole 60 to compress. Accordingly, the shock member 126 experiences compression and tension on opposing sides.

[0062] FIGS. 7A to 7D illustrate a path of movement or curve 10 having four extreme positions 2, 4, 6, and 8 depending on the displacement of the various displacement devices. The principles discussed above with respect to FIGS. 3A to 3D are similar to that shown in FIGS. 7A to 7D while the degree of displacement of each position 2, 4, 6, and 8 can vary as required. FIG. 7A illustrates the first and second displacement devices 110 and 120 coupling a main frame portion or assembly 102 to a swing arm portion or assembly 104. In FIG. 7A the suspension system is at an initial position resulting in rear wheel axle 107 located at position 2.

[0063] FIG. 7B illustrates the condition where movement A1 drives axle 107 in a vertical direction or arc. This movement causes movement of the first displacement device 110 along its axis to move rear axle 108 to position 4. In the illustrated example, the movement causes compression of the first displacement device 110. Because the second displacement device 120 includes a first pivot bearing 128, movement of the swing arm 104 in the vertical direction or arc can occur with or without displacement of the shock member located within the second displacement device. As noted above, this feature permits independent movement of the swing arm assembly (especially the portion coupled to the second deflection device) in either a horizontal or vertical direction or arc.

[0064] FIG. 7C shows the situation where swing arm assembly 104 is still driven vertically as shown in FIG. 7B, however, lateral movement A3 of the rear wheel (as transferred by rear wheel axle 107 and the swing arm assembly 104 results in lateral or horizontal displacement of the first pivot bearing 128 and displacement of the shock assembly. This action moves rear axle 107 to position 6. FIG. 7D illustrates the condition after the rear axle retreats from vertical movement A1 but while rear axle 107 is still subject to movement A3. As a result, rear axle moves to position 8.

[0065] FIG. 8 illustrates yet another variation of a suspension system for providing the benefits as discussed herein. In this variation, the suspension system includes a first and second displacement device 110 and 120 where the second displacement device 120 can comprise any of the variations discussed herein as well as modifications or combinations of such variations. The first displacement device 110 can include a shock absorber or damper including but not limited to hydraulic, pneumatic, coil sprung, non-spring based, elastomerically damped or any conventional shock or damper configuration that provides the desired spring, damping, and displacement properties required.

[0066] FIGS. 9A and 9B illustrate oblique views of additional variations of a displacement device according to the present disclosure. For example, FIG. 9A shows a displacement device 140 having additional plates 142 that act as thrust bearing surfaces and which increase the lateral stiffness of the frame assembly. FIG. 9B illustrates another displacement device 150 having a slotted plate 152 configuration that acts as a linear bearing.

[0067] FIGS. 10A and 10B illustrate yet another variation of a suspension assembly described herein where the second displacement device 120 includes a spring and damper 134

as a shock. FIG. 10C illustrates an exploded view of the variation shown in FIG. 10A. As illustrated this variation replaces an elastomeric shock member with a pneumatic piston 144 (alternatively or in combination, the shock member can be spring based). A first side 146 of the piston 144 couples to a transfer plate 124 while a second side 148 of the piston 144 couples to the main frame 102. The swing arm 104 couples to pivot bearings 128 as noted above. In the illustrated variation one or more transfer plates 124 allow for movement of the swing arm 104 as needed. The transfer plate 124 can be optionally coupled to one or more large bearings to facilitate movement. FIG. 10C also illustrates a first deflection device 110 for coupling a second portion of the main frame 102 to the swing arm 104.

[0068] Each of the figures diagrammatically illustrates aspects of the invention. To facilitate understanding, the same reference numerals have been used (where practical) to designate similar elements that are common to the figures. Some such numbers have, however, been omitted.

[0069] While any of the features or advantages described in connection with the present invention may be provided, it may be the case that only some are employed. Whatever the case, the present invention includes systems comprising any of the features described herein (and/or "consisting" of any such features). Stated otherwise, it is specifically contemplated that any optional feature of the inventive embodiments/variations described herein may be set forth and claimed independently, or in combination with any one or more of the features described herein. Further, methodology described in association with the devices disclosed also forms part of the invention. The invention also comprises such hardware (e.g., built-up bicycles) and methodology as may be used in connection with that described which is incorporated by reference

[0070] Though the invention has been described in reference to certain examples optionally incorporating various features and depicted in reference to a single example, the invention is not to be limited as such. Numerous modifications and/or additions to or adaptations of the above described embodiments may be apparent to one skilled in the art; it is intended that the scope of the present inventions extend to all such modifications and/or additions.

CLAIMS

We claim:

1. A bicycle suspension system for use with a bicycle having a main frame assembly and a swing arm assembly, the system allowing improved movement of a wheel coupled to the swing arm assembly, the suspension system comprising:
 - a first deflection device coupling the swing arm assembly to the main frame assembly at a first coupled location, where the first deflection device is configured to allow relative motion between the swing arm assembly and the main frame;
 - a second deflection device coupling the swing arm assembly to the main assembly at a second coupled location;
 - where a frame end of the first deflection device is pivotally coupled to the main frame assembly and a swing arm end of the first deflection device is pivotally coupled to the swing arm assembly; and
 - where a frame portion of the second deflection device is coupled to the main frame assembly and a swing arm portion of the second deflection device is coupled to the swing arm assembly such that the second deflection device permits relative movement between the swing arm assembly and the main assembly independently in either a horizontal direction or a vertical direction.
2. The bicycle suspension system of claim 1, where the second deflection device comprises at least a first pivot bearing located at the swing arm portion of the second delivery device, where the first pivot bearing allows movement of the swing arm assembly in the vertical direction upon rotation of the swing arm assembly about an axis of the first pivot bearing.
3. The bicycle suspension system of claim 1, where the second deflection device comprises a shock member coupled to the main frame assembly at the frame portion of the second deflection device, where deflection of the shock member results in movement of the swing arm in the horizontal direction.

4. The bicycle suspension system of claim 3, where the shock member comprises an elastomeric material.
5. The bicycle suspension system of claim 3, further comprising at least a first pivot bearing mechanically coupled to a portion of the shock member.
6. The bicycle suspension system of claim 5, further comprising a second pivot bearing coupling the first pivot bearing to the portion of the shock member, where rotation of the second pivot bearing is driven by torsion of the portion of the shock member, where the rotation of the second pivot bearing and rotation of the first pivot bearing permits movement of the swing arm in the horizontal direction.
7. The bicycle suspension system of claim 6, further comprising a pivot boss coupled to the shock member the pivot boss also being coupled to the second pivot bearing such that deflection of the shock member causes movement of the second pivot bearing.
8. The bicycle suspension system of claim 7, further comprising frame plate coupled to the main frame assembly at the frame portion of the second deflection device, where the frame plate comprises defines an opening that limits movement of the pivot boss or second pivot bearing to limit movement of the shock member.
9. The bicycle suspension system of claim 8, where the opening comprises a shape selected from an ellipse, a circular opening, and a slot.
10. The bicycle suspension system of claim 3, where the shock member is housed in a portion of the main frame assembly.
11. The bicycle suspension system of claim 3, where the shock member comprises a circular shape.
12. The bicycle suspension system of claim 3, where a first portion of the shock member comprises at least one opening or cavity that increases deflection of at least a second portion of the shock member.

13. The bicycle suspension system of claim 1, where the first deflection device comprises a shock absorber.
14. The bicycle suspension system of claim 13, where the shock absorber comprises a damper assembly selected from the group consisting of a hydraulic, pneumatic, coil sprung, non-sprung based, elastomeric structures.
15. The bicycle suspension system of claim 1, where the horizontal direction comprises a horizontal arcing direction.
16. The bicycle suspension system of claim 1, where the vertical direction comprises a vertical arcing direction.
17. A bicycle comprising:
 - a main frame assembly;
 - a swing arm assembly, the swing arm assembly having a rear wheel axis portion for affixing a rear wheel thereto;
 - a first deflection device mechanically coupling the swing arm assembly to the main frame assembly at a first location;
 - a second deflection device mechanically coupling the swing arm assembly to the main assembly at a second location;
 - where a frame end of the first deflection device is pivotally coupled to the main frame assembly and a swing arm end of the first deflection device is pivotally coupled to the swing arm assembly, where the frame end and swing arm end of the first deflection device are moveable relative to each other; and
 - where a frame portion of the second deflection device is coupled to the main frame assembly and a swing portion of the second deflection device assembly is coupled to the swing arm assembly such that the second deflection assembly permits relative movement between the swing arm assembly and the main assembly independently in either a horizontal direction or a vertical direction.
18. The bicycle of claim 17, where the second deflection device comprises at least a first pivot bearing located at the swing arm portion of the second delivery device, where the

first pivot bearing allows movement of the swing arm assembly in the vertical direction upon rotation of the swing arm assembly about an axis of the first pivot bearing.

19. The bicycle of claim 17, where the second deflection device comprises a shock member coupled to the main frame assembly at the frame portion of the second deflection device, where deflection of the shock member results in movement of the swing arm in the horizontal direction.
20. The bicycle of claim 19, where the shock member comprises an elastomeric material.
21. The bicycle of claim 19, further comprising at least a first pivot bearing mechanically coupled to a portion of the shock member.
22. The bicycle of claim 21, further comprising a second pivot bearing coupling the first pivot bearing to the portion of the shock member, where rotation of the second pivot bearing is driven by torsion of the portion of the shock member, where the rotation of the second pivot bearing and rotation of the first pivot bearing permits movement of the swing arm in the horizontal direction.
23. The bicycle of claim 22, further comprising a pivot boss coupled to the shock member the pivot boss also being coupled to the second pivot bearing such that deflection of the shock member causes movement of the second pivot bearing.
24. The bicycle of claim 23, further comprising frame plate coupled to the main frame assembly at the frame portion of the second deflection device, where the frame plate comprises defines an opening that limits movement of the pivot boss or second pivot bearing to limit movement of the shock member.
25. The bicycle of claim 24, where the opening comprises a shape selected from an ellipse, a circular opening, and a slot.
26. The bicycle of claim 19, where the shock member is housed in a portion of the main frame assembly.
27. The bicycle of claim 19, where the shock member comprises a circular shape.

28. The bicycle of claim 19, where a first portion of the shock member comprises at least one opening or cavity that increases deflection of at least a second portion of the shock member.
29. The bicycle of claim 17, where the first deflection device comprises a shock absorber.
30. The bicycle of claim 19, where the shock absorber comprises a damper assembly selected from the group consisting of a hydraulic, pneumatic, coil sprung, non-spring based, elastomeric structures.
31. A bicycle suspension component for use with a bicycle having a main frame assembly and a swing arm assembly and a linear damper device pivotally coupling to both the swing arm assembly and the main frame assembly, the suspension component comprising:
 - a frame portion for affixing to the frame assembly;
 - a swing arm portion for affixing to the swing arm assembly, where the swing arm assembly includes a rear axle; and
 - where when the frame portion is affixed to the main frame assembly and the swing arm portion is affixed to the swing arm assembly the main frame assembly and the swing arm assembly are able to move independently in either a horizontal direction or a vertical direction.

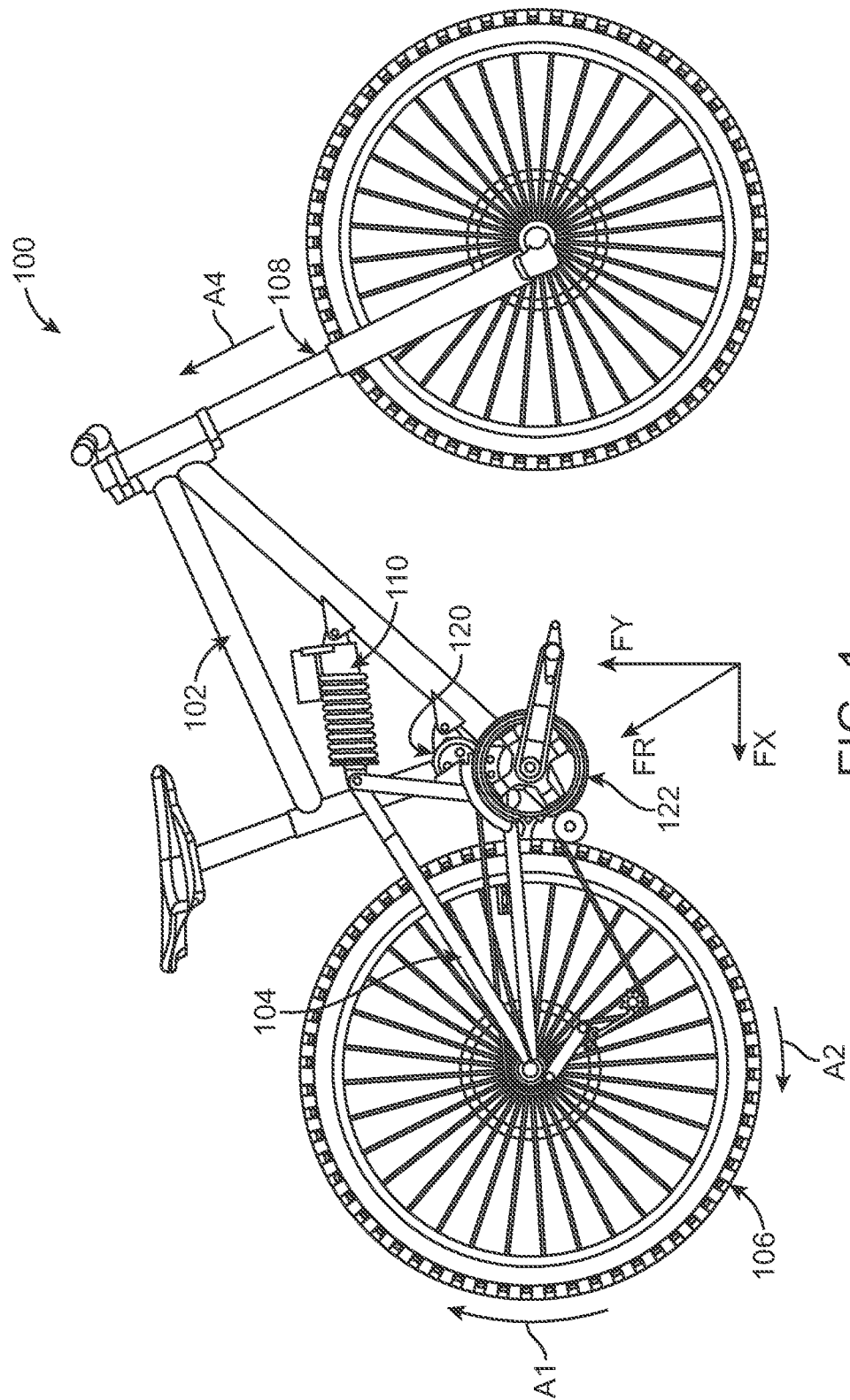


FIG. 1

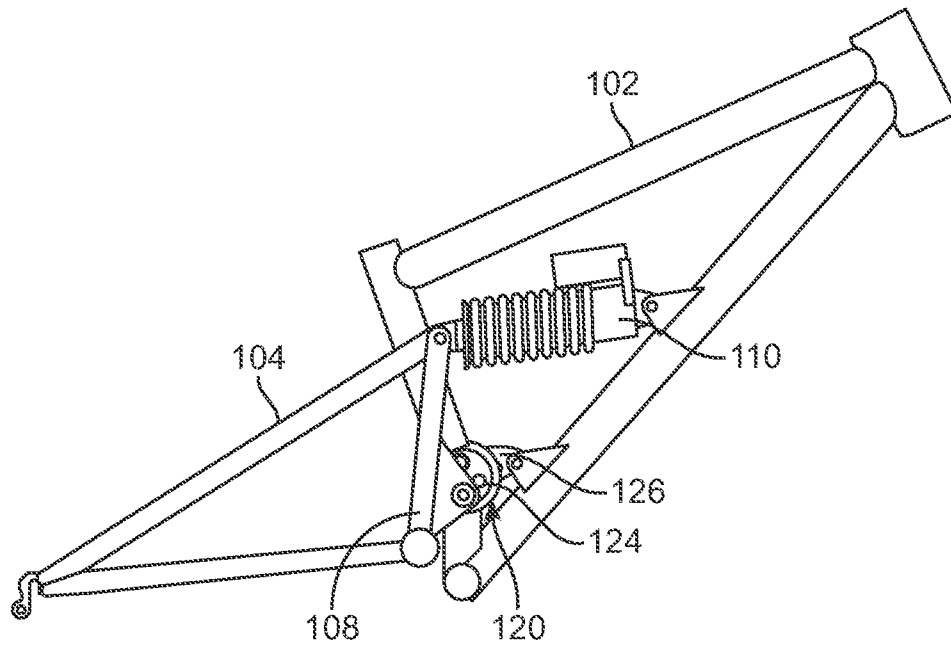


FIG. 2A

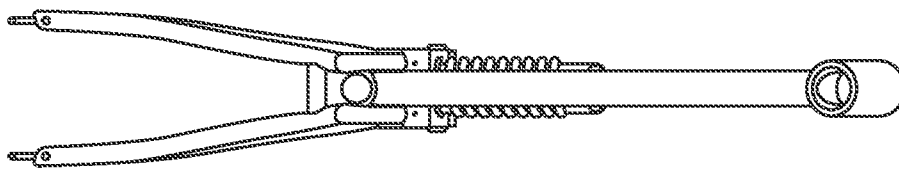


FIG. 2B

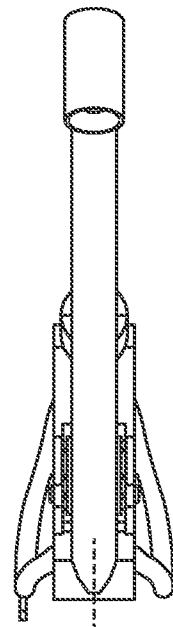


FIG. 2C

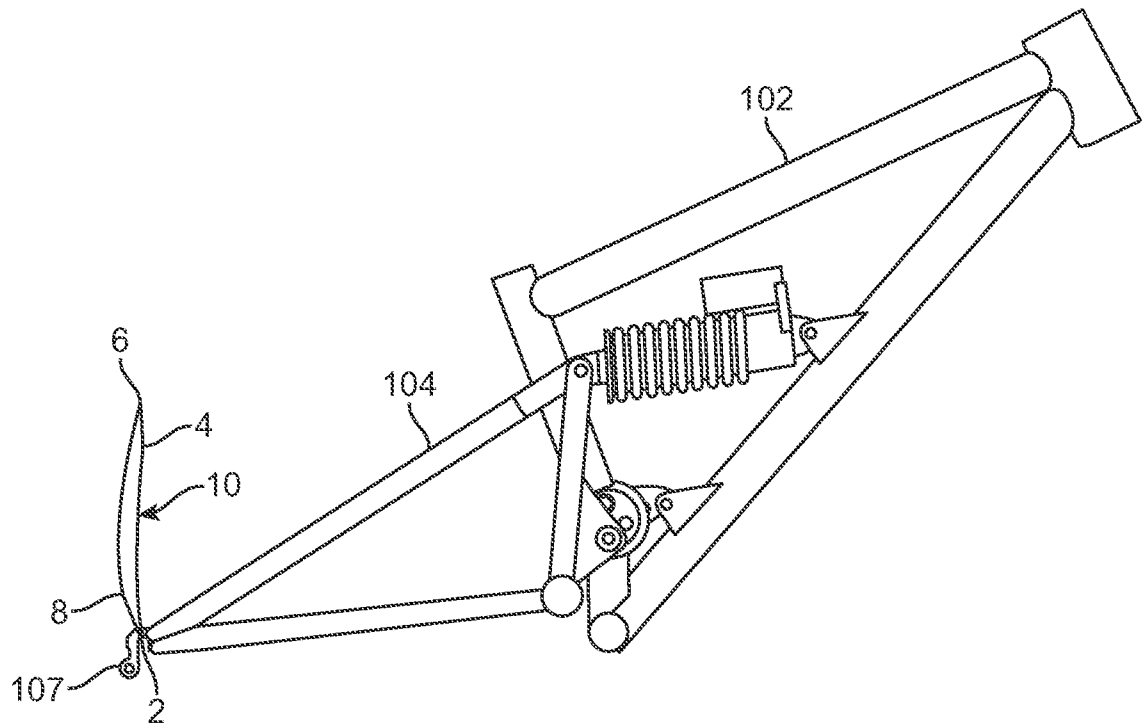


FIG. 3A

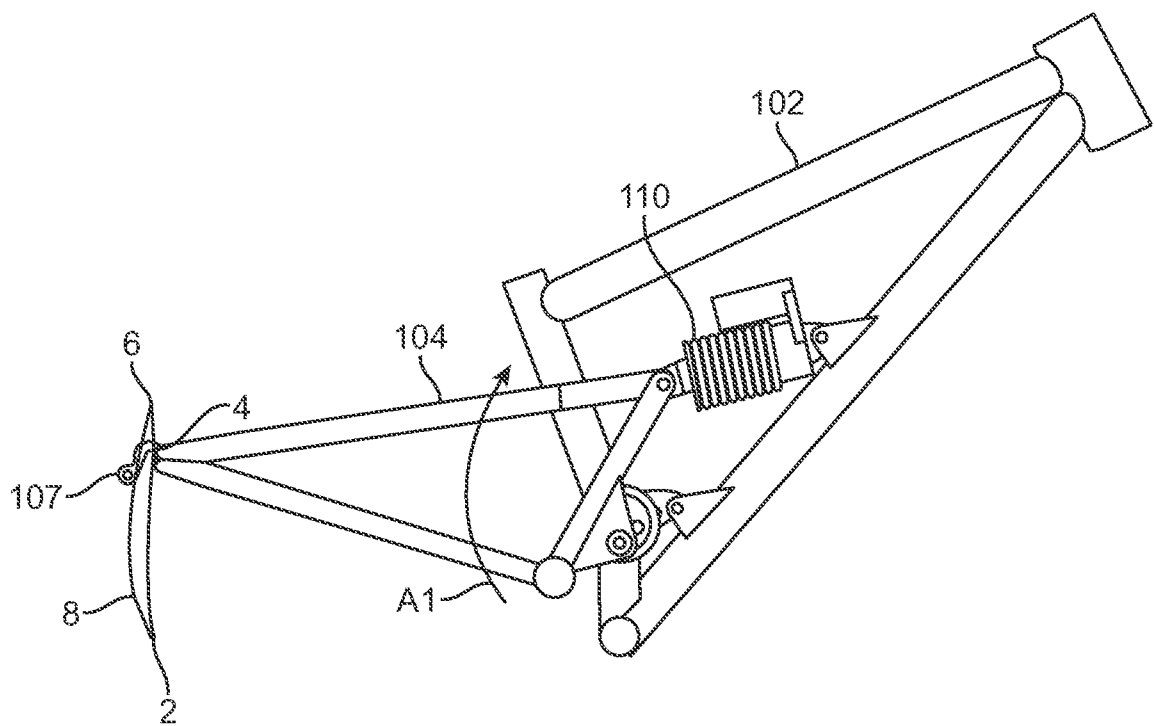


FIG. 3B

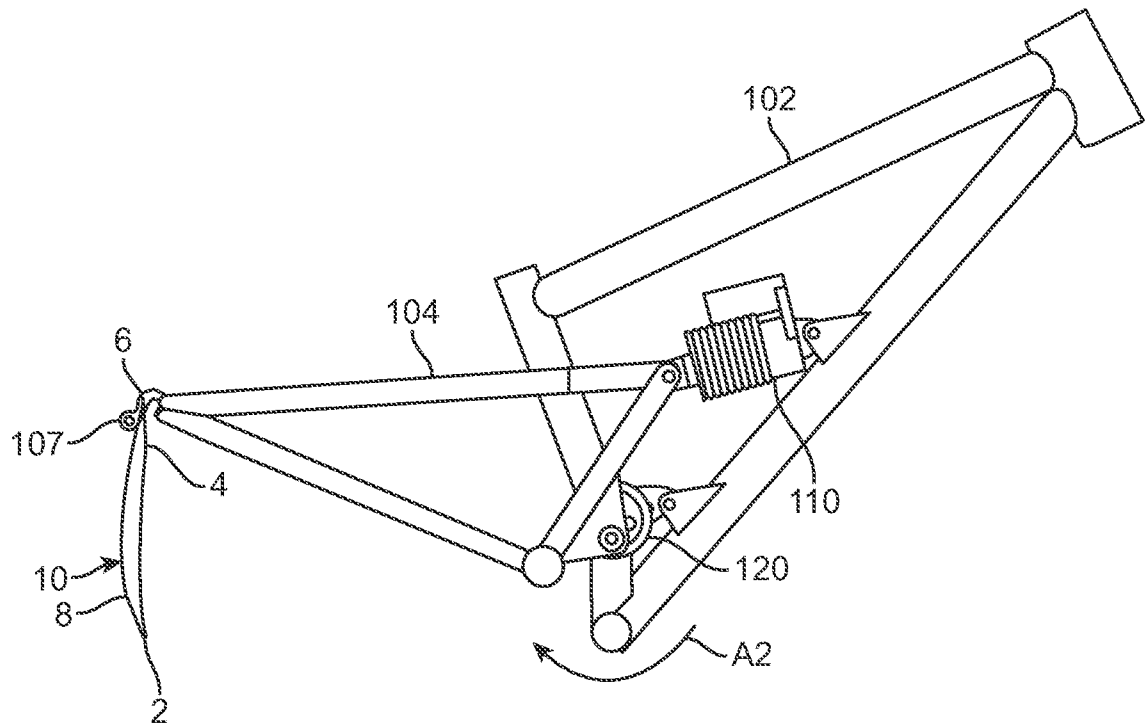


FIG. 3C

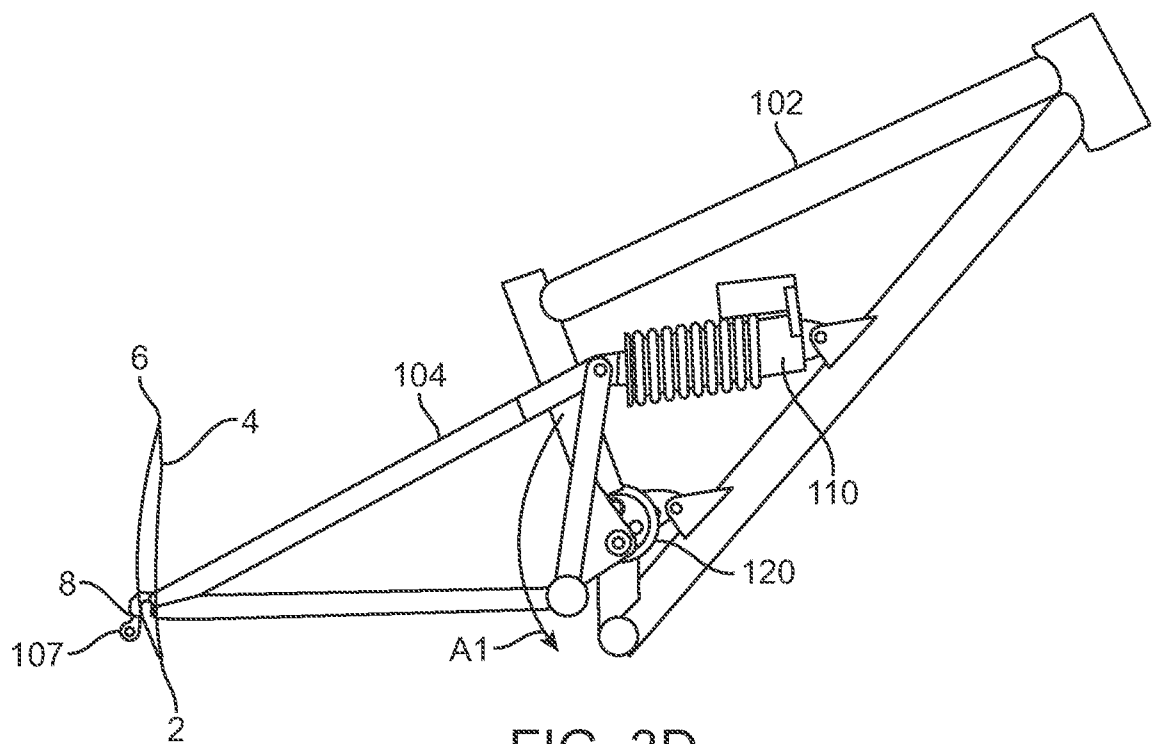


FIG. 3D

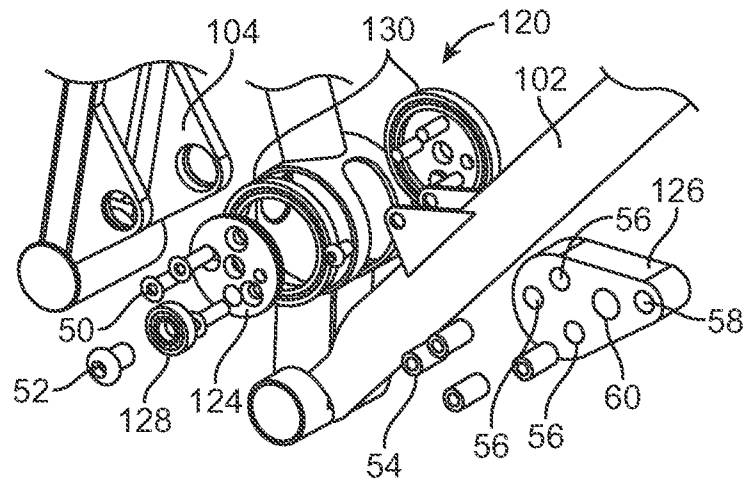


FIG. 4A

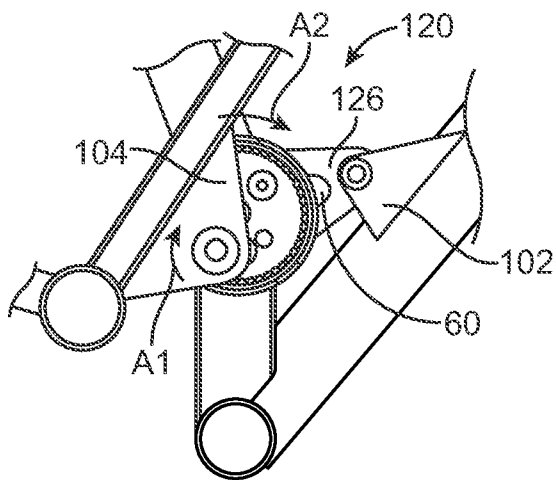


FIG. 4B

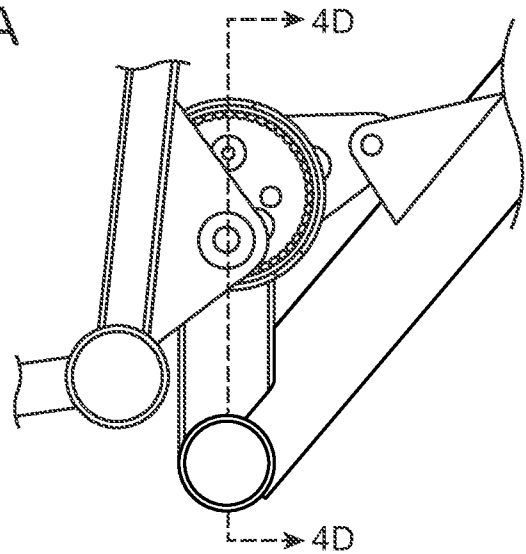


FIG. 4C

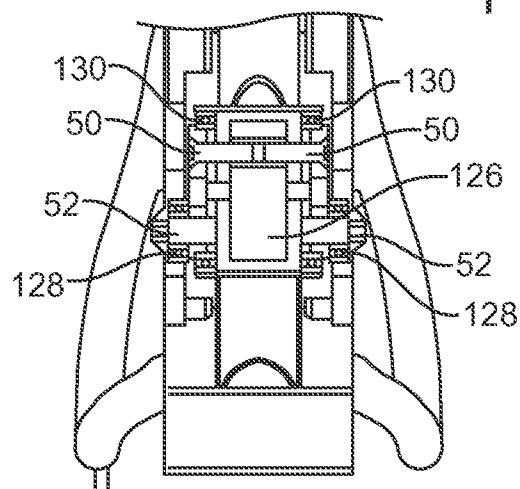


FIG. 4D

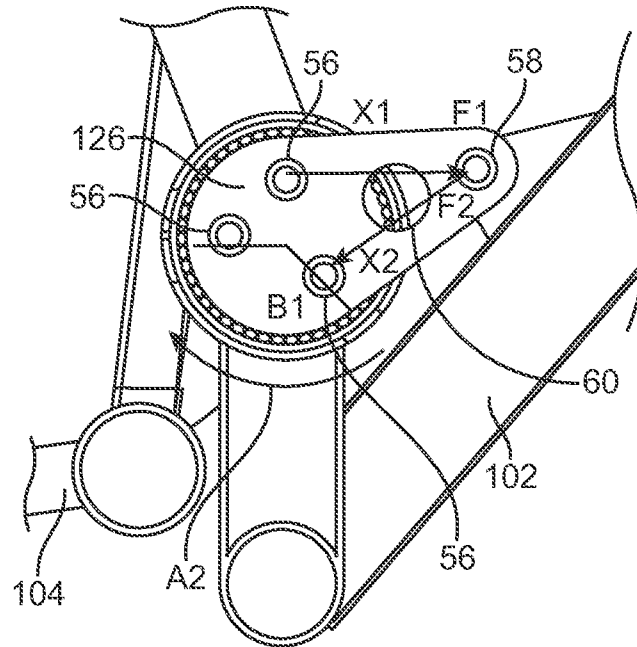


FIG. 5A

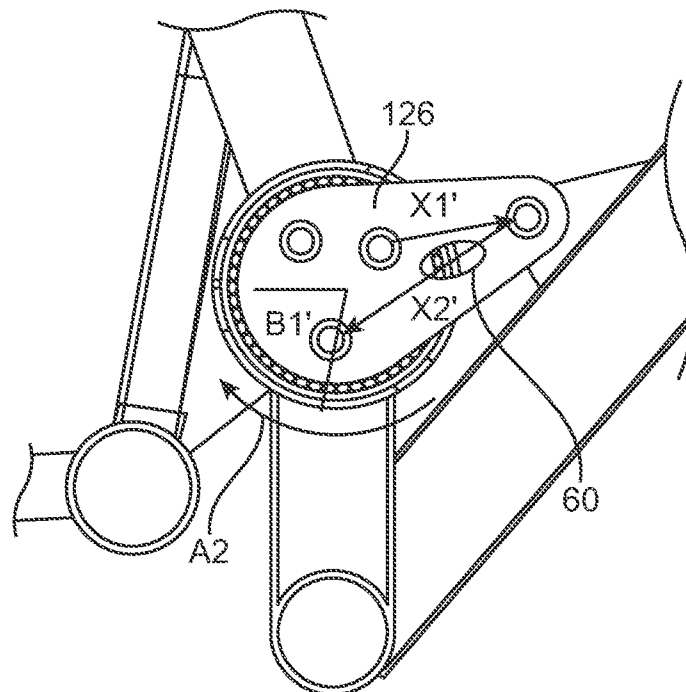


FIG. 5B

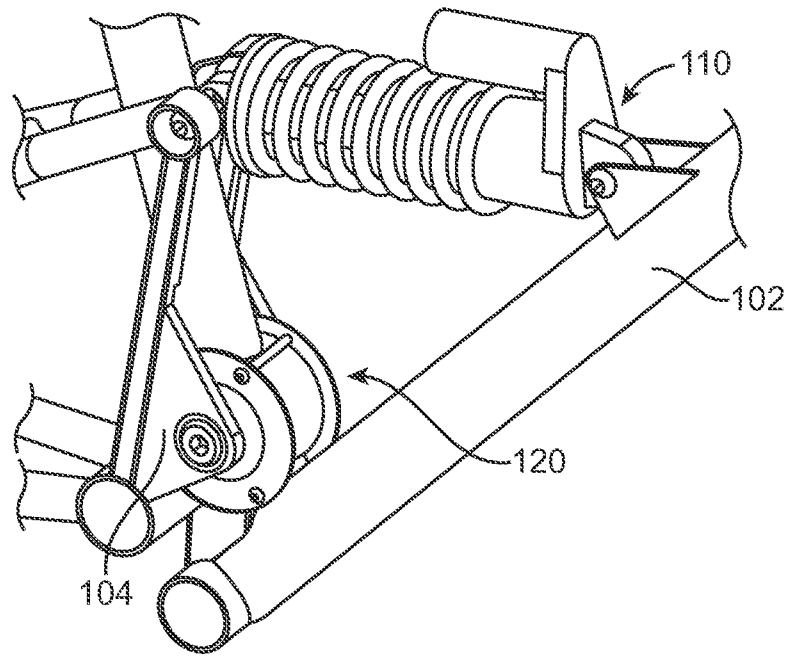


FIG. 6A

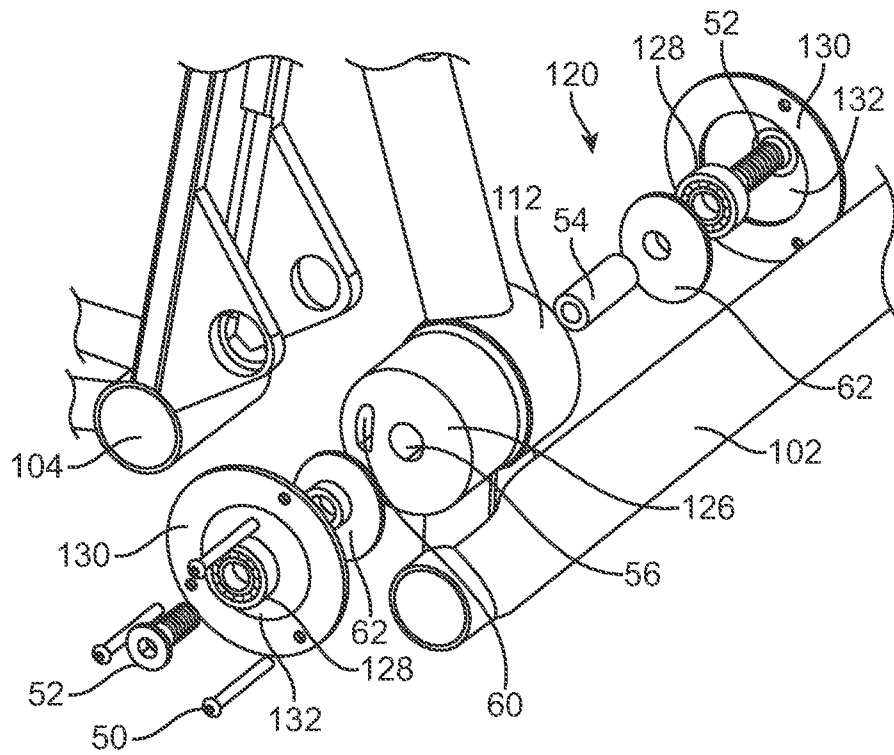


FIG. 6B

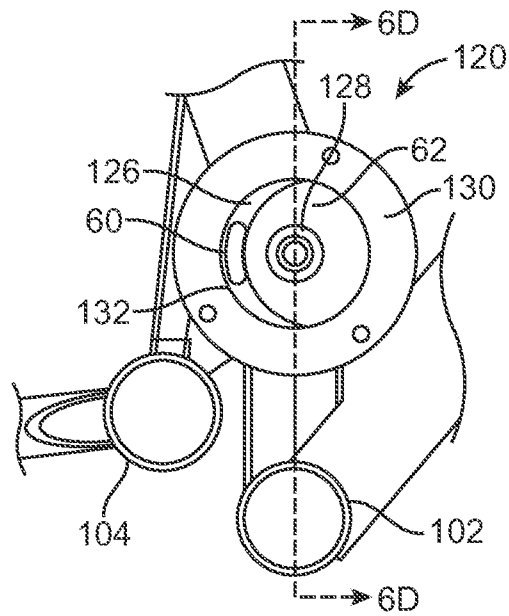


FIG. 6C

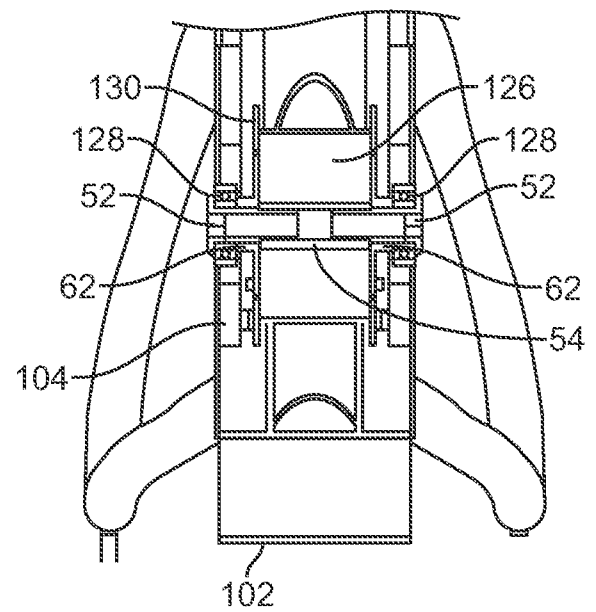


FIG. 6D

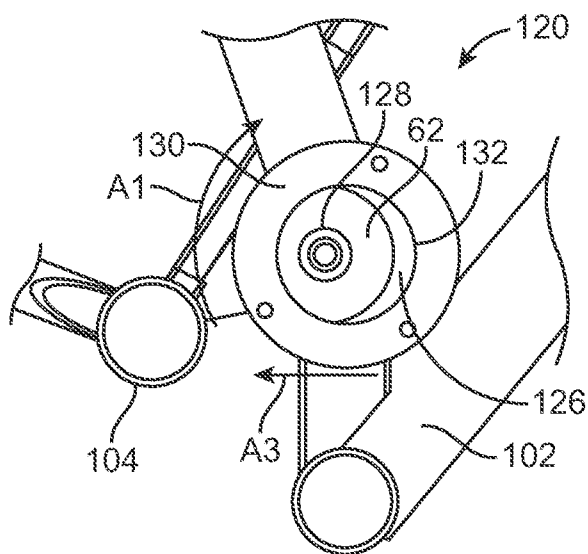


FIG. 6E

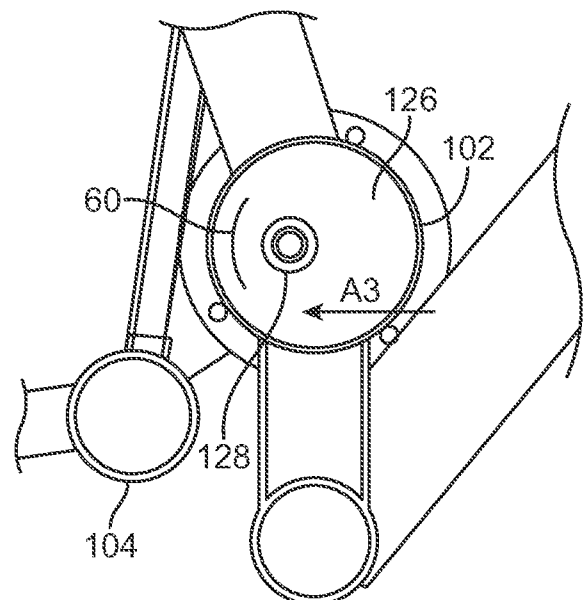


FIG. 6F

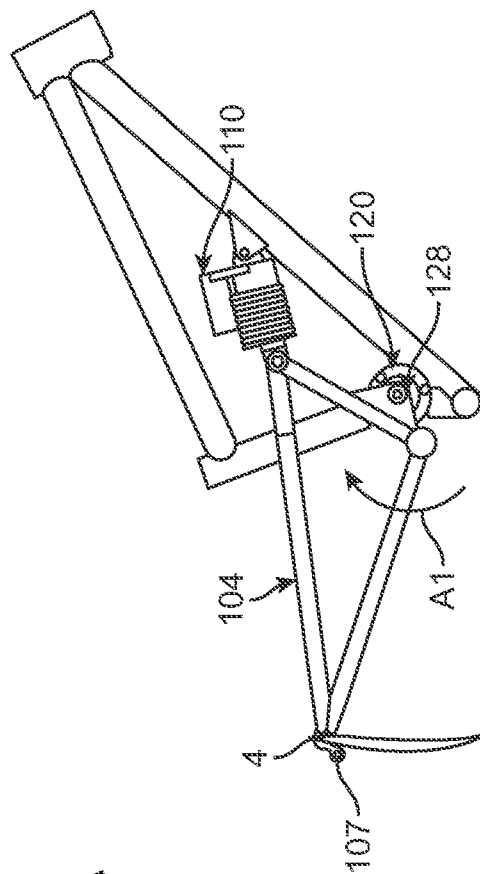


FIG. 7B

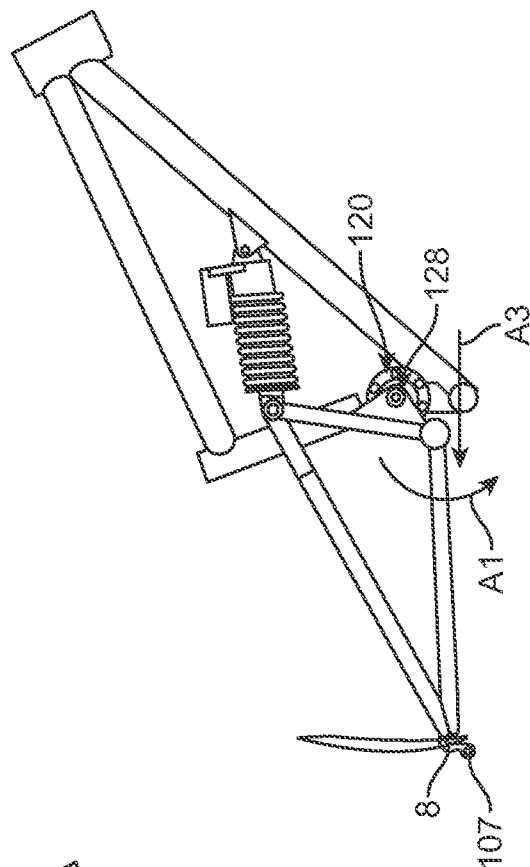


FIG. 7D

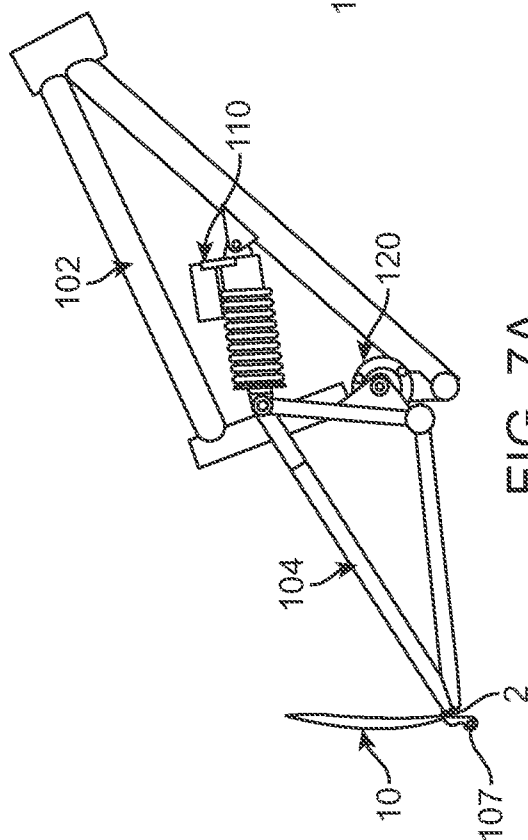


FIG. 7A

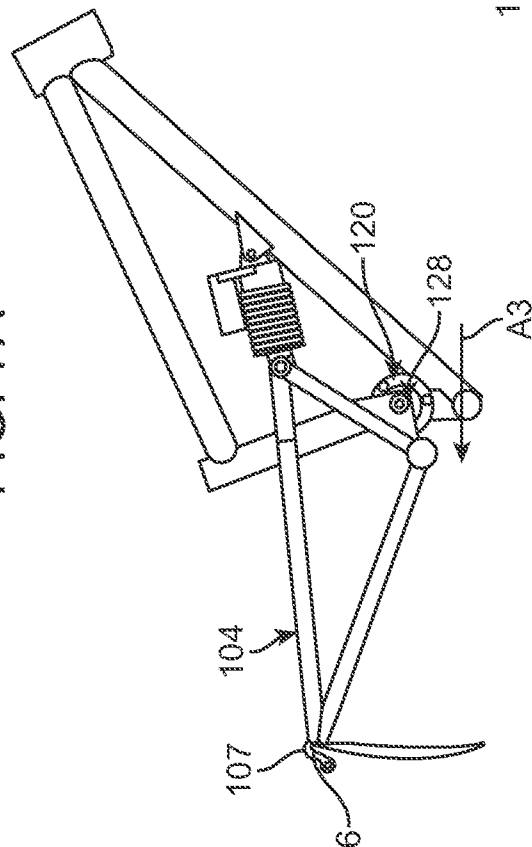


FIG. 7C

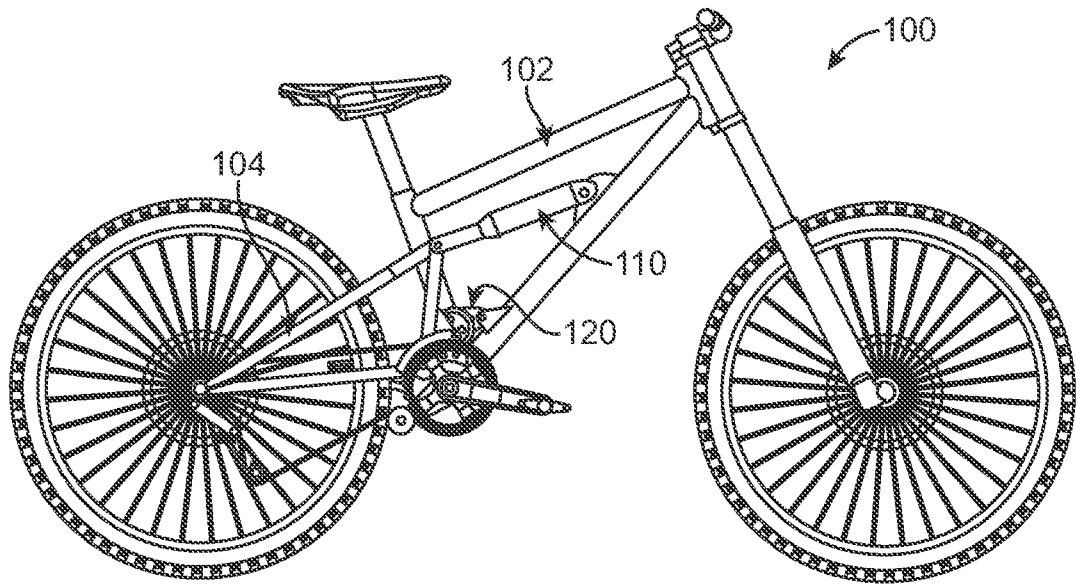


FIG. 8

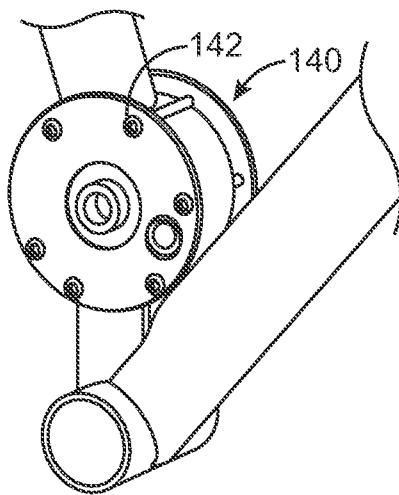


FIG. 9A

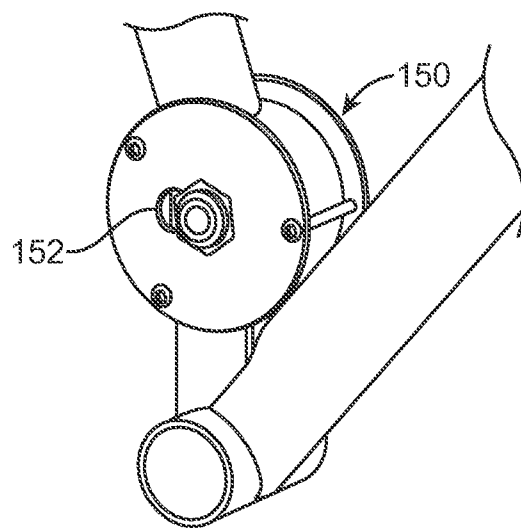


FIG. 9B

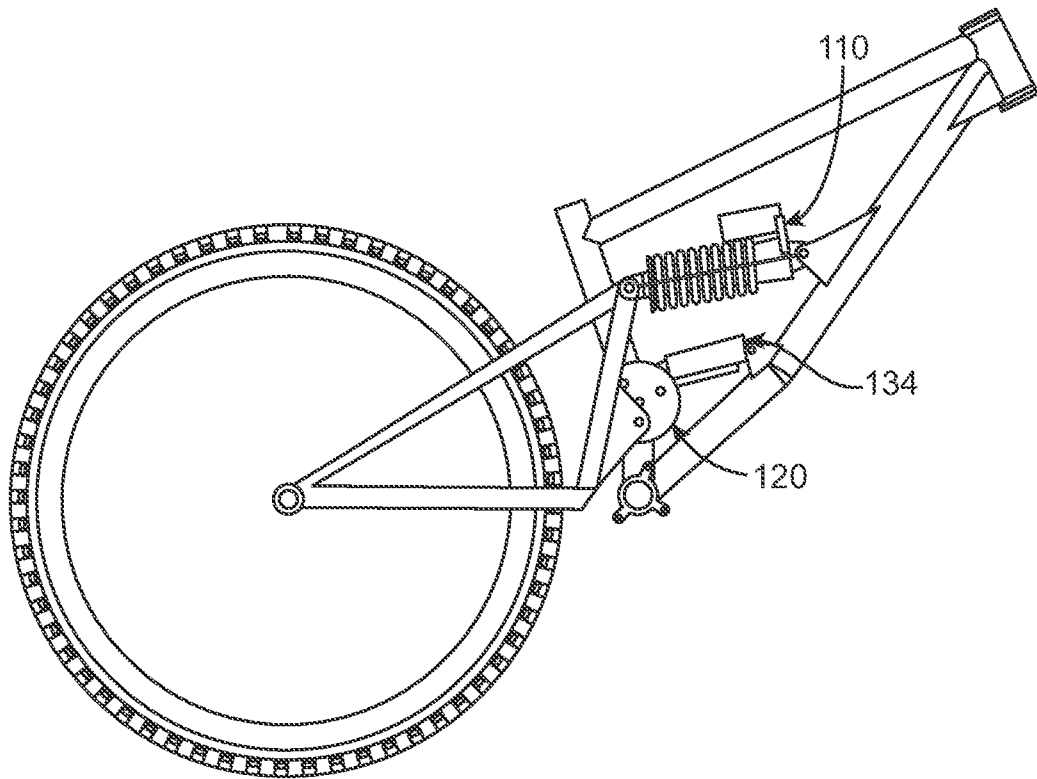


FIG. 10A

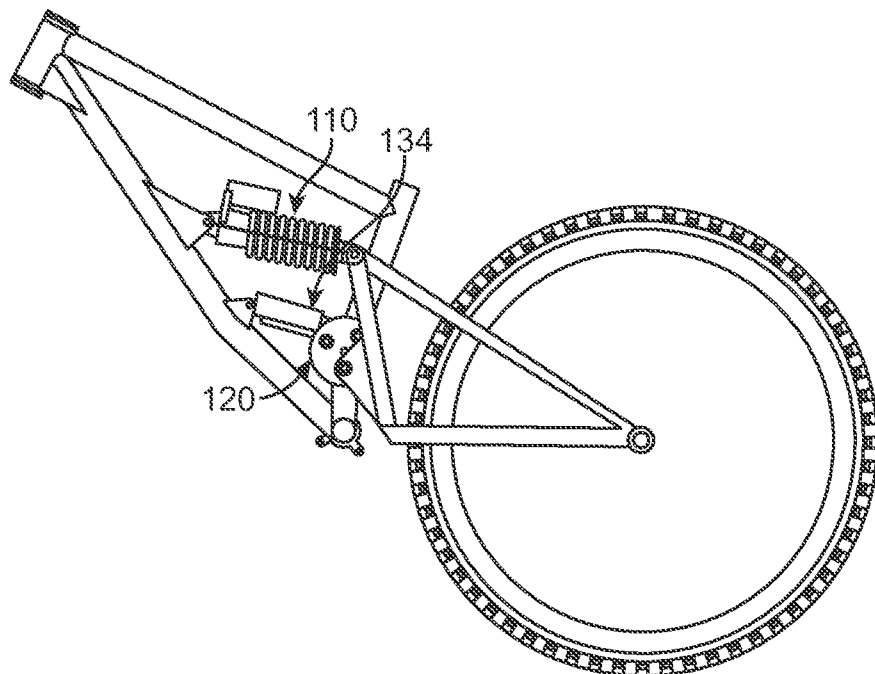


FIG. 10B

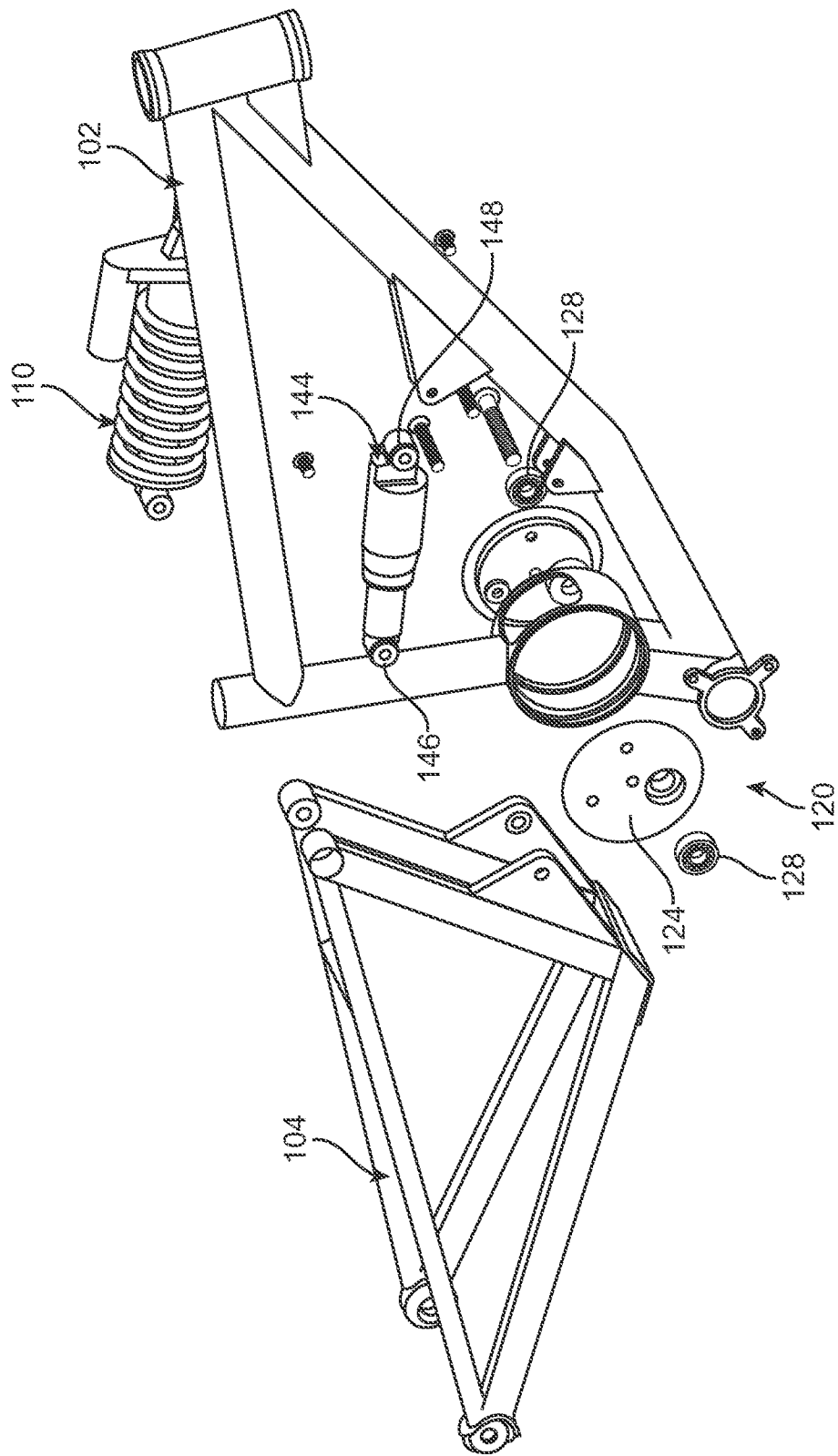


FIG. 10C

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/047392

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B62K 25/00 (2013.01)

USPC - 280/284

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - B62K 25/00, 25/04, 25/28; B62M 9/12 (2013.01)

USPC - 180/227; 280/261, 283, 284, 285, 286

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

CPC - B62K 25/04, 25/26, 25/28, 25/286 (2013.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents, Google

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,735,277 A (PRINCE), 05 April 1988 (05.04.1988) entire document	1, 2, 13-18, 29-31
A	US 6,203,042 B1 (WILCOX) 20 March 2001 (20.03.2001) entire document	1-31
A	US 5,791,674 A (D'ALUISIO et al) 11 August 1998 (11.08.1998) entire document	1-31
A	US 2006/0071442 A1 (HOOGENDOORN) 06 April 2006 (06.04.2006) entire document	1-31

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


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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

05 November 2013

Date of mailing of the international search report

14 NOV 2013

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