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(54) Title of the Invention: **Rear suspension system for velocipedes**
Abstract Title: **Bicycle suspension**

(57) A velocipede frame 10 with a rear suspension system comprising a rear sub-frame and a shock absorber 32. The sub-frame is pivotably coupled to the frame body 16 at an upper pivot point 28 and at a lower pivot point 30. The shock absorber 32 has an upper end connected to an upper connection point 34 on the sub-frame, the upper connection point 34 being located adjacent the upper pivot point 28, and a lower end connected to a lower connection point 36 on the sub-frame, the lower connection point 36 being located adjacent the lower pivot point 30. In an at rest position, the shock compression axis may align with a notional straight line extending through the lower pivot point 30 and lower connection point 36. The frame may include a seat tube 22 that is bifurcated to create a gap between transversely spaced apart seat tube portions (22, figure 3), a portion of the sub-frame being located in the gap and pivotably coupled to the seat tube portions at the lower pivot point 30.

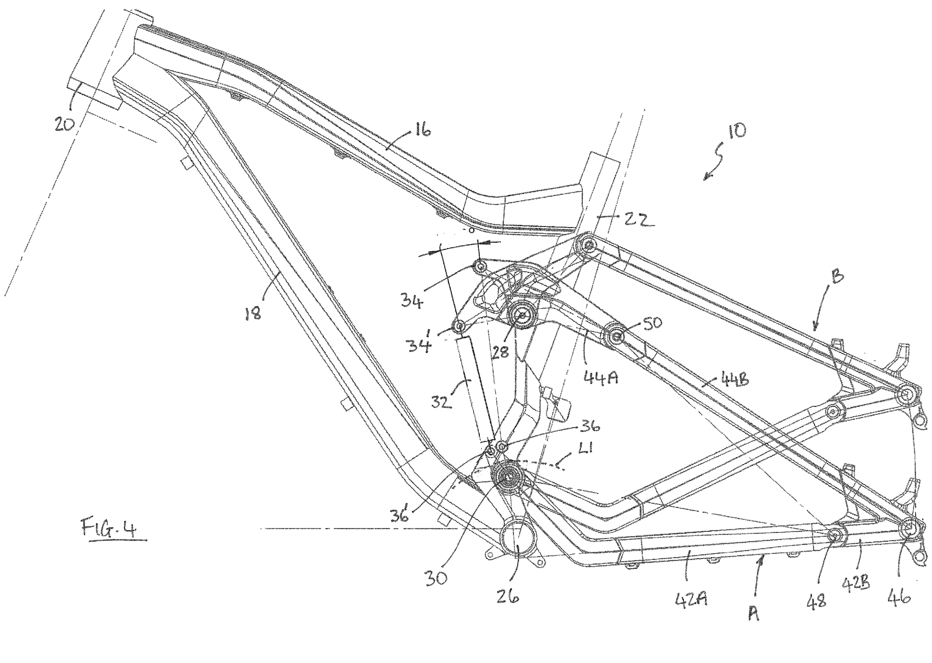

FIG. 4

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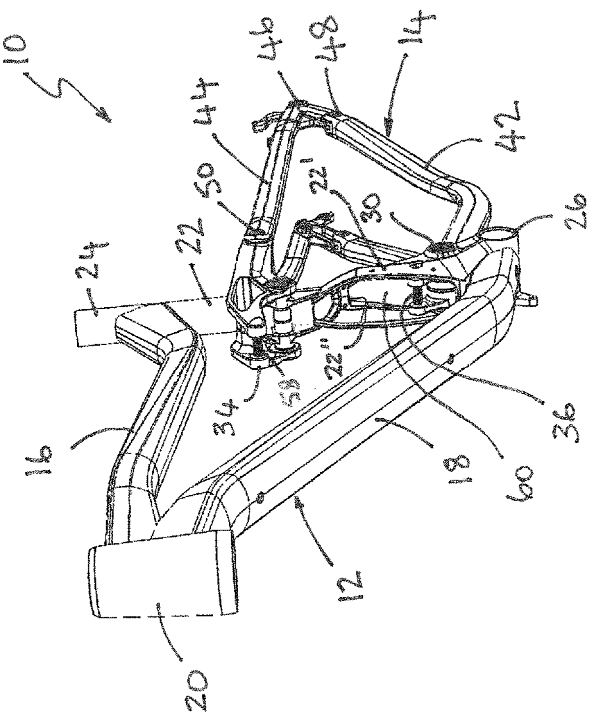

FIG. 1

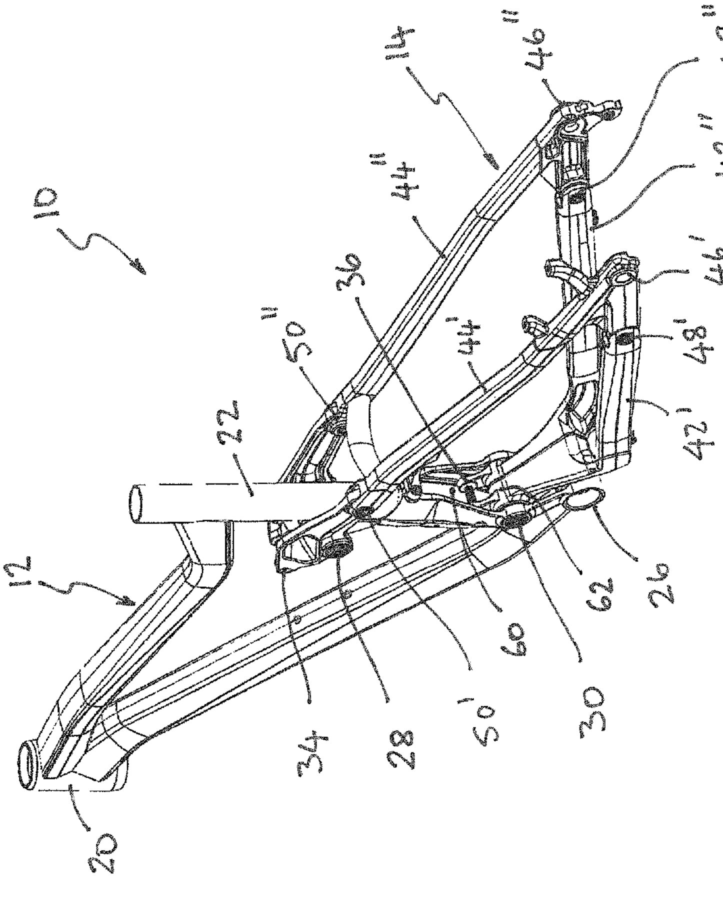

FIG. 2

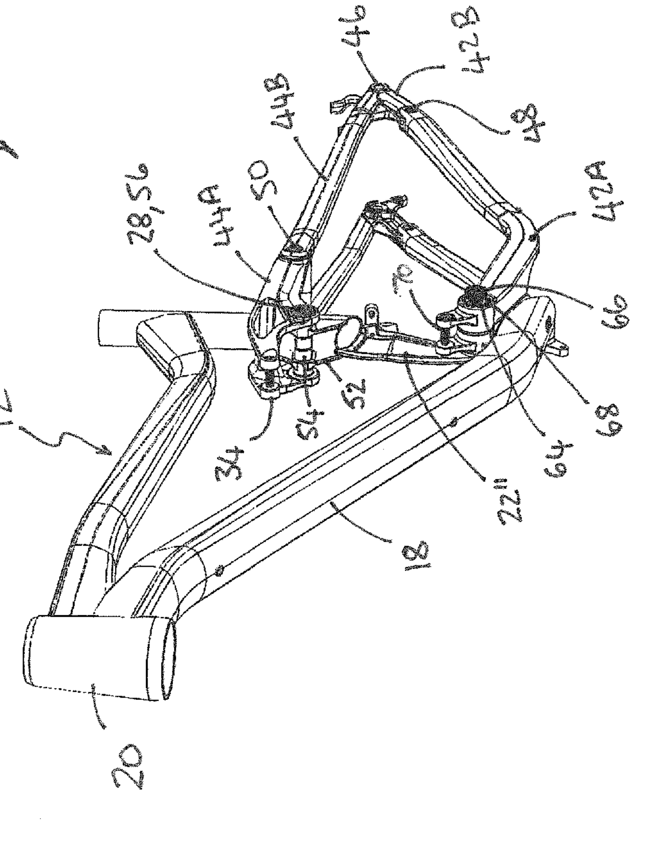

FIG. 3

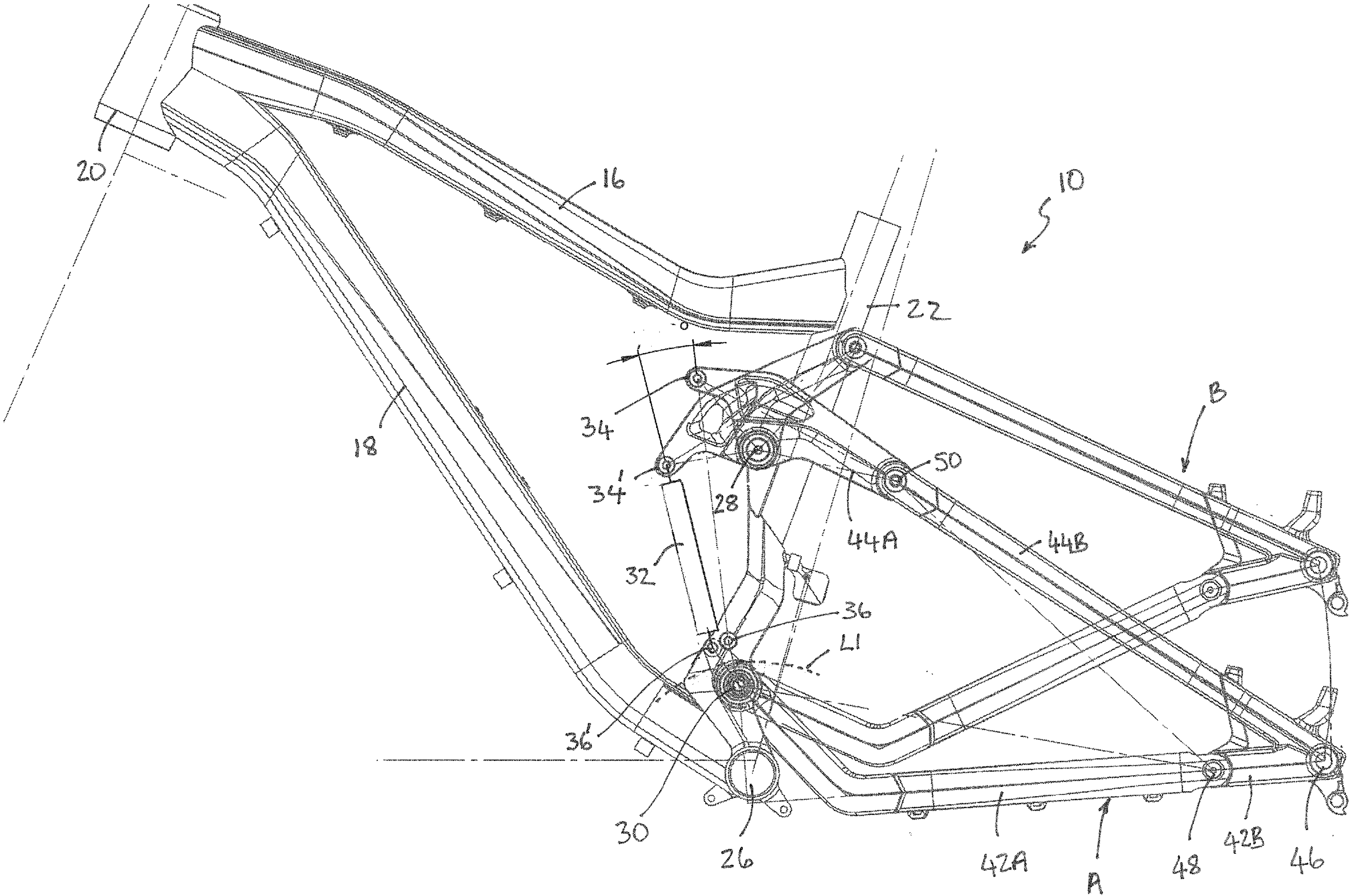

FIG. 4

Rear Suspension System for Velocipedes

Field of the Invention

The present invention relates to rear suspension systems for velocipedes, especially but not exclusively bicycles.

Background to the Invention

Pivotable rear suspension systems for bicycles are well known. For example, the “Horst Link" suspension is a known four-bar linkage suspension in which connecting links pivot on the seat tube.

It is an aim of the present invention to provide an improved rear suspension system suitable for use with bicycles in particular.

Summary of the Invention

A first aspect of the invention provides a velocipede frame comprising a main body and a rear suspension system, wherein the main body comprises:

a bottom bracket for receiving a crankset;
a head tube located at the front of the frame;
a seat tube extending upwardly from said bottom bracket;
a top tube extending between said seat tube and said head tube; and
a down tube extending between said head tube and said bottom bracket,

wherein said rear suspension system comprises:

a sub-frame pivotably coupled to the rear of the body for pivoting movement with respect to the body about at least one transverse axis; and
at least one shock absorber configured to resiliently resist pivoting movement of said sub-frame away from a rest state,

wherein said sub-frame is pivotably coupled to said body at an upper pivot point and at a lower pivot point, said upper and lower pivot points being spaced apart in a top-to-bottom direction of said frame,

and wherein said at least one shock absorber has an upper end connected to an upper connection point on said sub-frame adjacent said upper pivot point, and a lower end connected to a lower connection point on said sub-frame adjacent said lower pivot point.

A second aspect of the invention provides a velocipede frame comprising a main body and a rear suspension system, wherein the main body comprises:

a bottom bracket for receiving a crankset;
a head tube located at the front of the frame;
a seat tube extending upwardly from said bottom bracket;
a top tube extending between said seat tube and said head tube; and
a down tube extending between said head tube and said bottom bracket,

wherein said rear suspension system comprises:

a sub-frame pivotably coupled to the rear of the body for pivoting movement with respect to the body about at least one transverse axis; and
at least one shock absorber configured to resiliently resist pivoting movement of said sub-frame away from a rest state,

wherein said sub-frame is pivotably coupled to said body at an upper pivot point and at a lower pivot point, said upper and lower pivot points being spaced apart in a top-to-bottom direction of said frame,

and wherein the seat tube is bifurcated to create a gap between transversely spaced apart seat tube portions, and wherein a portion of the sub-frame is located in the gap and is pivotably coupled to the seat tube portions at the lower pivot point.

A third aspect of the invention provides a rear suspension system for a velocipede frame comprising a main body, the rear suspension system comprising:

a sub-frame for pivotable coupling to the rear of the body for pivoting movement with respect to the body about at least one transverse axis; and
at least one shock absorber configured to resiliently resist, in use, pivoting movement of said sub-frame away from a rest state,

wherein said sub-frame is configured to be pivotably coupled in use to said body at an upper pivot point and at a lower pivot point, said upper and lower pivot points being spaced apart in a top-to-bottom direction of said frame,

and wherein said at least one shock absorber has an upper end connected to an upper connection point on said sub-frame, said upper connection point being located adjacent said upper pivot point in use, and a lower end connected to a lower connection point on said sub-frame, said lower connection point being located adjacent said lower pivot point in use.

A fourth aspect of the invention provides a velocipede, especially a bicycle, comprising the velocipede frame of the first or second aspects of the invention, said velocipede further comprising a handlebar assembly and a front wheel assembly coupled to the head tube, a crankset coupled to the bottom bracket, at least one rear wheel mounted on the sub-frame, and a chain coupling the crankset to the rear wheel.

Preferred features are recited in the dependent claims.

Further advantageous aspects of the invention will become apparent to those ordinarily skilled in the art upon review of the following description of a preferred embodiment and with reference to the accompanying description.

Brief Description of the Drawings

An embodiment of the invention is now described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a front perspective view of a bicycle frame incorporating a rear suspension system embodying one aspect of the present invention;

Figure 2 is a rear perspective view of the bicycle frame and rear suspension system of Figure 1;

Figure 3 is a front perspective view of the bicycle frame and rear suspension system of Figure 1 with part of the seat tube removed; and

Figure 4 is a side view of the bicycle frame and rear suspension system of Figure 1 with the rear suspension system shown in two different positions.

Detailed Description of the Drawings

Referring now in particular to Figures 1 to 3 of the drawings there is shown, generally indicated as 10, a velocipede frame. The illustrated frame 10 is a bicycle frame and the present invention is particularly suited for use with bicycles. It will be understood however that aspects of the invention may be used with other velocipedes having more than two wheels e.g. tricycles, as would be apparent to a skilled person.

The frame 10 comprises a main body 12 and a rearward sub-frame 14 pivotably coupled the body 12. The body 12 comprises a top tube 16, a down tube 18, a head tube 20 and a seat tube 22. Although these structures are commonly referred to as tubes and are typically tubular, they do not necessarily have to be tubular. For example, one or more of the structures 16, 18, 20, 22 may be solid and/or may comprise multiple bars. In any event, the structures 16, 18, 20, 22 are typically formed from a substantially rigid material such as metal or carbon fibre. The structures 16, 18, 20, 22 are referred to herein as tubes for consistency with common nomenclature, and their respective functions and arrangement are conventional unless otherwise stated. The body 12 also includes a bottom bracket 26 for rotatably receiving the crankset (not shown), which typically includes at least one chain ring (typically a 32 to 36 tooth chain ring - not shown) and pedal cranks (not shown). A respective pedal (not shown) may be provided on each crank, or the cranks may be configured to receive a removable pedal.

In typical embodiments, the head tube 20 is configured to receive a handlebar assembly (not shown) and a front wheel assembly (not shown), which includes at least one front wheel. The upper end 24 of the seat tube 22 is configured to receive a seat (not shown), typically mounted on a seat post (not shown). The top tube 16 extends between the head tube 20 and the seat tube 22. The down tube 18 extends between the head tube 20 and the bottom bracket 26. The seat tube 22 extends generally upwards from the bottom bracket 26. Together, the top tube 16, down tube 18 and seat tube 22 make a generally triangular formation. In use at least one rear wheel is mounted on the sub-frame 14 with at least one rear chain ring, coupled to the crankset chain ring by a chain as is conventional.

The body 12 may be said to have a front corresponding with the location of the head tube 20, and a rear corresponding to the location of the seat tube 22. The sub-frame 14 is located at the rear of the body 12, and in preferred embodiments is pivotably coupled to the seat tube 22. The coupling is such that the sub-frame 14 is capable of pivoting with respect to the body 12 about at least one transversely oriented axis. In this context, the transverse direction is the direction parallel or coincident with the rotational axis of the crankset and chain ring, and of the front and rear wheels, when fitted, and is perpendicular to the front-to-rear direction of the body 12.

In the preferred embodiment, the sub-frame 14 is pivotably coupled to the body 12 and upper and lower pivot points 28, 30, each located at the rear of the body 12, conveniently at or substantially at the seat tube 22. The pivot points 28, 30 are located between the bottom bracket 26 and the upper end 24 of the seat tube 22 and are mutually spaced apart in the top-to-bottom direction, i.e. the direction perpendicular to both the front-and-rear direction and the transverse direction.

In use, the sub-frame 14 is able to pivot about pivot points 28, 30 into and out of a rest state, which is depicted in Figures 1 to 3. In typical embodiments, the sub-frame 14 is able to pivot out of the rest state in one direction only (anticlockwise as viewed in the drawings). The rest state is assumed to correspond to no load being exerted on the suspension, e.g. when the bicycle is without rider.

The sub-frame 14 is part of a rear suspension system embodying one aspect of the invention. The rear suspension system further includes at least one shock absorber that is coupled to the sub-frame 14 and configured to resiliently resist, and preferably also to damp, pivoting movement of the sub-frame 14 in a direction away from the rest state (anticlockwise as viewed in the drawings). The, or each, shock absorber may take any convenient conventional form, e.g. spring, pneumatic and/or hydraulic. Typically, the or each shock absorber has a linear compression axis, typically corresponding to the longitudinal axis of the shock absorber, any reaction forces exerted by the shock absorber being exerted along the compression axis. Typical shock absorbers use air or springs, or a combination of each, to provide resistance and damping. A shock absorber normally has a pre-set uncompressed length, which may correspond to the rest state, and is installed into the frame 10 at this length. During use (of a typical compression type shock absorber) compressive force applied to the shock absorber through the frame 10 compresses the shock absorber up to its maximum stroke (minimum length) to provide the suspension travel. The design of the frame can significantly impact how much resistance the shock absorber offers throughout its stroke. This can be quantified by a characteristic known as leverage ratio. The leverage ratio is determined by the design of the frame 10, in particular the position of all the linkage points relative to each other. For example, a poor frame design provide too stiff a suspension for little bumps and too weak a suspension for big bumps, and so on. Also as part of the consideration of the frame design is the “sag point”, i.e. how much the shock absorber compresses under the weight of the rider and frame with no other forces. Setting this point properly so the bike still feels lively and does not slump into this point or move too much or too little, is also an important aspect of the design.

In the illustrated example, a single shock absorber 32 is provided (shown schematically in Figure 4), although more than one may be provided in alternative embodiments. The shock absorber 32 is connected between upper and lower connection points 34, 36, each of which is provided on the sub-frame 14, the action of the shock absorber 30 being such that in use it resiliently resists movement of the connection points 34, 36 towards one another. The upper connection point 34 is located adjacent, but spaced apart from, the upper pivot point 28, and is preferably positioned such that the action of the shock absorber 32 on the sub-frame 14 at connection point 34 resists pivoting movement of the sub-frame away from the rest state. The lower connection point 36 is located adjacent, but spaced apart from, the lower pivot point 30 and is preferably positioned such that the action of the shock absorber 32 on the sub-frame 14 at connection point 36 resiliently resists pivoting movement of the sub-frame 14 in a direction towards the rest state, at least when the sub-frame 14 is out of the rest state. In the preferred embodiment, the lower connection point 36 is positioned such that, when the sub-frame 14 is in the rest state, the compression axis of the shock absorber 32 is co-incident with a notional straight line extending between the connection point 36 and the lower pivot point 30. As such, any reaction force exerted by the shock absorber 32 at connection point 36 does not cause or tend to cause pivoting movement of the sub-frame 14 about pivot point 30 in the rest state. Hence, in the rest state, the shock absorber 32 resiliently resists movement of the sub-frame out of the rest state and, if held under compression in the rest state, acts to urge the sub-frame to maintain the rest state. Preferably, the spacing between the upper connection point 34 and upper pivot point 28 is greater than the spacing between the lower connection point 36 and lower pivot point 30 such that the moment of force exerted on the sub-frame 14 by the shock absorber 32 via connection point 34 exceeds that exerted via connection point 36. Hence, the effective action of the shock absorber 32 is to resist pivoting movement of the sub-frame 14 in a direction way from the rest state.

During use, pivoting movement of the sub-frame 14 about pivot points 28, 30 is caused by the weight of the rider (not shown), e.g. as the bicycle travels over uneven ground. This pivoting movement is damped by the action of the shock absorber 32. Leverage ratio is a known characteristic by which the performance of bicycle rear suspension systems can be assessed, and relates in this instance to the (changing) angle at which the sub-frame 14 exerts force on the shock absorber 32 as it pivots about pivot points 28, 30. It is found that by connecting the shock absorber 32 between connection points 34, 36 on the sub-frame 14 itself (as opposed to having one connection point on the body 12 for example), affects the leverage ratio in a manner that improves the performance of the rear suspension system, as is described in more detail below. Moreover, in preferred embodiments, and as can be seen from Figure 4, the upper and lower connection points 34, 36 move forwardly as the sub-frame 14 moves away from the rest position. This maintains compression in the shock absorber 32 and helps to control the leverage ratio as is described in more detail hereinafter.

In preferred embodiments, the sub-frame 14 comprises a chain stay 42 and a seat stay 44. A rear axle location 46 is provided at the rear of the sub-frame 14. The chain stay 42 and seat stay 44 extend between the rear axle location 46 and the pivot points 28, 30 respectively. In preferred embodiments, a chain stay pivot 48 is provided in the chain stay 42 between the pivot point 30 and the axle location 46, preferably relatively close to the axle location 46. The chain stay pivot 48 allows relative pivoting movement between forward and rearward portions 42A, 42B of the chain stay 42. Preferably, a seat stay pivot 50 is provided in the seat stay 44 between the pivot point 28 and the axle location 46, preferably relatively close to the pivot point 28. The seat stay pivot 50 allows relative pivoting movement between forward and rearward portions 44A, 44B of the seat stay 44.

The precise locations of the chain stay pivot 48 and seat stay pivot 50 are design parameters that may be chosen to suit a given application and are not essential to understanding the present invention. It is preferred however that the chain stay 42 is shaped and oriented such that the chain stay pivot 48 is located below the rear axle location 46 in the top-to-bottom direction. Preferably, the chain stay pivot 48 is positioned no more than approximately 12mm below the rear axle location 46. This reduces any unwanted shock compression from chain tension under hard pedalling forces.

In the preferred embodiment, the respective locations of the chain stay pivot 48 and the lower pivot point 30 are selected such that the rear axle location 46 moves rearwardly during an initial part (e.g. approximately 63mm in this example) of the movement of the sub-frame away from the rest state. This helps with forward momentum when travelling over rough ground as the rear wheel moves away from an encountered object in a reward direction.

Typically, the chain stay 42 and seat stay 44 each comprise a respective pair of transversely spaced-apart stay structures 42’, 42’’ and 44’, 44’’, with corresponding axle locations 46’, 46’’ and, in the preferred embodiment corresponding chain and seat stay pivots 48’, 48’’, 50’, 50’’. In use, the rear wheel is located between the respective structure pairs, on an axle coupled to the axle locations 46’, 46’’.

The seat stay 44 is pivotably coupled to the seat tube 22 at the upper pivot point 28. The preferred coupling can best be seen from Figure 1, which shows a bracket 52 mounted on the seat post 22 and carrying a bearing 54. The seat stay 44 includes pin-receiving apertures (not visible) for receiving a pivot pin 56 that also passes through the bearing 54 to effect the coupling. It is noted that in the preferred embodiment, it is the forward portion 44A of the seat stay that is coupled to the seat tube 22.

The upper connection point 34 is provided on the seat stay 44, and is located beyond the pivot point 28 with respect to the rear axle location 46. To this end, the upper connection point is provided on a portion of the seat stay 44 (more particularly of the forward portion of the seat stay 44 in the preferred embodiment) that projects forwardly of the upper pivot point 28. The connection point 34 may comprise any convenient coupling to which an end of the shock absorber 32 can be connected. In this example, the connection point 34 comprises a rod 58 that extends between the spaced structures 44', 44'' of the seat stay 44.

The chain stay 42 is pivotably coupled to the seat tube 22 at the lower pivot point 30. In preferred embodiments, the seat tube is bifurcated at its lower end to create a gap 60 between transversely spaced apart seat tube portions 22', 22''. A portion 62 of the chain stay 42 is located in the gap 60 at the pivot point 30 to create the coupling between the chain stay 42 and seat tube 22. Typically it is a forward end portion 62 of the chain stay 42 that is located in the gap 60 and coupled to the seat tube 22. In the preferred embodiment, the paired structures 42', 42'' of the chain stay 42 converge with one another at the forward end 62 to facilitate location of the chain stay 42 in the gap 60 at the point of coupling.

Preferably, the pivotable coupling between the chain stay 42 and the seat tube portions 22', 22'' comprises a socket 64 formed in the chain stay 42 (at the forward end 62), a corresponding pin-receiving aperture (not visible) provided in each seat tube portion 22', 22'', and a pivot pin 66 passing through the apertures and the socket 64. Advantageously, a bearing 68 is provided in the socket 64 to facilitate pivoting movement of the chain stay 42. In the illustrated embodiment, a respective portion of the socket 64 and bearing 68 is provided in each of the paired chain stay structures 42', 42'', the respective portions being brought together by the convergence of the structures 42', 42'' at the pivot point 30. The preferred coupling is advantageous in that it provides a more stable coupling between the chain stay 42 and the seat post 22 than would be obtained by, for example, individually coupling the respective ends of spaced apart chain stay structures to a respective side of a conventional seat tube. This helps to stiffen the rear suspension.

The lower connection point 36 is provided on the chain stay 42, and is preferably located beyond the pivot point 30 with respect to the rear axle location 46. To this end, the lower connection point 36 is provided on a portion of the chain stay 42 (more particularly of the forward portion of the chain stay 42 in the preferred embodiment) that projects forwardly of the lower pivot point 30 (forwardly and upwardly in the illustrated embodiment). The connection point 36 may comprise any convenient coupling to which an end of the shock absorber 32 can be connected. In this example, the connection point 36 comprises a rod 70 that extends between the spaced structures 42’, 42’’ of the chain stay 42.

As can best be seen from Figure 4, the lower pivot point 30 is preferably located such that it is in register (in the transverse direction) with the chain ring, which is represented in Figure 4 by broken line L1. More preferably, the lower pivot point 30 is located in register with the top of the chain ring, preferably top dead centre, as shown in Figure 4. This gives excellent anti-squat properties when pedalling without excessive chain tension, chain growth or pedal feedback.

Figure 4 shows the rear suspension system in the rest state (indicated by arrow A) and in a displaced state (indicated by arrow B), which in this example is assumed to show the maximum travel of the sub-frame 14 from the rest state. It will be seen that the pivoting movement of the sub-frame 14 is facilitated by the stay pivots 48, 50. Displacement of the sub-frame 14 away from the rest state compresses the shock absorber 32, the action of the shock absorber 32 having a damping effect on the movement.

The characteristics, such as leverage ratio, of the suspension system depend on a number of factors such as the stiffness/resilience of the shock absorber 32, the dimensions and relative orientation of the chain stay 42 and seat stay 44 and the location of the stay pivots 48, 50.

One way to calculate the leverage ratio is to take the amount of the rear wheel travel of a bike and divide it by the corresponding amount of shock absorber travel. The bicycle may be design such that the leverage ratio changes as the shock absorber is compressed. A rising/falling rate ratio means that the ratio changes as the shock absorber is compressed. A rising rate means the shock absorber would increase resistance towards the end of its travel and a falling rate means that it would decrease its resistance towards the end of its travel. For example, a rising rate shock absorber might start off at, say, 3.0 : 1 and end at 2.5: 1, and falling would be the opposite. Rising rates are commonly said to be progressive.

In the preferred embodiment, the angle between the forward and rearward portions 44A, 44B of the seat stay 44 (which may be defined as the angle between a notional line running between the upper pivot point 28 and the seat stay pivot 50 and a notional line running between the seat stay pivot 50 and the rear axle location 46) is set to approximately 20° in the rest state. This gives a relatively low starting leverage ratio, e.g. approximately 2.32 mm/mm. As the sub-frame 14 begins to move away from the rest state, the leverage ratio increases. In particular, when a rider sits on the bicycle when static, the sub-frame 14 is pivoted by an amount corresponding to the sag point of the rear suspension system. During this movement, the leverage ratio changes with a falling rate to a sag point level, e.g. approximately 2.62 mm/mm. In the illustrated example, the sag point is assumed to correspond to approximately 30% compression of the shock absorber 32. The foregoing rest-to-sag characteristics helps to hold the rider at a desired ride height without any undue wallowing (i.e. providing stable platform).

As the sub-frame 14 moves beyond the sag point, the rate of change of the leverage ratio becomes progressive to end travel, i.e. the shock absorber acts progressively. This gives support for relatively large impacts. In this context “progressive” is a term used for the performance characteristics of the support provided by the suspension system through its travel. The movement of a linearly acting shock absorber has a linear relationship with the force applied to the shock absorber. In contrast, the movement of a progressively acting shock absorber has a non-linear relationship with the force applied to the shock absorber. Typically, for a progressively acting shock absorber the amount of force needed to move the shock absorber by a given amount increases as the shock absorber is compressed through its travel.

The preferred configuration described above whereby the lower end of the shock absorber 32 is connected to the lower connection point 36 on the chain stay 42 itself is advantageous in that it prevents the rate of change of the leverage ratio from becoming too progressive (which can result in limited use of travel). It is preferred to keep the initial angle of the shock absorber 32 (which may be measured as the angle between the shock absorber axis and the axis between the upper connection point 34 and the upper pivot point 28 and is approximately 34° in this example) relatively small and this is facilitated by the preferred configuration. The initial shock absorber angle is also kept relatively small by providing a relatively small angle (e.g. approximately 5.7°) between the longitudinal axis of the rear portion 44B of the seat stay 44 and the axis between the upper connection point 34 and the seat stay pivot 50 in the rest state.

Moreover, the lower connection point 36 moves forwardly with the upper connection point 34, and this keeps the angle between the shock absorber 32 and the forward portion 44A of the seat stay 44 within a desired range, e.g. between 100° and 80°, in order to prevent excess stress and loads being exerted on the shock absorber 32, particularly at full travel. It will be seen that the change in angular disposition of the shock absorber 32 between the rest state and maximum displaced state shown in Figure 4 is relatively small (e.g. approximately 7.5°), which reduces undesirable lateral loading of the shock absorber 32.

Advantageously, the upper pivot point 28, the seat stay pivot 50 and the chain stay pivot 48 are positioned to keep the rear suspension system active under braking. In particular, this is facilitated by the relatively shallow starting angle between the forward and rearward portions 44A, 44B of the seat stay 44 (which may be measured as the angle between the longitudinal axis of the rear portion 44B of the seat stay 44 and the axis between the upper pivot point 28 and the seat stay pivot 50, and is approximately 20° in this example), which maximizes the seat stay 44 movement resulting in maximum suspension movement under braking.

It will be apparent that the present invention may also be incorporated into a frame in which the seat tube 22 does not comprise a continuous structure extending between the bottom bracket and the top tube or seat. In such cases the seat tube may comprise a bottom structure extending upwardly from the bottom bracket or nearby location, which bottom structure may be the same as the bifurcated portion of seat tube 22, or at least comprise transversely spaced apart posts to define a yoke-receiving gap, and a separate top structure connected to the top tube and carrying the upper pivot point.

The invention is not limited to the embodiment(s) described herein but can be amended or modified without departing from the scope of the present invention.

CLAIMS:

1. A velocipede frame comprising a main body and a rear suspension system, wherein the main body comprises:

a bottom bracket for receiving a crankset;

a head tube located at the front of the frame;

a seat tube extending upwardly from said bottom bracket;

a top tube extending between said seat tube and said head tube; and

a down tube extending between said head tube and said bottom bracket,

wherein said rear suspension system comprises:

a sub-frame pivotably coupled to the rear of the body for pivoting movement with respect to the body about at least one transverse axis; and

at least one shock absorber configured to resiliently resist pivoting movement of said sub-frame away from a rest state,

wherein said sub-frame is pivotably coupled to said body at an upper pivot point and at a lower pivot point, said upper and lower pivot points being spaced apart in a top-to-bottom direction of said frame,

and wherein said at least one shock absorber has an upper end connected to an upper connection point on said sub-frame adjacent said upper pivot point, and a lower end connected to a lower connection point on said sub-frame adjacent said lower pivot point.

2. The velocipede frame as claimed in claim 1, wherein the upper and lower pivot points are located between the bottom bracket and an upper end of the seat tube.

3. The velocipede frame as claimed in claim 1 or 2, wherein the upper pivot point is provided on said seat tube.

4. The velocipede frame as claimed in any preceding claim, wherein the lower pivot point is provided on said seat tube.

5. The velocipede frame as claimed in any preceding claim, wherein said at least one shock absorber is configured to resiliently resist movement of the upper and lower connection points towards one another.

6. The velocipede frame as claimed in any preceding claim, wherein the lower connection point is positioned such that, when the sub-frame is in the rest state, the compression axis of said at least one shock absorber is co-incident with a notional straight line extending between the lower connection point and the lower pivot point.

7. The velocipede frame as claimed in any preceding claim, wherein the spacing between the upper connection point and upper pivot point is greater than the spacing between the lower connection point and lower pivot point.

8. The velocipede frame as claimed in any preceding claim, wherein the sub-frame comprises a chain stay, a seat stay and a rear axle location, wherein the rear axle location is provided at the rear of the sub-frame, the seat stay and chain stay extending between the rear axle location and the upper and lower pivot points respectively.

9. The velocipede frame as claimed in claim 8, wherein a chain stay pivot is provided in the chain stay between the lower pivot point and the axle location, preferably relatively close to the axle location, to allow relative pivoting movement between forward and rearward portions of the chain stay.

10. The velocipede frame as claimed in claim 8 or 9, wherein a seat stay pivot is provided in the seat stay between the upper pivot point and the axle location, preferably relatively close to the pivot point, to allow relative pivoting movement between forward and rearward portions of the seat stay.

11. The velocipede frame as claimed in claim 9 or 10, wherein the chain stay is shaped and oriented such that the chain stay pivot is located below the rear axle location in the top-to-bottom direction, preferably no more than approximately 12 mm below the rear axle location.

12. The velocipede frame as claimed in any one of claims 9 to 11, wherein the respective locations of the chain stay pivot and the lower pivot point are selected such that the rear axle location moves rearwardly during an initial part of the movement of the sub-frame away from the rest state.

13. The velocipede frame as claimed in any one of claims 8 to 12, wherein the chain stay and seat stay each comprises a respective pair of transversely spaced-apart stay structures with corresponding rear axle locations and, preferably, corresponding chain and seat stay pivots.

14. The velocipede frame as claimed in any one of claims 8 to 13, wherein the seat stay is pivotably coupled to the seat tube at the upper pivot point.

15. The velocipede frame as claimed in claim 14, wherein the upper connection point is provided on the seat stay, and is located beyond the upper pivot point with respect to the rear axle location.

16. The velocipede frame as claimed in claim 15, wherein the upper connection point is provided on a portion of the seat stay that projects forwardly of the upper pivot point.

17. The velocipede frame as claimed in any one of claims 8 to 16, wherein the chain stay is pivotably coupled to the seat tube at the lower pivot point.

18. The velocipede frame as claimed in claim 17, wherein the seat tube is bifurcated to create a gap between transversely spaced apart seat tube portions, and wherein a portion, typically a forward end, of the chain stay is located in the gap and is pivotably coupled to the seat tube portions at the lower pivot point.

19. The velocipede frame as claimed in claim 18, when dependent on any one of claims 13 to 17, wherein the paired structures of the chain stay converge with one another at the forward end to facilitate location of the forward end of chain stay in the gap 60 at the point of coupling.

20. The velocipede as claimed in claim 18 or 19, wherein the pivotable coupling between the chain stay and the seat tube portions comprises a socket formed in the chain stay, preferably at said forward end, a corresponding pin-receiving aperture provided in each seat tube portion, and a pivot pin passing through the apertures and the socket.

21. The velocipede as claim in claim 20, wherein a bearing is provided in the socket.

22. The velocipede as claimed in claim 21, when dependent on any one of claims 13 to 21, wherein a respective portion of the socket and bearing is provided in each of the paired chain stay structures, the respective portions being brought together by the convergence of the chain stay structures at the pivot point.

23. The velocipede as claimed in any one of claims 17 to 22, wherein the lower connection point is provided on the chain stay.

24. The velocipede as claimed in claim 23, wherein the lower connection point is located beyond the lower pivot point with respect to the rear axle location.

25. The velocipede as claimed in claim 24, wherein the lower connection point is provided on a portion of the chain stay that projects forwardly of the lower pivot point, preferably forwardly and upwardly.

26. The velocipede as claimed in any preceding claim wherein the lower pivot point is located such that, in use, it is in register in the transverse direction with a chain ring being part of the crankset coupled in use to said bottom bracket.

27. The velocipede as claimed in claim 26, wherein the lower pivot point is located in register with the top of the chain ring, preferably top dead centre.

28. The velocipede as claimed in any one of claims 10 to 27, wherein the angle between the forward and rearward portions of the seat stay is set to approximately 20° in the rest state.

29. A rear suspension system for a velocipede frame comprising a main body, the rear suspension system comprising:

a sub-frame for pivotable coupling to the rear of the body for pivoting movement with respect to the body about at least one transverse axis; and

at least one shock absorber configured to resiliently resist, in use, pivoting movement of said sub-frame away from a rest state,

wherein said sub-frame is configured to be pivotably coupled in use to said body at an upper pivot point and at a lower pivot point, said upper and lower pivot points being spaced apart in a top-to-bottom direction of said frame,

and wherein said at least one shock absorber has an upper end connected to an upper connection point on said sub-frame, said upper connection point being located adjacent said upper pivot point in use, and a lower end connected to a lower connection point on said sub-frame, said lower connection point being located adjacent said lower pivot point in use.

30. A velocipede frame comprising a main body and a rear suspension system, wherein the main body comprises:

a bottom bracket for receiving a crankset;

a head tube located at the front of the frame;

a seat tube extending upwardly from said bottom bracket;

a top tube extending between said seat tube and said head tube; and

a down tube extending between said head tube and said bottom bracket,

wherein said rear suspension system comprises:

a sub-frame pivotably coupled to the rear of the body for pivoting movement with respect to the body about at least one transverse axis; and

at least one shock absorber configured to resiliently resist pivoting movement of said sub-frame away from a rest state,

wherein said sub-frame is pivotably coupled to said body at an upper pivot point and at a lower pivot point, said upper and lower pivot points being spaced apart in a top-to-bottom direction of said frame,

and wherein the seat tube is bifurcated to create a gap between transversely spaced apart seat tube portions, and wherein a portion of the sub-frame is located in the gap and is pivotably coupled to the seat tube portions at the lower pivot point.

31. A velocipede comprising a velocipede frame as claimed in any preceding claim, said velocipede further comprising a handlebar assembly and a front wheel assembly coupled to the head tube, a crankset coupled to the bottom bracket, at least one rear wheel mounted on the sub-frame, and a chain coupling the crankset to the rear wheel.

32. The velocipede of claim 31 being a bicycle with single front and rear wheels.

Intellectual Property Office

Application No:	GB1407983.4	**Examiner:**	Mr Philip Osman
Claims searched:	1-29, 31, 32	**Date of search:**	15 September 2014

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-5, 7-17, 23-29, 31, & 32	US2008/252040 A1 (COLGRAVE et al) See abstract and figures
X	1-5, 7-17, 23-29, 31, & 32	EP1982911 A3 (TREK) See abstract and figures
X	1-5, 7, 8, 13, 26, 27, 29, 31, & 32	US2007/246909 A1 (WENG) See abstract and figures
X	1-5, 7, 8, 13, 26, 27, 29, 31, & 32	US2012/228850 A1 (TSENG) See abstract and figures
X	1-5, 7, 8, 13, 26, 27, 29, 31, & 32	DE202006012023 U1 (SIMPLON FAHRRAD) See English language abstract and figures
X	1-5, 7, 8, 13, 26, 27, 29, 31, & 32	ES2285952 A1 (BLUE FACTORY TEAM) See figures
X	1-5, 7, 8, 13, 26, 27, 29, 31, & 32	DE202011004542 U1 (KINESIS) See figures

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Field of Search:

Intellectual Property Office

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B62K

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
B62K	0025/26	01/01/2006