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REAR SUSPENSION SYSTEM

Abstract

The present disclosure relates to a rear suspension system for a rear wheel of a vehicle and to a vehicle having such a rear suspension system. The suspension system at least includes a leading lower link, a transverse lower link, and a track rod, wherein chassis-side hard points of the leading lower link and of the transverse lower link are arranged at or behind the a wheel center with respect to a specific direction when the suspension system is installed on the vehicle, wherein the specific direction points from the front to the rear of the vehicle parallel to the vehicle's center axis, wherein a knuckle-side kinematic point of the transverse lower link is behind the wheel center with respect to the specific direction.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. application Ser. No. 18/051,246, filed on Oct. 31, 2022, which claims priority to European Patent Application No. 21205807.7, filed Nov. 1, 2021, both of which are incorporated by reference herein in their entireties.

TECHNICAL FIELD

[0002] The present disclosure relates to a rear suspension system for a rear wheel of a vehicle, in particular an automotive vehicle, and to a vehicle having such a rear suspension system.

BACKGROUND

[0003] In the motor vehicle industry the process towards fully electric or hybrid vehicles is in full progress. Particular attention is being paid to the distance that can be reached with the electric drive without stopping to recharge. However, the distance that can be reliably reached is still less than that with a conventional vehicle with an internal combustion engine. In addition, it remains a constant endeavor to improve the driving characteristics of the vehicle in general.

SUMMARY

[0004] It is, therefore, an object of the present disclosure to provide means which allow to overcome the problems known from the state of the art and, in particular, to provide means which contribute a vehicle configuration that conduces an increase of the distance that can be reached with the electric drive before recharging is necessary while at the same time also improving the driving characteristics.

[0005] The object is solved according to a first aspect of the disclosure in that a rear suspension system for a rear wheel of a vehicle is proposed, in particular an automotive vehicle, wherein the suspension system comprises a leading lower link.

[0006] It is, thus, the surprising finding that providing a leading lower link for the rear suspension system which is attributed to a rear wheel of the vehicle allows to free additional space within the wheelbase of the vehicle without loss of safety and comfort. In this respect it has been particularly found that additional space can be freed within the wheelbase in the proximity of the rear axis. This is, because due to the presence of the leading lower link it is possible to omit the conventional trailing link.

[0007] A respective design of the arrangement of the rear suspension system's components, thus, allows that in fully or partly electric-driven vehicles a larger battery can be accommodated in the vehicle and/or the size, such as the length, of the vehicle can be reduce, hence, its weight.

[0008] The increased battery size allows more energy for the same vehicle dimensions, hence, an increased driving range. It is also possible to keep the same battery size but to redistribute the vehicle's geometry to shorten the vehicle, with a lower cabin and vehicle height and/or shorter vehicle length and lower weight, with additional range opportunity from lower weight. It is also possible to decrease the battery height, while keeping the battery energy constant, with a lower cabin and vehicle height. This may lead to better vehicle dynamics, with additional range opportunity from lower aero drag.

[0009] These aspects alone or in combination allow increasing the distance which can be traveled by the vehicle until the battery needs to be recharged.

[0010] Especially it turned out that the proposed rear suspension system is capable of being conceived for the simultaneous achievement of multiple aims which is more than normally in the scope of suspension concepts. The proposed design can, hence, be regarded as a framework which

allows easy implementation for further features.
[0011] The proposed design of the rear suspension system is, thus, a further step towards an optimal use of space, for the benefit of overall vehicle architecture efficiency, in terms of maximizing usable space which can be used for battery volume and cabin space within the wheelbase. In addition, this may also lead to improved center of gravity placement opportunities, and to lower weight of the vehicle.
[0012] It is understood that the technical advantages, such as improved space efficiency and weight reduction, are beneficial for both electric vehicles and conventional combustion engine vehicles.
[0013] In an embodiment, the suspension system can be or be formed as or comprise a five-link suspension system. The suspension system can comprise a transverse lower link, a rear upper link, a front upper arm or links, and/or a track rod.
[0014] In other words, the rear suspension system comprises the leading lower link, the transverse lower link, the rear upper link, the front upper arm or links, and the track rod so as to form a particular five-link suspension system.
[0015] In an implementation, the term “link” or “links”, especially “upper link” or “upper links”, refers to when in the upper part of the suspension, two separate elements connect the knuckle (hub carrier) to the chassis.
[0016] In an implementation, the term “arm”, especially “upper arm”, refers to when a single element connects the knuckle to the chassis. In this case, because of stability, the arm has one connection to the knuckle, and two connections to the chassis.
[0017] Alternatively or in addition, in an embodiment the chassis-side hard point/s of the leading lower link, of the rear upper link and/or of the transverse lower link can be arranged, respectively, at or behind the wheel center with respect to a specific direction, especially when the suspension system is installed on the vehicle, [0018] wherein the specific direction points from the front to the rear of the vehicle parallel to the vehicle's center axis, especially for the suspension system being installed on the vehicle.
[0019] By convention, the term “trailing link” denotes a link whose joint to the wheel knuckle (corresponding to a kinematic coupling point of the respective link) is behind the joint on the chassis side with respect to a direction of travel of the vehicle. Correspondingly, the term “leading link” denotes a link whose joint to the knuckle is in front of the joint on the chassis side with respect to the direction of travel of the vehicle. The term “transversal link” denotes a link which extends substantially transversally between its chassis-sided and knuckle-sided joints with respect to the direction of travel of the vehicle. In terms of their function(s), trailing links, leading links and transversal links in a wheel suspension system serve for managing, to different extents, a longitudinal and/or a transversal compliance in the suspension in the case of impacts through the wheel.
[0020] Said links (or at least sections thereof) are typically elements of the suspension system which are located or running closer to the ground and/or at the level of the battery, which in electric vehicles is accommodated low and within the wheelbase. Hence, designing the suspension system in the proposed manner so as to provide the hard points outside the wheelbase, allows to free additional space for accommodating parts of the battery. At the same time overall driving efficiency and stability can be maintained or even improved.
[0021] In other words, the proposed design options allow using space mostly behind the wheel center rather than in front of the same, respectively, with respect to the specific direction.
[0022] In an implementation, the centers of gravity of the chassis-side hard points are evaluated since the structure is typically extended in space.
[0023] If in this application reference is made to an element being “behind the wheel center” or being “in front of the wheel center”, it is understood that this reference is made with respect to the specific direction, unless otherwise stated or evident from the context. “Behind the wheel center” of a rear wheel refers to a side of the wheel facing towards the rear of the vehicle. Respectively, “in

front of the wheel center" of a rear wheel refers to a side of the wheel facing towards the front of the vehicle.

[0024] Alternatively or in addition, in an embodiment the chassis-side hard points of the front upper arm or links and/or of the track rod can be arranged, respectively, before the wheel center with respect to the specific direction. These elements, being located typically higher than the battery, do not prevent extending the battery towards the rear of the vehicle.

[0025] This improves the stability of the suspension system without demanding an excessive amount of space. This is because the hard points of the track rod and the front upper arm or links are typically close to the rear axis. Hence, in one embodiment, the hard points have a maximal distance from the rear axis of the vehicle, when the suspension system is installed on that vehicle, of 200 mm or less, or of 150 mm or less, and/or of 10 mm or more, or of 50 mm or more.

[0026] In an implementation, the centers of gravity of the chassis-side hard points are evaluated since the structure is typically extended in space.

[0027] Alternatively or in addition, in an embodiment the leading lower link, the transverse lower link, the rear upper link, the front upper arm or links and/or the track rod can be arranged, especially respectively with one of its ends, at a system's knuckle. For example, the respective other end of each of said elements might be connected to the chassis side. This supports the wheel bearing.

[0028] Alternatively or in addition, in an embodiment the rear upper link and the front upper arm or links extend such in space that they can cross each other within a projective view of the suspension system on the ground when installed on the vehicle. The crossing allows achieving a virtual instantaneous center that forms the suspension's kingpin axis in a position different from where the upper links' knuckle-side hard points are located.

[0029] A respective design turned out to improve stability of the suspension system while at the same time improving also driving comfort.

[0030] Alternatively or in addition, in an embodiment the center lines, especially the virtual extension of the center lines, of two or more of: the leading lower link, the front upper arm or links and the transverse lower link can cross at a single position, which is located behind the wheel center with respect to the specific direction.

[0031] A respective design turned out to improve stability of the suspension system while at the same time improving also driving comfort.

[0032] In an implementation, the center line of each link may be defined, especially in a projective view of the suspension system on the ground when installed on the vehicle, as a line extending from the center of a kinematic coupling point to the center of a bushing and/or chassis-side hard point, respectively, of the respective link. The kinematic coupling point and the bushing and/or chassis-side hard point are provided at opposite ends of the respective link.

[0033] The center of a kinematic coupling point, a bushing and/or a chassis-side hard point may be the center of gravity of that element.

[0034] Alternatively or in addition, in an embodiment each of one or more of the links can have a bushing at one of its ends for coupling the link to a chassis of the vehicle, wherein the bushing provides the respective chassis-side hard points.

[0035] Alternatively or in addition, in an embodiment the suspension system can be designed, especially the leading lower link and the transverse lower link can be arranged, such that for the suspension system a separation of longitudinal compliance for comfort and side stiffness for roadholding and/or handling is obtained.

[0036] It is, thus, possible in an easy and economic manner to obtain said separation solely by appropriate design of the two links.

[0037] It surprisingly turned out that this effect may be obtained by said two lower links which are located entirely or mostly behind the wheel center. The upper links may act as a pivot point, and the track rod may keep the wheel alignment.

[0038] For example, the suspension system can be designed such, that independent characteristics of longitudinal compliance for comfort, and side stiffness for roadholding and handling is obtained.
[0039] For example, the suspension system can be designed such, that longitudinal impact comfort is achieved with suspension alone.
[0040] Alternatively or in addition, in an embodiment the transverse lower link can comprise a stiff and pivoting bushing, especially for setting a roadholding response and/or a side stiffness.
[0041] It turned out that a respective chosen bushing allows controlling of the vehicle dynamic in a precise and efficient manner. All the more, a respective design option is cheap in implementation.
[0042] The inboard bushing on the transverse lower link may act as a pivot. The radial stiffness of this bushing may be high. However, it may allow rotation in a similar manner to a spherical joint. A bushing with rubber is to a spherical joint. This is because it provides road noise isolation. More commonly, spherical joints are at the knuckle side, with the noise isolation of the full suspension at the chassis side.
[0043] In an implementation, a bushing is regarded as being “stiff”, if the radial stiffness is between 1000 and 50000 N/mm.
[0044] In an implementation, a bushing is regarded as being “pivoting”, if the conical stiffness is below 5000 Nm/degree.
[0045] Alternatively or in addition, in an embodiment the leading lower link can comprise a large and/or soft bushing, especially aimed at setting a longitudinal impact comfort, especially thanks to a longitudinal compliance up to 20 mm at the wheel.
[0046] The softer the, especially “large”, bushing at the chassis-side of the leading lower link, the lower the longitudinal stiffness at the wheel. This longitudinal compliance acts as a “cushion” to spread the impact over a longer time, thus lowering the force peak fed to the chassis.
[0047] In an implementation, a bushing is regarded as being “soft”, if the radial stiffness is between 100 and 1000 N/mm.
[0048] It turned out that a respective chosen bushing allows controlling of the vehicle dynamic in a precise and efficient manner. All the more, a respective design option is cheap in implementation, based on conventional technology for these components in the automotive industry.
[0049] The proposed features allow a longitudinal impact comfort with suspension alone, and still provide for noise isolation between the full suspension and the chassis, to enable hard-mounted rear subframe or mounting the suspension directly to the body structure. Hence, in case a subframe is used, it can be hard-mounted to a vehicle chassis, with a better structural integration of the rear subframe, that also performs as a stiffening and reinforcing element of the body structure, and this can allow weight reduction.
[0050] For example, soft mounting of the subframe is usually achieved with 4 large rubber bushings, so the subframe is fixed in 4 positions to the body (2 left and 2 right, symmetric to the vehicle's longitudinal centerline, 2 in front of the wheel, and two behind the wheel). A rigidly (hard) mounted subframe can be fixed to the body with more than 4 points: no large bushings are necessary (space and weight saving), no relative motion of subframe to body (further space saving), and with more than 4 fixing points, the subframe reinforces the body structure where it is most desirable.
[0051] In an implementation, a bushing is regarded as being “large”, if it has a diameter of 60 mm or more, or of 100 mm or more (especially on subframes).
[0052] In an implementation, a bushing is regarded as being “soft”, if it has below 6000 N/mm radial stiffness (for example, 6000 is stiff, bus still not hard mounting).
[0053] For example, a large bushing for suspension links may be of a diameter of more than 60 mm. On subframes, more than 100 mm. A soft subframe bushing is below 6000 N/mm radial stiffness (6000 is stiff, bus still not hard mounting).
[0054] Alternatively or in addition, in an embodiment the suspension system can comprise a spring, which (a) is located and/or extends behind the wheel center with respect to the specific direction

and/or (b) has a center axis, wherein at least that section of the spring's center axis which extends within the spring has a minimal distance from a vertical extending diameter-line of the wheel mid plane, especially (i) of less than 200 mm, or of less than 150 mm, or of less than 100 mm, or of less than 50 mm, (ii) of more than 10 mm, or of more than 50 mm, or of more than 100 mm, or of more than 150 mm, or of more than 200 mm, and/or (iii) so as to create a motion ratio of the spring deflection compared to wheel vertical motion of more than 0.6, and ideally more than 0.70.
[0055] This is especially the case for the suspension system installed on the vehicle.
[0056] A design implementing a respective minimal distance allows for an increased spring motion ratio. This may lead to lower road force NVH (Noise, Vibration, Harshness) inputs to the vehicle's body structure.
[0057] Alternatively or in addition, in an embodiment the suspension system can comprise a damper, which (a) is located and/or extends in front of the wheel center with respect to the specific direction and/or (b) is mounted with its bottom on the knuckle. Locating the damper on the knuckle promotes a high motion ration also for the damper (for example higher than 0.75, ideally between 0.85 and 0.95, such as 0.90); this also allows to achieve the desired damping effect with lower damping forces, also reducing the NVH inputs from the camper to the body structure. The simultaneous increase of both spring and damper motion ratios is a clear NVH advantage for the vehicle, ideally with more than 0.70 for the spring and at the same time more than 0.90 for the damper.
[0058] The damper in front of wheel center can create space to locate a spring, such as the spring mentioned above, closer to the rear wheel (especially with the spring located behind the wheel center) for higher spring motion ratio, so with lower spring or air spring forces.
[0059] These design options in addition can allow for a particular efficient suspension system so that only little space is required within the wheelbase, especially if both, the damper and the spring are incorporated.
[0060] It has been particularly found that in case of the spring being behind the wheel center and the damper being in front of wheel center, the phase delay of amplitude and frequency modulation is promoted. Furthermore, use of gyroscopic effect in favor of wheel travel with less tire patch force variation is obtained. This allows for a longer tire life, a better efficiency and less tire bounce.
[0061] Hence, the proposed features promote isolation from powertrain disturbance, and exploitation of gyroscopic effects, for the purpose of optimizing tire-road interactions and rolling efficiency.
[0062] Alternatively or in addition, in an embodiment the track rod can be located and/or extends in front of the wheel center with respect to the specific direction.
[0063] A respective designed track rod allows for an independent rear steer even with a large air spring.
[0064] Thus, the proposed features allow incorporating the possibility of independent rear wheel steering, to enable active toe control, for more rolling efficiency and more vehicle dynamics options.
[0065] Alternatively or in addition, in an embodiment a kinematic point of the leading lower link and/or a kinematic point of the transverse lower link can be located behind the wheel center with respect to the specific direction.
[0066] Since said links are typically lower links, i.e., links which are arranged and extending close to the ground when the system is installed on the vehicle, it provides them outside of the wheelbase. Hence, each of the transverse lower link and/or the leading lower link is arranged and extends behind the wheel center with respect to the specific direction.
[0067] Alternatively or in addition, in an embodiment a kinematic point of the rear upper link and/or a kinematic point of the front upper arm or links can be located in front of the wheel center with respect to the specific direction.
[0068] Alternatively or in addition, in an embodiment a kinematic point of the track rod can be

arranged at a side front of the knuckle.
[0069] This further improves the independent rear steer option even with a large air spring.
[0070] The object is solved according to a second aspect of the disclosure in that a vehicle, especially an electric vehicle or a hybrid vehicle, more precisely an electric automotive vehicle or a hybrid automotive vehicle, having at least one suspension system according to the first aspect of the disclosure is proposed.
[0071] Alternatively or in addition, in an embodiment the vehicle can comprise at least one space for receiving a battery capable of energizing at least one motor of the vehicle, wherein the space is located within the wheelbase of the vehicle.
[0072] Alternatively or in addition, in an embodiment the vehicle can comprise a rear subframe which is hard-mounted (for example directly bolted without using rubber interface elements like bushings) to a vehicle chassis.
[0073] According to a third aspect, a rear suspension system for a rear wheel of a vehicle is proposed, in particular an automotive vehicle, wherein the suspension system for the rear wheel is a leading link suspension system.
[0074] The leading link suspension system can be defined as a suspension system comprising one or more lower links, wherein among all lower links of the suspension system a link having a largest distance between a chassis-side hard point and a knuckle-side kinematic point of the respective link in a direction parallel to a specific direction of the vehicle is a leading link.
[0075] In addition, the leading link suspension system can be defined as a suspension system comprising one or more lower links, wherein further among all lower links of the suspension system at least one leading link of the suspension system is configured to manage longitudinal compliance in the suspension. In particular, the at least one leading link can be arranged to accommodate a greater portion of an impact in a direction parallel to a longitudinal direction of the vehicle than any trailing lower link possibly comprised by the suspension system.
[0076] According to a fourth aspect, a rear suspension system for a rear wheel of a vehicle is proposed, in particular an automotive vehicle, wherein the suspension system comprises a plurality of lower links and wherein a chassis-side hard point of at least one rear lower link, in particular a rear lower leading link, among the plurality of lower links is located rearwards from a center axis of the rear wheel by a greater distance than a distance between a chassis-side hard point of any other lower link, in particular including at least one front lower trailing link or front lower transversal link, among the plurality of lower links and the center axis of the wheel.
[0077] Embodiments of a rear suspension system according to the third or fourth aspect include combinations with any of the features as set forth above in connection with a rear suspension system according to the first aspect.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0078] For a better understanding of embodiments of the disclosure and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings in which like numerals designate corresponding elements or sections throughout.
[0079] In the accompanying drawings:
[0080] FIG. **1** shows a three-quarter front inboard view of a rear suspension system;
[0081] FIG. **2** shows a three-quarter rear inboard view of the system;
[0082] FIG. **3** shows a top view of the system;
[0083] FIG. **4** shows a bottom view of the system;
[0084] FIG. **5** shows a rear view of the system;
[0085] FIG. **6** shows a vehicle; and

[0086] FIG. **7** shows the vehicle with an increased battery.

LIST OF REFERENCE SIGNS

[0087] **1**, **1**′ Rear Suspension System [0088] **3** Brake system [0089] **5***a* caliper [0090] **5***b* Brake disc [0091] **7**, **7**′ Leading lower link [0092] **9** Transverse lower link [0093] **11** Rear upper link [0094] **13**, **13**′ Front upper arm [0095] **15** Track rod [0096] **17** Bushing [0097] **19** Hard point [0098] **21** Hard point [0099] **23** Hard point [0100] **25** Hard point [0101] **27** Hard point [0102] **29** Kinematic point [0103] **31** Kinematic point [0104] **33** Kinematic point [0105] **35** Kinematic point [0106] **37** Kinematic point [0107] **39** Spring [0108] **41** Damper [0109] **43** Knuckle [0110] **45** Vehicle [0111] **47** Battery [0112] **49** Area [0113] A, A′ Wheel's center axis [0114] C Center line [0115] L Center Axis [0116] d Distance [0117] D Diameter [0118] W Contact line [0119] X Direction [0120] Y Direction [0121] Z Direction

DESCRIPTION OF EMBODIMENTS

[0122] Various examples of embodiments of the present disclosure will be explained in more detail by virtue of the following embodiments illustrated in the figures and/or described below.

[0123] FIG. **1** shows a three-quarter front inboard view of a rear suspension system **1** according to the first aspect of the disclosure. FIG. **2** shows a three-quarter rear inboard view of the system **1**. FIGS. **3-5**, respectively, show a top view, a bottom view and a rear view of the system **1**. The same features are labeled with same numerals throughout the Figures.

[0124] The system **1** can be used with a rear wheel of a vehicle, a contact line with the ground W of which wheel is partly indicated in FIGS. **1** and **5** for illustration purposes only. Actually, the shown system **1** is designed for a left-handed side rear wheel of the vehicle. Furthermore, also a disc brake **3** with a caliper **5***a* and a brake disc **5***b* are shown for illustration purposes only.

[0125] The system **1** has a leading lower link **7**, a transverse lower link **9**, a rear upper link **11**, a front upper arm **13** and a track rod **15**. Hence, the system **1** is a five-link suspension system. Each of the links **7**, **9**, **11** and **13** and the track rod **15** has a bushing **17** at one of its ends for coupling the respective link or track rod to a chassis of the vehicle.

[0126] The bushing **17** of the transverse lower link **9** is a stiff and pivoting bushing. The bushing **17** of the leading lower link **7** is a large and/or soft bushing.

[0127] The leading lower link **7** has a chassis-side hard point **19**, the transverse lower link **9** has a chassis-side hard point **21**, the rear upper link **11** has a chassis-side hard point **23**. Likewise has the front upper arm **13** a chassis-side hard point **25** and the track rod **15** a chassis-side hard point **27**. The chassis-side hard points are provided by the respective bushings **17**.

[0128] In FIGS. **3** and **4** a horizontal line A parallel to a direction Y indicates the rear wheel's center axis in form of a projection on top of the drawing plane for the system **1** being installed on the vehicle (that axis here indicates at the same time also the axis of the brake disc **5***b*). It is clear, that the center axis of the wheel actually is offset a certain distance into the drawing planes of FIGS. **3** and **4**. However, the line A is intended just for illustrating purposes of the course of the wheel's center axis.

[0129] It is apparent from these Figures, that the chassis-side hard points of the leading lower link **7**, of the rear upper link **11** and of the transverse lower link **9** are, respectively, at or behind the wheel center with respect to a direction X. The direction X points from the front to the rear of the vehicle parallel to the vehicle's center axis and may be regarded as a specific direction to which can be referred to. The directions Y and Z are perpendicular to each other and to the X direction. The Z direction points from bottom to top and the Y direction from left to right, for the system being installed on the vehicle.

[0130] In other words, along the direction X, the (center of gravities of the) chassis-side hard points of the leading lower link **7**, of the rear upper link **11** and of the transverse lower link **9** are passed, respectively, not before the wheel center is passed or reached.

[0131] It is likewise apparent from these Figures that the (center of gravities of the) chassis-side hard points of the front upper arm **13** and/or of the track rod **15** are, respectively, before the wheel

center with respect to the specific direction (direction X). Furthermore, the track rod **15** is located and extends in front of the wheel center with respect to the specific direction (direction X).
[0132] As can be best seen from FIG. **4**, a kinematic point **29** of the leading lower link **7** and a kinematic point **31** of the transverse lower link **9** are located behind the wheel center with respect to the specific direction (X direction). Contrary, a kinematic point **33** of the rear upper link **11** and a kinematic point **35** of the front upper arm **13** are located in front of the wheel center with respect to the specific direction (X direction). A kinematic point **37** of the track rod is arranged at a side front of the knuckle.
[0133] As can be best seen from FIG. **3**, the rear link **11** and the front link **13** extends such in space that they do cross each other within a projective view of the suspension system on the ground when installed on the vehicle.
[0134] As can be best seen from FIG. **4**, the center lines C, respectively, of the leading lower link **7**, the transverse lower link **9** and the front upper arm **13** do cross at a single position P, which is located behind the wheel center with respect to the specific direction (X direction).
[0135] The center line C of each link **7**, **9**, **13** is defined, in a projective view of the suspension system on the ground when installed on the vehicle, as a line extending from the center of gravity of the kinematic coupling point **29**, **31**, **35** to the center of gravity the bushing **17**, respectively, of the respective link **7**, **9**, **13**.
[0136] The system **1** further comprises a spring **39** which is located and extends behind the wheel center with respect to the specific direction (X direction). The spring **39** also has a center axis L. The section of the spring's center axis which extends within the spring **39** has a minimal distance d from a vertical extending diameter-line D of the wheel mid plane so as to create a motion ratio of the spring deflection compared to wheel vertical motion of more than 0.6, and ideally more than 0.70.
[0137] The system **1** further comprises a damper **41** which is located and extends in front of the wheel center with respect to the specific direction (X direction) and which is mounted with its bottom on a knuckle **43** of the system **1**. Also the links **7**, **9**, **11**, **13** and the track rod **15** are arranged at the system's knuckle **43**.
[0138] The rear suspension system **1**, as described above in connection with FIGS. **1** to **5**, constitutes what can be regarded as a leading link suspension system. Specifically, among the lower links **7**, **9** of system **1** a link having a greatest distance between a chassis-side hard point **19** and a knuckle-side kinematic point **29** of the respective link **7** in the specific direction (X direction) is a leading link.
[0139] Furthermore, a chassis-side hard point **19** of at least one rear lower link **7** among the plurality of lower links **7**, **9** of the system **1** is located rearwards (according to a direction of travel of the vehicle) from the center axis A of the wheel by a greater distance than a distance between a chassis-side hard point **21** of any other lower link, in particular including at least one front (transverse) lower link **9**, among the plurality of lower links **7**, **9** and the center axis A of the rear wheel.
[0140] FIG. **6** shows a rear part of a vehicle **45** according to the second aspect of the disclosure. The vehicle **45** has a rear suspension system **1** for the left-handed rear wheel and a rear suspension system **1′** for the right-handed rear wheel. The system **1** the system as described above with respect to FIGS. **1**-**5**.
[0141] The system **1′** might be similar to system **1**, however, mirrored about the vertically extending longitudinal center plane of the vehicle **45** (i.e. a plane which is extending perpendicular to the drawing plane of FIG. **6** and crosses the illustrated center line of the vehicle). Each suspension system **1**, **1′** is represented by its leading lower link **7**, ′**7** and its front upper arm **13**, **13′**.
[0142] The vehicle **45** also has a battery **47**. Since the proposed rear suspension systems **1**, **1′** are used, additional space is freed, as indicated by a hatched area **49**.
[0143] In FIG. **7** the use of a larger battery **43** is illustrated by respective arrows.

[0144] The following numbered clauses form part of the disclosure. [0145] Clause 1. A rear suspension system for a rear wheel of a vehicle, in particular an automotive vehicle, the suspension system comprising a leading lower link. [0146] Clause 2. The suspension system according to Clause 1, wherein the suspension system is a five-link suspension system and/or comprises a transverse lower link, a rear upper link, a front upper arm or links and/or a track rod. [0147] Clause 3. The suspension system according to any one of the preceding Clauses, wherein the chassis-side hard points of the leading lower link, of the rear upper link and/or of the transverse lower link is or are arranged, respectively, at or behind the wheel center with respect to a specific direction, especially when the suspension system is installed on the vehicle, wherein the specific direction points from the front to the rear of the vehicle parallel to the vehicle's center axis, especially for the suspension system being installed on the vehicle. [0148] Clause 4. The suspension system according to any one of Clauses 2 to 3, wherein the chassis-side hard points of the front upper arm or links and/or of the track rod is or are, respectively, before the wheel center with respect to the specific direction. [0149] Clause 5. The suspension system according to any one of the preceding Clauses, wherein each of one or more of the links has a bushing at one of its ends for coupling the link to a chassis of the vehicle, wherein the bushing provides the respective chassis-side hard points. [0150] Clause 6. The suspension system according to any one of the preceding Clauses, wherein the suspension system is designed such, especially the leading lower link and the transverse lower link are arranged such, that for the suspension system a separation of longitudinal compliance for comfort and side stiffness for roadholding and/or handling is obtained. [0151] Clause 7. The suspension system according to Clause 6, wherein the transverse lower link comprises a stiff and pivoting bushing, especially for setting a roadholding response and/or a side stiffness. [0152] Clause 8. The suspension system according to any one of the Clauses 6 to 7, wherein the leading lower link comprises a large and/or soft bushing, especially aimed at setting a longitudinal impact comfort, especially thanks to a longitudinal compliance up to 20 mm at the wheel. [0153] Clause 9. The suspension system according to any one of the preceding Clauses, wherein the suspension system comprises a spring, which (a) is located and/or extends behind the wheel center with respect to the specific direction and/or (b) has a center axis, wherein at least that section of the spring's center axis which extends within the spring has a minimal distance from a vertical extending diameter-line of the wheel mid plane, especially so as to create a motion ratio of the spring deflection compared to wheel vertical motion of more than 0.6, and ideally more than 0.70. [0154] Clause 10. The suspension system according to any one of the preceding Clauses, wherein the suspension system comprises a damper, which (a) is located and/or extends in front of the wheel center with respect to the specific direction and/or (b) is mounted with its bottom on the knuckle. [0155] Clause 11. The suspension system according to any one of the preceding Clauses, wherein the track rod is located and/or extends in front of the wheel center with respect to the specific direction. [0156] Clause 12. The suspension system according to any one of the preceding Clauses, wherein a kinematic point of the leading lower link and/or a kinematic point of the transverse lower link is or are located behind the wheel center with respect to the specific direction. [0157] Clause 13. The suspension system according to any one of the preceding Clauses, wherein a kinematic point of the rear upper link and/or a kinematic point of the front upper arm or links is or are located in front of the wheel center with respect to the specific direction. [0158] Clause 14. The suspension system according to any one of the preceding Clauses, wherein a kinematic point of the track rod is arranged at a side front of the knuckle. [0159] Clause 15. A rear suspension system for a rear wheel of a vehicle, in particular an automotive vehicle, wherein the suspension system for the rear wheel is a leading link suspension system. [0160] Clause 16. The suspension system according to Clause 15, wherein the leading link suspension system is a suspension system comprising one or more lower links, wherein among all lower links of the suspension system a link having a greatest distance between a chassis-side hard point and a knuckle-side kinematic point of the respective link in a direction parallel to a specific direction of the vehicle is a leading link.

[0161] Clause 17. The suspension system according to Clause 15, wherein the suspension system is a five-link suspension system and/or comprises a transverse lower link, a rear upper link, a front upper arm or links and/or a track rod. [0162] Clause 18. The suspension system according to any one of Clauses 15 to 17, wherein the chassis-side hard points of the leading lower link, of the rear upper link and/or of the transverse lower link is or are arranged, respectively, at or behind the wheel center with respect to a specific direction, especially when the suspension system is installed on the vehicle, wherein the specific direction points from the front to the rear of the vehicle parallel to the vehicle's center axis, especially for the suspension system being installed on the vehicle. [0163] Clause 19. The suspension system according to any one of Clauses 17 or 18, wherein the chassis-side hard points of the front upper arm or links and/or of the track rod is or are, respectively, before the wheel center with respect to the specific direction. [0164] Clause 20. The suspension system according to any one of Clauses 15 to 19, wherein each of one or more of the links has a bushing at one of its ends for coupling the link to a chassis of the vehicle, wherein the bushing provides the respective chassis-side hard points. [0165] Clause 21. The suspension system according to any one of Clauses 15 to 20, wherein the suspension system is designed such, especially the leading lower link and the transverse lower link are arranged such, that for the suspension system a separation of longitudinal compliance for comfort and side stiffness for roadholding and/or handling is obtained. [0166] Clause 22. The suspension system according to Clause 21, wherein the transverse lower link comprises a stiff and pivoting bushing, especially for setting a roadholding response and/or a side stiffness. [0167] Clause 23. The suspension system according to any one of Clauses 21 or 22, wherein the leading lower link comprises a large and/or soft bushing, especially aimed at setting a longitudinal impact comfort, especially thanks to a longitudinal compliance up to 20 mm at the wheel. [0168] Clause 24. The suspension system according to any one of Clauses 15 to 23, wherein the suspension system comprises a spring, which (a) is located and/or extends behind the wheel center with respect to the specific direction and/or (b) has a center axis, wherein at least that section of the spring's center axis which extends within the spring has a minimal distance from a vertical extending diameter-line of the wheel mid plane, especially so as to create a motion ratio of the spring deflection compared to wheel vertical motion of more than 0.6, and ideally more than 0.70. [0169] Clause 25. The suspension system according to any one of Clauses 15 to 24, wherein the suspension system comprises a damper, which (a) is located and/or extends in front of the wheel center with respect to the specific direction and/or (b) is mounted with its bottom on the knuckle. [0170] Clause 26. The suspension system according to any one of Clauses 15 to 25, wherein the track rod is located and/or extends in front of the wheel center with respect to the specific direction. [0171] Clause 27. The suspension system according to any one of Clauses 15 to 26, wherein a kinematic point of the leading lower link and/or a kinematic point of the transverse lower link is or are located behind the wheel center with respect to the specific direction. [0172] Clause 28. The suspension system according to any one of Clauses 15 to 27, wherein a kinematic point of the rear upper link and/or a kinematic point of the front upper arm or links is or are located in front of the wheel center with respect to the specific direction. [0173] Clause 29. The suspension system according to any one of Clauses 15 to 28, wherein a kinematic point of the track rod is arranged at a side front of the knuckle. [0174] Clause 30. A rear suspension system for a rear wheel of a vehicle, in particular an automotive vehicle, wherein the suspension system comprises a plurality of lower links and wherein a chassis-side hard point of at least one rear lower link, in particular a rear lower leading link, among the plurality of lower links is located rearwards from a center axis of the rear wheel by a greater distance than a distance between a chassis-side hard point of any other lower link, in particular including at least one front lower link, among the plurality of lower links and the center axis of the rear wheel. [0175] Clause 31. The suspension system according to Clause 30, wherein the leading link suspension system is a suspension system comprising one or more lower links, wherein among all lower links of the suspension system a link having a greatest distance between a chassis-side hard point and a

knuckle-side kinematic point of the respective link in a direction parallel to a specific direction of the vehicle is a leading link. [0176] Clause 32. The suspension system according to Clause 31, wherein the suspension system is a five-link suspension system and/or comprises a transverse lower link, a rear upper link, a front upper arm or links and/or a track rod. [0177] Clause 33. The suspension system according to any one of Clauses 30 to 32, wherein the chassis-side hard points of the leading lower link, of the rear upper link and/or of the transverse lower link is or are arranged, respectively, at or behind the wheel center with respect to a specific direction, especially when the suspension system is installed on the vehicle, wherein the specific direction points from the front to the rear of the vehicle parallel to the vehicle's center axis, especially for the suspension system being installed on the vehicle. [0178] Clause 34. The suspension system according to any one of Clauses 32 or 33, wherein the chassis-side hard points of the front upper arm or links and/or of the track rod is or are, respectively, before the wheel center with respect to the specific direction. [0179] Clause 35. The suspension system according to any one of Clauses 30 to 34, wherein each of one or more of the links has a bushing at one of its ends for coupling the link to a chassis of the vehicle, wherein the bushing provides the respective chassis-side hard points. [0180] Clause 36. The suspension system according to any one of Clauses 30 to 35, wherein the suspension system is designed such, especially the leading lower link and the transverse lower link are arranged such, that for the suspension system a separation of longitudinal compliance for comfort and side stiffness for roadholding and/or handling is obtained. [0181] Clause 37. The suspension system according to Clause 36, wherein the transverse lower link comprises a stiff and pivoting bushing, especially for setting a roadholding response and/or a side stiffness. [0182] Clause 38. The suspension system according to any one of Clauses 36 or 37, wherein the leading lower link comprises a large and/or soft bushing, especially aimed at setting a longitudinal impact comfort, especially thanks to a longitudinal compliance up to 20 mm at the wheel. [0183] Clause 39. The suspension system according to any one of Clauses 30 to 38, wherein the suspension system comprises a spring, which (a) is located and/or extends behind the wheel center with respect to the specific direction and/or (b) has a center axis, wherein at least that section of the spring's center axis which extends within the spring has a minimal distance from a vertical extending diameter-line of the wheel mid plane, especially so as to create a motion ratio of the spring deflection compared to wheel vertical motion of more than 0.6, and ideally more than 0.70. [0184] Clause 40. The suspension system according to any one of Clauses 30 to 39, wherein the suspension system comprises a damper, which (a) is located and/or extends in front of the wheel center with respect to the specific direction and/or (b) is mounted with its bottom on the knuckle. [0185] Clause 41. The suspension system according to any one of Clauses 30 to 40, wherein the track rod is located and/or extends in front of the wheel center with respect to the specific direction. [0186] Clause 42. The suspension system according to any one of Clauses 30 to 41, wherein a kinematic point of the leading lower link and/or a kinematic point of the transverse lower link is or are located behind the wheel center with respect to the specific direction. [0187] Clause 43. The suspension system according to any one of Clauses 30 to 42, wherein a kinematic point of the rear upper link and/or a kinematic point of the front upper arm or links is or are located in front of the wheel center with respect to the specific direction. [0188] Clause 44. The suspension system according to any one of Clauses 30 to 43, wherein a kinematic point of the track rod is arranged at a side front of the knuckle. [0189] Clause 45. Vehicle, especially an electric vehicle or a hybrid vehicle, having at least one suspension system according to any one of Clauses 1 to 44. [0190] Clause 46. Vehicle according to Clause 45, wherein the vehicle comprises a rear subframe which is hard-mounted to a vehicle chassis.

Claims

1. A rear suspension system for a rear wheel of a vehicle, the suspension system comprising a leading lower link, a transverse lower link, and a track rod, wherein chassis-side hard points of the leading lower link and of the transverse lower link are arranged at or behind a wheel center with respect to a specific direction when the suspension system is installed on the vehicle, wherein the suspension system further comprises a rear upper link, and further comprises a front upper arm or front upper link, the specific direction points from the front to the rear of the vehicle parallel to a vehicle's center axis, and along a direction opposite to the specific direction, the chassis-side hard points of the leading lower link, of the rear upper link and of the transverse lower link are sequentially passed before the wheel center is reached; wherein a knuckle-side kinematic point of the transverse lower link is behind the wheel center with respect to the specific direction; wherein a distance from a kinematic point of the front upper arm or front upper link to the vehicle's center axis is smaller than that from a kinematic point of the track rod to the vehicle's center axis; and wherein a chassis-side hard point of the rear upper link is arranged at or behind the wheel center with respect to the specific direction while a kinematic point of the rear upper link is located in front of the wheel center with respect to the specific direction.

2. The rear suspension system according to claim 1, wherein a chassis-side hard point of at least one of the front upper arm or front upper link or of the track rod of the suspension system is, respectively, before the wheel center with respect to the specific direction.

3. The rear suspension system according to claim 1, wherein each of one or more of the links has a bushing at one of its ends for coupling the link to a chassis of the vehicle, wherein the bushing provides the respective chassis-side hard points.

4. The rear suspension system according to claim 1, wherein the leading lower link and the transverse lower link are arranged such that for the suspension system a separation of longitudinal compliance for comfort and side stiffness for roadholding and handling is obtained.

5. The rear suspension system according to claim 4, wherein the transverse lower link comprises a stiff and pivoting bushing for setting at least one of a roadholding response or a side stiffness.

6. The rear suspension system according to claim 4, wherein the leading lower link comprises a large or soft bushing, the large or soft bushing aimed at setting a longitudinal impact comfort thanks to a longitudinal compliance up to 20 mm at the wheel.

7. The rear suspension system according to claim 1, wherein the suspension system comprises a spring, the spring being (a) at least one of located or extending behind the wheel center with respect to the specific direction; or (b) arranged such that at least a section of a spring's center axis which extends within the spring has a minimal distance from a vertical extending diameter-line of the wheel mid plane, so as to create a motion ratio of the spring deflection compared to wheel vertical motion of more than 0.6.

8. The rear suspension system according to claim 1, wherein the suspension system comprises a damper, the damper being (a) at least one of located or extending in front of the wheel center with respect to the specific direction; or (b) mounted with its bottom on a knuckle.

9. The rear suspension system according to claim 1, wherein the track rod is located or extending in front of the wheel center with respect to the specific direction.

10. The rear suspension system according to claim 1, wherein at least one of a kinematic point of the leading lower link or a kinematic point of the transverse lower link is located behind the wheel center with respect to the specific direction.

11. The rear suspension system according to claim 1, wherein a kinematic point of the track rod is arranged at a side front of a knuckle.

12. An automotive vehicle comprising the rear suspension system according to claim 1.

13. The automotive vehicle according to claim 12, wherein the automotive vehicle comprises a rear subframe which is hard-mounted to a vehicle chassis.

14. A rear suspension system for a rear wheel of a vehicle, wherein the rear suspension system for

the rear wheel is a leading link suspension system comprising one or more lower links, wherein among all lower links of the suspension system, a link having a greatest distance between a chassis-side hard point and a knuckle-side kinematic point of the respective link in a direction parallel to a specific direction of the vehicle is a leading link, wherein the specific direction points from the front to the rear of the vehicle parallel to a vehicle's center axis, and the lower link is directly connected to a spring connected to a chassis of the vehicle.

15. A rear suspension system for a rear wheel of a vehicle, wherein the rear suspension system is a five-link suspension system and comprises a plurality of lower links, a rear upper link, and a front upper arm or front upper link, wherein the plurality of lower links comprises all lower links of the suspension system, and wherein a chassis-side hard point of at least one leading lower link among the plurality of lower links is located rearwards from a center axis of the rear wheel by a greater distance than a distance between a chassis-side hard point of any one of every other lower link among the plurality of lower links, the rear upper link, and the front upper arm or front upper link and the center axis of the rear wheel.

16. The rear suspension system according to claim 15, wherein the rear suspension system for the rear wheel is a leading link suspension system comprising the plurality of lower links, wherein among all lower links of the plurality of lower links, a link having a greatest distance between a chassis-side hard point and a knuckle-side kinematic point of the respective link in a direction parallel to a specific direction of the vehicle is a leading link.

17. The rear suspension system according to claim 7, wherein the motion ratio of the spring deflection compared to wheel vertical motion is more than 0.7.

18. The rear suspension system according to claim 1, the track rod extends in front of the wheel center with respect to the specific direction.

19. The rear suspension system according to claim 14, wherein the chassis-side hard point of the leading link is located rearwards from the wheel center in the specific direction.

20. The rear suspension system according to claim 18, wherein the chassis-side hard point of the leading link is located rearwards from the wheel center in the specific direction by a greater distance than a distance between chassis-side hard points of all other lower links of the suspension system.