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(54) Gas spring system for a vehicle

(57) The invention relates to a gas spring device for a vehicle, in particular a rail vehicle, comprising a gas spring unit (106) and an emergency spring unit (107), the gas spring unit comprising a first housing part (106.1), a second housing part (106.2) and a bellows (106.3). The bellows (106.3) moveably connects the first housing part (106.1) and the second housing part (106.2) such that a substantially gas tight gas spring chamber (106.4) is confined by the bellows (106.3), the first housing part (106.1) and the second housing part (106.2). The first housing part (106.1) is adapted to be connected to a loading structure (102) while the second housing part (106.2) is adapted to be connected to a support structure (103) adapted to support a load exerted by the loading structure (102). The gas spring unit (106) has an inflated state and a deflated state, the gas spring unit (106) being adapted to resiliently support the load exerted by the loading structure (102) on the support structure (103) in the inflated state, the emergency spring unit (107) being adapted to resiliently support the load exerted by the loading structure (102) on the support structure (103) in the deflated state. The emergency spring unit (107) has a first end (107.3) and a second end (107.4) and a longitudinal axis (107.5) extending between the first end and the second end, the emergency spring unit (107) being connected to the first housing part (106.1) or the second housing part (106.2) in such a manner that one end (107.4) of the emergency spring unit (107), in the inflated state, is a free end. The free end (107.4) of the emergency spring unit (107) is located closer to the bellows (106.3) than the other end (107.3) of the emergency spring unit (107).

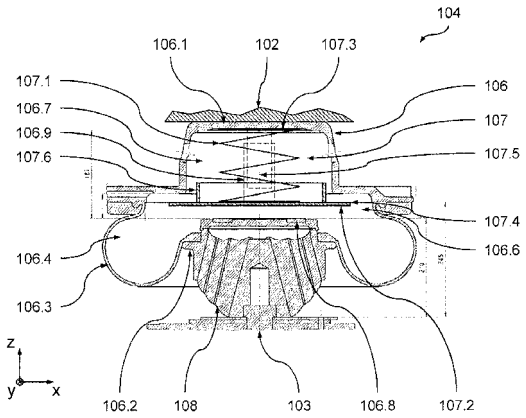

Fig. 2

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Description

[0001] The present invention relates to a gas spring device for a vehicle, in particular a rail vehicle, comprising a gas spring unit and an emergency spring unit. The gas spring unit comprises a first housing part, a second housing part and a bellows, the bellows moveably connecting the first housing part and the second housing part such that a substantially gas tight gas spring chamber is confined by the bellows, the first housing part and the second housing part. The first housing part is adapted to be connected to a loading structure while the second housing part is adapted to be connected to a support structure adapted to support a load exerted by the loading structure. The gas spring unit has an inflated state and a deflated state of the gas spring chamber. The gas spring unit is adapted to resiliently support the load exerted by the loading structure on the support structure in the inflated state of the gas spring chamber. The emergency spring unit is adapted to resiliently support the load exerted by the loading structure on the support structure in the deflated state of the gas spring chamber. The emergency spring unit has a first end and a second end and a longitudinal axis extending between the first end and the second end. The emergency spring unit is connected to said first housing part or said second housing part in such a manner that one end of said emergency spring unit, in said inflated state, is a free end.

[0002] Gas spring systems (frequently being designed as air spring systems), typically are used in secondary suspension systems in passenger rail vehicles in order to increase riding comfort for the passengers. In these cases, the relative movement between the carbody and the bogie is provided by the flexibility of the bellows. In many known systems, the bellows is supported on the running gear via an auxiliary spring device (e.g. a helical metal spring or a laminated metal-rubber-spring). This auxiliary spring (among others) provides an emergency function in case of deflation of the air spring (i.e. a pressure drop below the value necessary to take the external load). In this instance, the axial stiffness of the secondary suspension system is defined by the stiffness of the auxiliary spring.

[0003] In many designs, the auxiliary spring can not be made resilient enough to ensure derailment safety in this deflated condition. Thus, under certain riding conditions, for instance, the deflated system relying only on the auxiliary spring would be dynamically overloaded leading to running conditions with insufficient contact pressure between the individual wheels and the rail.

[0004] In order to solve this problem, certain known systems use additional emergency springs sitting on top of the auxiliary spring within the pressure chamber of the air spring. However, these additional emergency springs, both, increase the required height of the system and require a large diameter in the upper first housing part to prevent early limitation of the lateral deflection of the air spring in the inflated condition. This is unfavorable since design space is highly limited in modern rail vehicles. In other words, with this known solution, the reduction of the vertical stiffness of the suspension system is relatively low compared to the space it requires.

[0005] It is thus an object of the present invention to provide a gas spring device that, at least to some extent, overcomes the above disadvantages. It is a further object of the present invention to provide a gas spring device that ensures good emergency riding properties while requiring few design space.

[0006] The above objects are achieved starting from a gas spring device according to the preamble of claim 1 by the features of the characterizing part of claim 1.

[0007] The present invention is based on the technical teaching that good emergency riding properties may be achieved while at the same time requiring few design space by placing the free end of the emergency spring device closer to the bellows than the other end of the emergency spring device. By this means it is in particular possible to place the free end of the emergency spring device in the region of motion defined by the bellows such and that the free end (moving in synchronicity with the bellows) may move freely in this region of motion of the bellows which is to be provided for the motion of the bellows anyway. Thus, in other words, this region of motion not only represents the region of motion for the bellows but also integrates the function of the region of motion for the free end of the emergency spring device. This leads to an overall reduced design space required by the gas spring device without any drawbacks in relation to riding properties and flexibility.

[0008] Thus, according to a first aspect, the invention relates to a gas spring device for a vehicle, in particular a rail vehicle, comprising a gas spring unit and an emergency spring unit. The gas spring unit comprises a first housing part, a second housing part and a bellows, the bellows moveably connecting the first housing part and the second housing part such that a substantially gas tight gas spring chamber is confined by the bellows, the first housing part and the second housing part. The first housing part is adapted to be connected to a loading structure while the second housing part is adapted to be connected to a support structure adapted to support a load exerted by the loading structure. The gas spring unit has an inflated state and a deflated state of the gas spring chamber, the gas spring unit being adapted to resiliently support the load exerted by the loading structure on the support structure in the inflated state of the gas spring chamber. The emergency spring unit is adapted to resiliently support the load exerted by the loading structure on the support structure in the deflated state of the gas spring chamber. The emergency spring unit has a first end and a second end and a longitudinal axis extending between the first end and the second end. The emergency spring unit is connected to the first housing part or the second housing part in such a manner that one end of the emergency spring unit, in the inflated state, is a free end. The free end of the emergency spring unit is located

closer to the bellows than the other end of the emergency spring unit.

[0009] As mentioned previously, the free end of the emergency spring unit is preferably located in the region of the bellows such that both may share the same space for motion during operation of the vehicle.

[0010] It will be appreciated that, in particular depending on the design of the bellows, the emergency spring may either be connected to the first housing part or the second housing part. Preferably, the emergency spring is connected to the first housing part since this allows a very simple design using conventional bellows of the so-called half-hourglass design. Thus, preferably, the first end of the emergency spring unit is connected to the first housing part, the second end of the emergency spring unit, in the inflated state, being the free end, the second end of the emergency spring unit, in the deflated state, contacting the second housing part.

[0011] The emergency spring unit may be located outside of the gas spring chamber. However, due to the functional integration of the design space taken, it is preferred that the emergency spring unit is arranged within the gas spring chamber.

[0012] The emergency spring unit may be of any suitable type. Preferably, the emergency spring unit comprises a coil spring and/or a laminated rubber-and-metal spring. Furthermore, the emergency spring unit may comprise tensile spring elements. However, since they allow a very simple and space saving design, the use of compressive spring elements is preferred. That is, preferably, the emergency spring unit comprises a compressive spring element.

[0013] The two housing parts may be of any desired suitable design. Preferably the first housing part or the second housing part forms a receptacle, the emergency spring unit being at least partially received within the receptacle in order to achieve a very compact design. The receptacle may be of any shape adapted to the shape of the emergency spring unit. In designs that are very simple to implement the receptacle is of substantially cylindrical shape or of substantially conical shape. Preferably, the first housing part or the second housing part is substantially shaped in the manner of a hat since, by this means, a very space-saving designs achieved.

[0014] To improve the emergency riding performance it is preferred that the first housing part or the second housing part comprises a guide device, the guide device guiding the emergency spring unit along the longitudinal axis upon compression or extension of the emergency spring unit. Such a guide device has the advantage that a very compact design may be achieved, in particular, if the guide device is centrally arranged or integrated within the emergency spring unit. Thus, preferably, the emergency spring unit defines an inner circumference and the guide device is located internally to this inner circumference of the emergency spring unit and/or cooperating with (e.g. slidably engaging) the inner circumference of the emergency spring unit.

[0015] The emergency spring device, in the inflated state, may be completely unloaded such that the loading of the emergency spring device only occurs upon deflation of the gas spring device and contact of the free end with the adjacent housing part. However, in order to reduce the drop of the supported structure in case of deflation of the gas spring preferably a preloading device is provided, the preloading device, in the inflated state, exerting a preload on the emergency spring unit along the longitudinal axis. Preferably, the preloading device is part of a guide device as mentioned above (guiding the emergency spring unit along the longitudinal axis upon compression or extension) allowing a very compact and space saving design.

[0016] With advantageous embodiments of the gas spring device according to the invention the emergency spring unit, at the free end, has a first sliding element and the housing part located adjacent to the free end has a second sliding element, the first sliding element and the second sliding element being arranged such that, in the deflated state, the first sliding element contacts the second sliding element. Preferably, the first sliding element and the second sliding element are adapted to allow, in the deflated state, sliding relative movement in a direction transverse to the longitudinal axis. By this means, even under emergency operation conditions, lateral motion comparable to the normal operating conditions (i.e. with normal gas spring operation) may be achieved.

[0017] With preferred embodiments of the gas spring device according to the invention an auxiliary spring unit is provided, the auxiliary spring unit being connected to the second housing part and being adapted to support the second housing part on the support structure. This allows integration of the gas spring device according to the invention in conventional vehicle designs.

[0018] The bellows may be designed in any desired suitable way. Preferably, the bellows is designed in the manner of a half-hourglass bellows sensed this allows for very easy and space-saving implementation of the present invention.

[0019] The limitation of the relative motion of the components of the gas spring device in the deflated state may be provided by the resilient elements used in the design. However, preferably, separate elements are provided functioning as stop elements to avoid overloading the resilient elements. Thus, preferably, the emergency spring unit has a stop device, the stop device limiting relative motion of the second end of the emergency spring unit with respect to the first housing part in a direction transverse to the longitudinal axis and/or in a direction along the longitudinal axis.

[0020] The present invention furthermore relates to a vehicle, in particular rail vehicle, comprising a car body, a running gear and a gas spring device according to the invention, the car body forming the loading structure and being supported by the gas spring device on the running gear forming the support structure. With such a vehicle, the embodiments and advantages of the present inven-

tion as they have been described in the foregoing may be achieved to the same extent. Thus, it is simply referred here to the above.

[0021] Further embodiments of the present invention will become apparent from the dependent claims and the following description of preferred embodiments which refers to the appended figures.

Figure 1 is a schematic representation of a preferred embodiment of a vehicle according to the present invention comprising a preferred embodiment of a gas spring device according to the present invention;

Figure 2 is a schematic sectional representation of a detail of Figure 1;

Figure 3 is a schematic sectional view of a further preferred embodiment of a gas spring device according to the present invention;

Figure 4 is a schematic sectional view of a further preferred embodiment of a gas spring device according to the present invention.

First embodiment

[0022] With reference to Figure 1 and 2 a preferred embodiment of a rail vehicle 101 according to the present invention with a gas spring device according to the present invention will now be described in greater detail.

[0023] Figure 1 is a schematic representation of the rail vehicle 101 which comprises a car body 102 for transporting passengers supported on a support structure in the form of a running gear 103 (e.g. a bogie). The car body 102 is supported on the running gear 103 via a secondary spring device 104. The secondary spring device comprises a preferred embodiment of a gas spring device 105 according to the invention.

[0024] The gas spring device 105 is operated with air such that it forms an air spring device. However, it will be appreciated that, with other embodiments of the invention, any other gas may be used for operating the gas spring device.

[0025] As can be seen in greater detail from Figure 2, the gas spring device 105 comprises a gas spring unit 106, and emergency spring unit 107 and an auxiliary spring unit 108. The auxiliary spring unit 108 is formed by a laminated metal-rubber spring supported on a part of the running gear 103. The gas spring unit 106 in turn is supported on the auxiliary spring unit 108 and supports the car body 102.

[0026] The gas spring unit 106 comprises a first housing part 106.1 connected to the car body 102, a second housing part 106.2 connected to the auxiliary spring unit 108 and a bellows 106.3. The first housing part 106.1, the second housing part 106.2 and the bellows 106.3 are connected to each other such that they form a substantially gas tight gas spring chamber 106.4. The bellows 106.3 is of a conventional half-hourglass type.

[0027] The gas spring unit 106 further comprises one or more gas inlet and outlet devices (not shown in further detail) connected to a pressure control device 106.5 controlling the air pressure within the gas spring chamber 106.4. The gas spring unit 106 has an inflated state wherein the pressure within the gas spring chamber 106.4 is adjusted such that the gas spring unit 106 provides a support force sufficient to resiliently support the load introduced into it via the car body 102 (forming a loading structure for the gas spring unit 106). The gas spring unit 106 furthermore has a deflated state wherein the pressure prevailing within the gas spring chamber 106.4 is not sufficient to resiliently support the load introduced into it via the car body 102.

[0028] The emergency spring unit 107 (only shown in a very schematic way in Figure 2) comprises a compressive spring element in the form of a helical metal spring 107.1 and a first sliding element in the form of a sliding plate 107.2. The emergency spring unit 107 has a first end 107.3 fixedly connected to the first housing part 106.1 and a second end 107.4 carrying the sliding plate 107.2 and located closer to the bellows 106.3 than the first end 107.3. A longitudinal axis 107.5 of the emergency spring unit 107 extends between the first and 107.3 and the second in 107.4.

[0029] In the deflated state of the gas spring unit 106 (e.g. upon malfunction of the pressure control unit 106.4 or a leakage of the gas spring chamber 106.4) the sliding plate 107.2 of the emergency spring unit 107 contacts a second sliding element 106.8 located on top of the second housing part 106.2. Thus, in this deflated state the emergency spring unit 107 takes over the function of supporting the load of the car body 102 from the gas spring unit 106.

[0030] In this deflated state, relative motion between the car body 102 and the running gear 103 is provided by deflection the compressive spring element 107.1, both, in a direction transverse to the longitudinal axis 107.5 (lateral relative motion) and along the longitudinal axis 107.5 (axial relative motion). In order to avoid excessive lateral deflection of the compressive spring element 107.1 a lateral hard stop element 107.6 is provided to co-operate with the first housing part 106.1. Further lateral relative motion may be provided via a sliding motion between the first sliding element 107.2 and the second sliding element 106.8.

[0031] In the inflated state of the gas spring unit 106, the second end 107.4 is a free end located in the region of the bellows 106.3. More precisely, in this inflated state, the free end 107.4 of the emergency spring unit 107 is located in the region of motion 106.6 defined by the bellows 106.3. By this means the free end 107.4 (moving in synchronicity with the bellows 106.3) may move freely in this region of motion of the bellows 106.3 which is to be provided for the motion of the bellows 106.3 during deflection of the gas spring device 104 anyway. Thus, in

other words, this region of motion 106.6 not only represents the region of motion for the bellows 106.3 but also integrates the function of the region of motion for the free end 107.4 of the emergency spring device 107.

[0032] Compared to the previously known designs, this leads to an overall reduced design space required by the gas spring device 104 without any drawbacks in relation to riding properties and flexibility. More precisely, the first housing part 106.1 to which the first end 107.3 of the emergency spring unit 107 is fixedly connected may be formed in a very simple space-saving manner as it is shown in Figure 2.

[0033] As can be seen from Figure 2, the first housing part 106.1 is formed in the manner of a hat forming a substantially cylindrical receptacle 106.7 receiving most of the compressive spring element 107.1. The inner diameter of the receptacle 106.7 is adapted to the outer diameter of the compressive spring element 107.1. More precisely, the inner diameter of the receptacle 106.7 may be only slightly larger than the outer diameter of the compressive spring element 107.1. The clearance may be chosen to correspond to the maximum lateral deflection to be provided by the compressive spring element 107.1.

[0034] However, it will be appreciated that, with other embodiments of the invention, a guide device, e.g. in the form of a telescopic guide element pair (one connected to the sliding plate 107.2 and one connected to the first housing part 106.1) located internally to the emergency spring element 107.1, may be provided as it is indicated by the dashed contour 106.9 in Figure 2. Thus, in the deflated state, the guide device 106.9 prevents relative motion between the car body 102 and the running gear 103 in a direction transverse to the longitudinal axis 107.5 (i.e. hard stop element 107.6 may then be omitted) and allows relative motion between the car body 102 and the running gear 103 along the longitudinal axis 107.5 (axial relative motion).

[0035] Consequently, due to this centrally arranged guide device 106.9, the clearance between the inner diameter of the receptacle 106.7 and the outer diameter of the compressive spring element 107.1 may be minimized to a very small gap (necessary to take any lateral expansion of the spring element 107.1 during operation) allowing a very compact design. Lateral relative motion is then provided via a sliding motion between the first sliding element 107.2 and the second sliding element 100.8 exclusively.

[0036] It will be further appreciated that the outer diameter of the sliding plate 107.2 is chosen to sufficiently exceed the inner diameter of the receptacle 106.7 such that the sliding plate 107.2 also forms an axial hard stop to prevent excessive axial loading of the compressive spring element 107.1.

Second embodiment

[0037] With reference to Figure 1 and 3 a further preferred embodiment of a gas spring device 204 according to the present invention will now be described in greater detail. The gas spring device 204 may replace the gas spring device 104 in the vehicle 101 of Figure 1. The gas spring device 204, in its basic design and functionality, largely corresponds to the gas spring device 104 such that it will be mainly referred to the differences only. Moreover, identical or like components are given the same reference numerals increased by 100. Unless deviating explanations are given in the following it is here explicitly referred to the explanations given above with respect to the features and functions of these components.

[0038] One difference with respect to the gas spring device 104 lies in the design of the compressive spring element 207.1 of the emergency spring device 207. As can be seen from Figure 3, the spring element 207.1 is formed by a conical laminated metal-rubber spring sitting in a conical receptacle 206.7 of the first housing part 206.1. This design has the advantage that the axial stiffness (along the longitudinal axis 207.5) of the emergency spring device 207 may be adjusted in a simple way in a very broad range by suitably selecting the design (e.g. the composition) of the laminated metal-rubber spring 207.1. At the same time, such a laminated metal-rubber spring 207.1 (in particular, along the longitudinal axis 207.5) allows a very compact design.

[0039] A further difference lies within the fact that a preloading device 209 is provided. The preloading device 209 compressively preloads the emergency spring element 207.1 along its longitudinal axis 207.5. The preloading device 209 comprises a stop element 209.1 connected to the free end of a guide device in the form of a guide element 206.9 of the first housing part 206.1. An inner circumference of the spring element 207.1 slideably engages the guide element 206.9 such that, in the inflated state of the gas spring unit 206, the emergency spring element 207.1 (under an axial preload) rests against the stop element 209.1.

[0040] In certain cases a friction influencing means (such as a lubricating device and/or a friction influencing coating on one or both sliding partners) may be provided at the location of the guide device in order to influence the friction effect on the axial stiffness. It will be appreciated that such a friction influencing means may be used to tune the axial stiffness to the desired properties. This tuning typically includes lowering the friction and, thus, the axial stiffness as well as the axial damping properties. However, raising the friction and, thus, the axial stiffness as well as the axial damping properties may also be provided in some cases.

[0041] This design with the laterally restricting guide device 206.9 integrating the preloading device 209 has the advantage that no lateral hard stop (similar to hard stop 107.6) is required allowing a very compact design.

[0042] In the deflated state of the gas spring unit 206, the sliding plate 207.2 of the emergency spring unit 207 contacts the second sliding element 206.8 such that the emergency spring element 207.1 is further deflected and slides along the guide element 206.9 along the longitu-

dinal axis 207.5 thereby taking the load of the car body 102. Either the stop element 209.1 (e.g. cooperating with the associated surface of the sliding plate 207.2) or a further stop element cooperating with the emergency spring element 207.1 (e.g. a further stop element on the guide element 206.9) may limit maximum deflection of the emergency spring element 207.1.

Third embodiment

[0043] With reference to Figure 1 and 4 a further preferred embodiment of a gas spring device 304 according to the present invention will now be described in greater detail. The gas spring device 304 may replace the gas spring device 104 in the vehicle 101 of Figure 1. The gas spring device 304, in its basic design and functionality, largely corresponds to the gas spring device 204 such that it will be mainly referred to the differences only. Moreover, identical or like components are given the same reference numerals increased by 100. Unless deviating explanations are given in the following it is here explicitly referred to the explanations given above with respect to the features and functions of these components.

[0044] The only difference with respect to the gas spring device 204 lies within the fact that the receptacle 306.7 is formed in the second housing part 306.2 (instead of the first housing part). Thus, the emergency spring unit 307 is fixedly connected to the second housing part 306.2. In other words, compared to the gas spring device 204, basically an upside down arrangement of the emergency spring unit 307 is chosen.

[0045] Although the present invention in the foregoing has only been described in the context of rail vehicles, it will be appreciated that it may also be applied to any other type of vehicle in order to overcome similar problems with respect to a space saving solution for an emergency suspension.

Claims

1. A gas spring device for a vehicle, in particular a rail vehicle, comprising

- a gas spring unit (106; 206; 306) and
- an emergency spring unit (107; 207; 307);
- said gas spring unit comprising a first housing part (106.1; 206.1; 306.1), a second housing part (106.2; 206.2; 306.2) and a bellows (106.3; 206.3; 306.3);
- said bellows (106.3; 206.3; 306.3) moveably connecting said first housing part (106.1; 206.1; 306.1) and said second housing part (106.2; 206.2; 306.2) such that a substantially gas tight gas spring chamber (106.4; 206.4; 306.4) is confined by said bellows (106.3; 206.3; 306.3), said first housing part (106.1; 206.1; 306.1) and said second housing part (106.2; 206.2; 306.2);
- said first housing part (106.1; 206.1; 306.1) being adapted to be connected to a loading structure (102);
- said second housing part (106.2; 206.2; 306.2) being adapted to be connected to a support structure (103) adapted to support a load exerted by said loading structure (102);
- said gas spring unit (106; 206; 306) having an inflated state and a deflated state of said gas spring chamber (106.4; 206.4; 306.4);
- said gas spring unit (106; 206; 306) being adapted to resiliently support said load exerted by said loading structure (102) on said support structure (103) in said inflated state of said gas spring chamber (106.4; 206.4; 306.4);
- said emergency spring unit (107; 207; 307) being adapted to resiliently support said load exerted by said loading structure (102) on said support structure (103) in said deflated state of said gas spring chamber (106.4; 206.4; 306.4);
- said emergency spring unit (107; 207; 307) having a first end (107.3; 207.3; 307.3) and a second end (107.4; 207.4; 307.4) and a longitudinal axis (107.5; 207.5; 307.5) extending between said first end and said second end;
- said emergency spring unit (107; 207; 307) being connected to said first housing part (105.1; 206.1; 306.1) or said second housing part (106.2; 206.2; 306.2) in such a manner that one end (107.4; 207.4; 307.4) of said emergency spring unit (107; 207; 307), in said inflated state, is a free end;
- said free end (107.4; 207.4; 307.4) of said emergency spring unit (107; 207; 307) is located closer to said bellows (106.3; 206.3; 306.3) than the other end (107.3; 207.3; 307.3) of said emergency spring unit (107; 207; 307);
- said first housing part (106.1; 206.1) or said second housing part (306.2) forms a receptacle (106.7; 206.7; 306.7), said emergency spring unit (107; 207; 307) being at least partially received within said receptacle (106.7; 206.7; 306.7);

characterized in that

- said first housing part (106.1; 206.1) or said second housing part (306.2) is substantially shaped in the manner of a hat.

2. The gas spring device according to claim 1, **characterized in that** said free end (107.4; 207.4; 307.4) of said emergency spring unit (107; 207; 307) is located in the region of said bellows (106.3; 206.3; 306.3).

3. The gas spring device according to claim 1 or 2, **characterized in that**

- said first end (107.3; 207.3) of said emergency

spring unit is connected to said first housing part (106.1; 206.1);
- said second end (107.4; 207.4) of said emergency spring unit (107; 207), in said inflated state, being said free end;
- said second end (107.4; 207.4) of said emergency spring unit (107; 207), in said deflated state, contacting said second housing part (106.2; 206.2).

4. The gas spring device according to any one of the preceding claims, **characterized in that** said emergency spring unit (107; 207; 307) is arranged within said gas spring chamber (106.4; 206.4; 306.4).

5. The gas spring device according to any one of the preceding claims, **characterized in that** said emergency spring unit (107; 207; 307) comprises a coil spring (107.1) and/or a laminated metal-rubber spring (207.1; 307.1), in particular, a conical spring.

6. The gas spring device according to any one of the preceding claims, **characterized in that** said emergency spring unit (107; 207; 307) comprises a compressive spring element (107.1; 207.1; 307.1).

7. The gas spring device according to any one of the preceding claims, **characterized in that**

- said receptacle (106.7; 206.7; 306.7) is of substantially cylindrical shape or of substantially conical shape.

8. The gas spring device according to any one of the preceding claims, **characterized in that**

- said first housing part (106.1; 206.1) or said second housing part (306.2) comprises a guide device (106.9; 206.9; 306.9);
- said guide device (106.9; 206.9; 306.9) guiding said emergency spring unit (107; 207; 307) along said longitudinal axis (107.5; 207.5; 307.5) upon compression or extension of said emergency spring unit (107; 207; 307),
- said emergency spring unit (107; 207; 307), in particular, defining an inner circumference and said guide device (106.9; 206.9; 306.9) being located internally to said inner circumference of said emergency spring unit (107; 207; 307) and/or cooperating with said inner circumference of said emergency spring unit (207; 307).

9. The gas spring device according to any one of the preceding claims, **characterized in that**

- a preloading device (209; 309) is provided;
- said preloading device (209; 309), in said inflated state, exerting a preload on said emergency spring unit (207; 307) along said longitudinal axis (207.5; 307.5);
- said preloading device (209; 309), in particular, being part of a guide device (206.9; 306.9) guiding said emergency spring unit (207; 307) along said longitudinal axis (207.5; 307.5) upon compression or extension of said emergency spring unit (207; 307),.

10. The gas spring device according to any one of the preceding claims, **characterized in that**

- said emergency spring unit (107; 207; 307), at said free end, has a first sliding element (107.2; 207.2; 307.2) and
- said housing part located adjacent to said free end has a second sliding element (106.8; 206.8; 306.8);
- said first sliding element (107.2; 207.2; 307.2) and said second sliding element (106.8; 206.8; 306.8) being arranged such that, in said deflated state, said first sliding element (107.2; 207.2; 307.2) contacts said second sliding element (106.8; 206.8; 306.8);
- said first sliding element (107.2; 207.2; 307.2) and said second sliding element (106.8; 206.8; 306.8), in particular, being adapted to allow, in said deflated state, sliding relative movement in a direction transverse to said longitudinal axis (107.5; 207.5; 307.5).

11. The gas spring device according to any one of the preceding claims, characterized and that

- an auxiliary spring unit (108; 208; 308) is provided;
- said auxiliary spring unit (108; 208; 308) being connected to said second housing part (106.2; 206.2; 306.2) and being adapted to support said second housing part (106.2; 206.2; 306.2) on said support structure (103).

12. The gas spring device according to any one of the preceding claims, **characterized in that** said bellows (106.3; 206.3; 306.3) is designed in the manner of a half-hourglass bellows.

13. The gas spring device according to any one of the preceding claims, **characterized in that**

- said emergency spring unit (107; 207; 307) has a stop device (107.2, 107.6; 202.6; 304.6);
- said stop device (107.2, 107.6; 202.6; 304.6) limiting relative motion of said second end (107.4; 207.4; 307.4) of said emergency spring unit with respect to said first housing part (106.1; 206.1; 306.1) in a direction transverse to said longitudinal axis (107.5; 207.5; 307.5) and/or in

a direction along said longitudinal axis (107.5; 207.5; 307.5).

14. Vehicle, in particular rail vehicle, comprising

- a car body (102),
- a running gear (103) and
- a gas spring device (104; 204; 304) according to any one of the preceding claims;
- said car body (102) forming said loading structure and being supported by said gas spring device (104; 204; 304) on said running gear (103) forming said support structure.

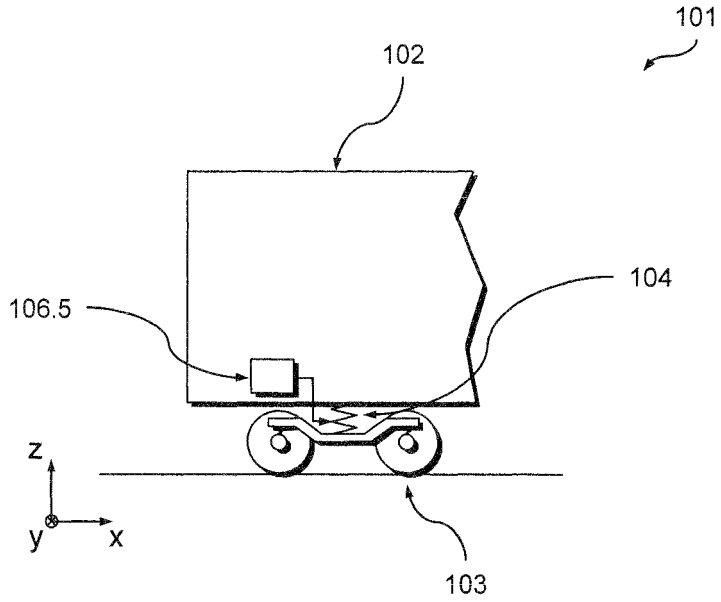
101
102
104
106.5
z
y
x
103

Fig. 1

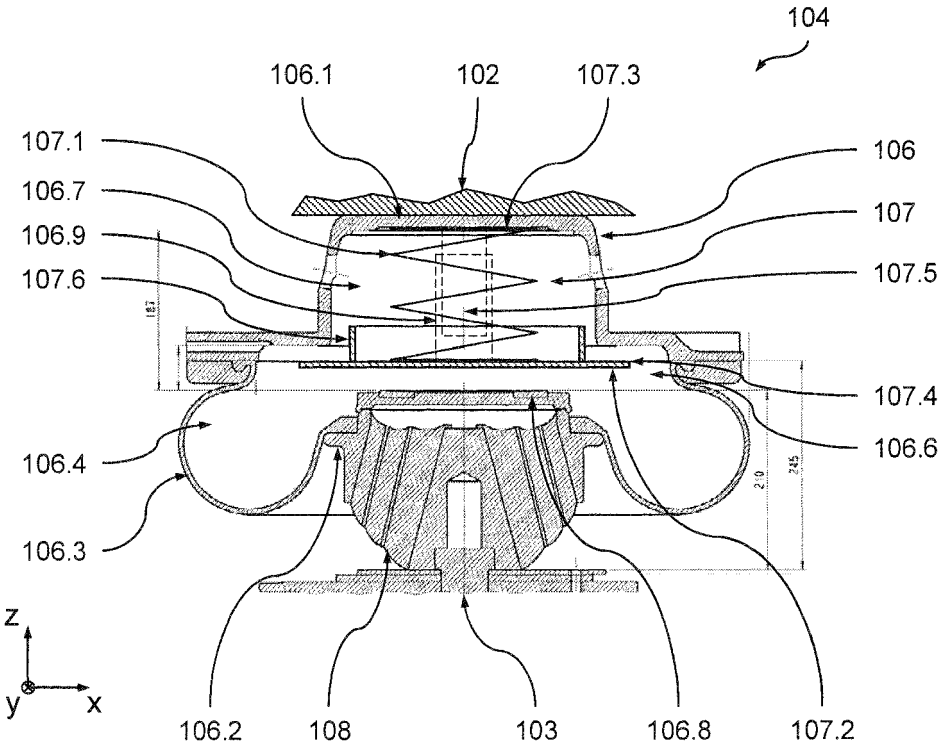
104
106.1
102
107.3
107.1
106
106.7
107
106.9
107.5
107.6
107.4
106.6
106.4
106.3
z
y
x
106.2
108
103
106.8
107.2

Fig. 2

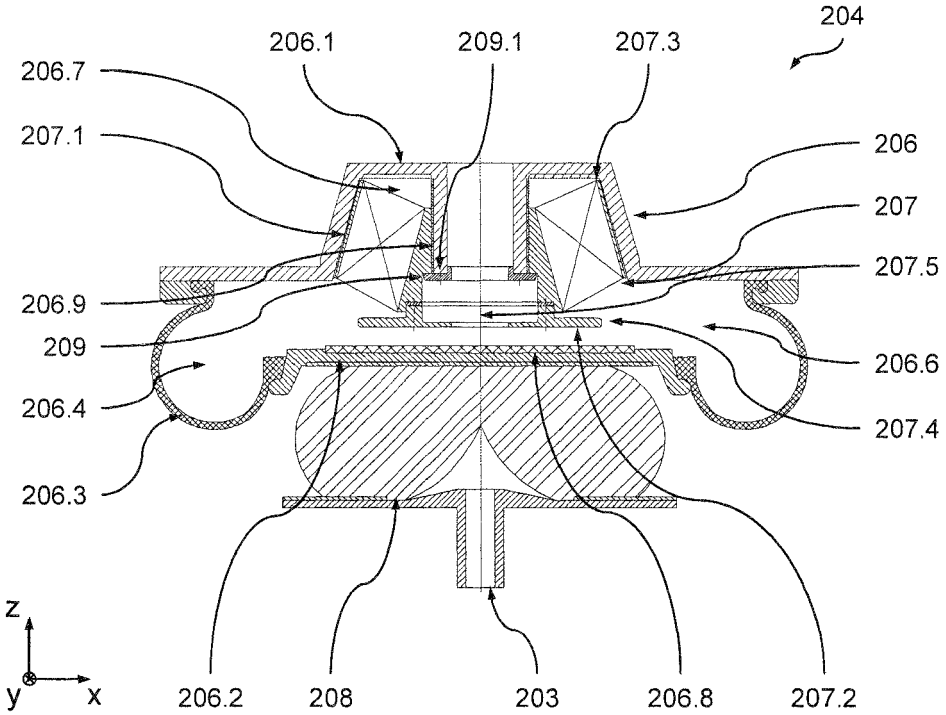
204
206.1
209.1
207.3
206.7
207.1
206
207
207.5
206.9
209
206.6
206.4
207.4
206.3
z
y
x
206.2
208
203
206.8
207.2

Fig. 3

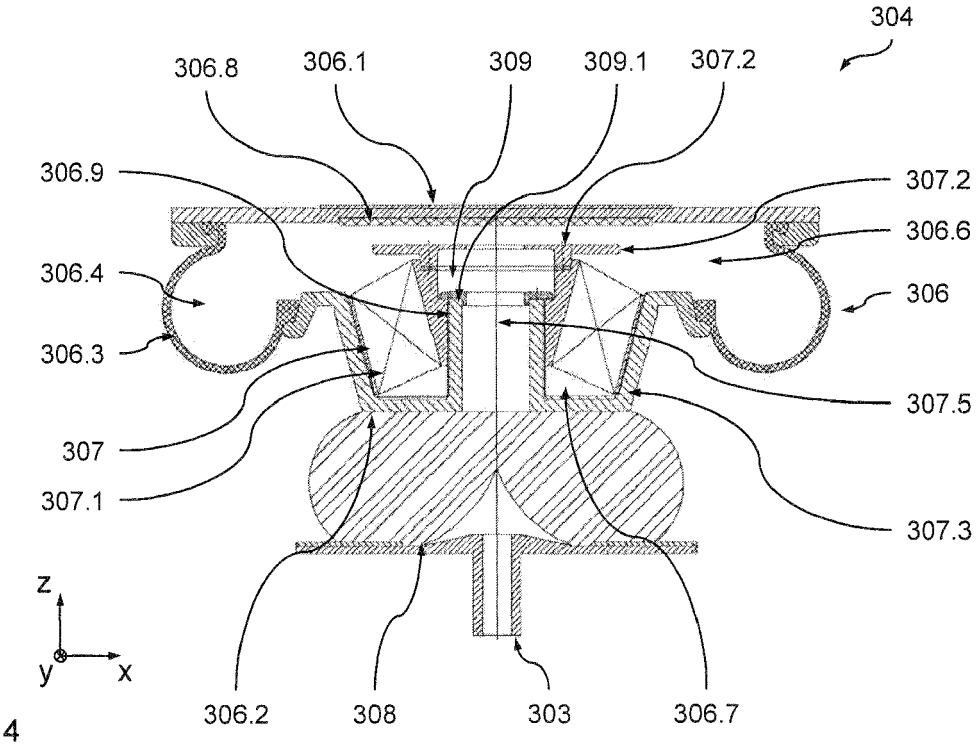
304
306.8
306.1
309
309.1
307.2
306.9
307.2
306.6
306.4
306
306.3
307.5
307
307.1
307.3
z
y
x
306.2
308
303
306.7

Fig. 4