US 20040016361A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2004/0016361 A1

Teichmann et al. (43) Pub. Date: Jan. 29, 2004

(54) LEVEL CONTROL FOR A RAIL-MOUNTED VEHICLE

(76) Inventors: **Martin Teichmann**, Graz (AT); **Herwig Waltensdorfer**, Graz (AT); **Alexander Schimanofsky**, Wien (AT)

Correspondence Address:
Welsh & Katz, Ltd.
THOMAS R. VIGIL
22nd Floor
120 South Riverside Plaza
Chicago, IL 60606 (US)

(21) Appl. No.: **10/422,260**

(22) Filed: **Apr. 24, 2003**

Related U.S. Application Data

(60) Provisional application No. 60/376,057, filed on Apr. 26, 2002.

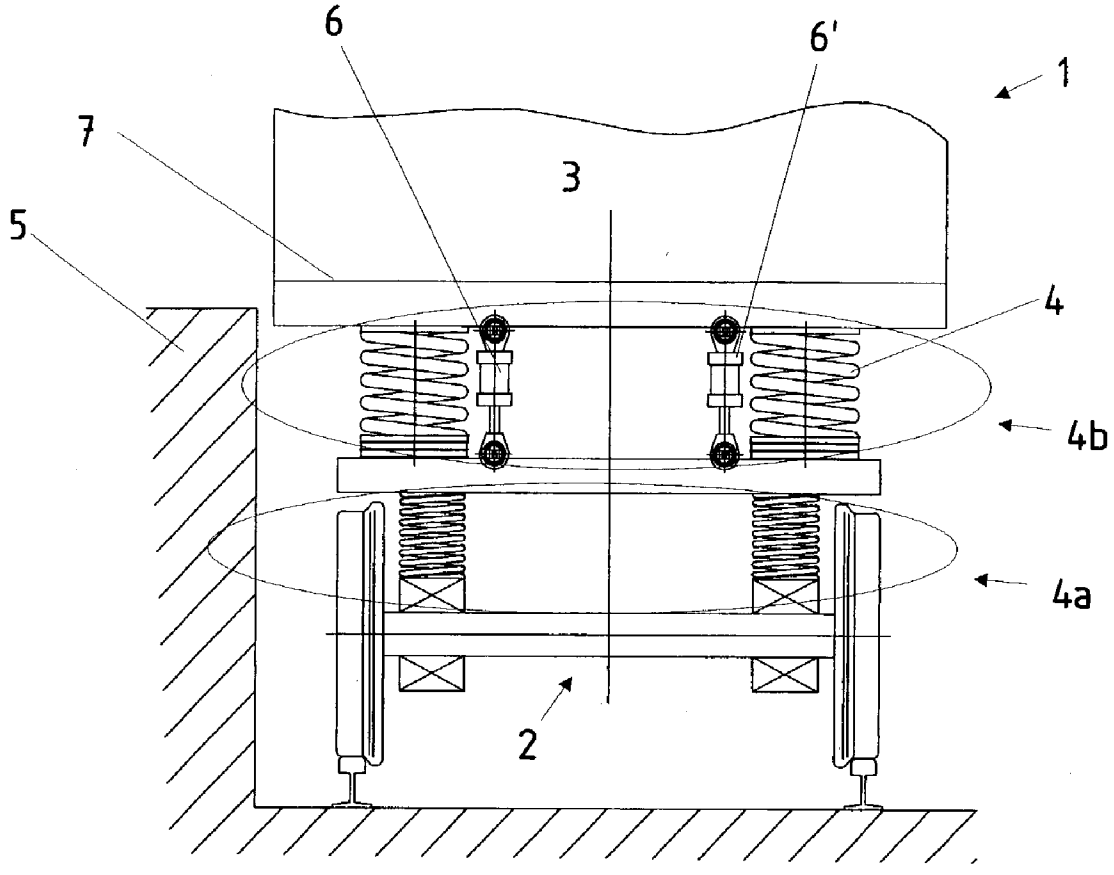
Publication Classification

(51) **Int. Cl.**[7] **B61D 1/00**

(52) **U.S. Cl.** **105/164**

(57) **ABSTRACT**

The rail vehicle (**1**) comprises a sub-frame (**2**) and a wagon body (**3**) disposed above it. Between the wagon body (**3**) and the sub-frame (**2**) a spring stage (**4**) is provided and between the wagon body (**3**) and the sub-frame (**2**) at least one actuator (**6**) is provided which is arranged to bring the wagon body (**3**) from a raised travel position into a lowered load/unload position against a restoring force produced by the spring stage (**4**) to keep it in the load/unload position. The wagon body (**3**) is raised into a travel position by the restoring force upon deactivation of the actuator (**6**).



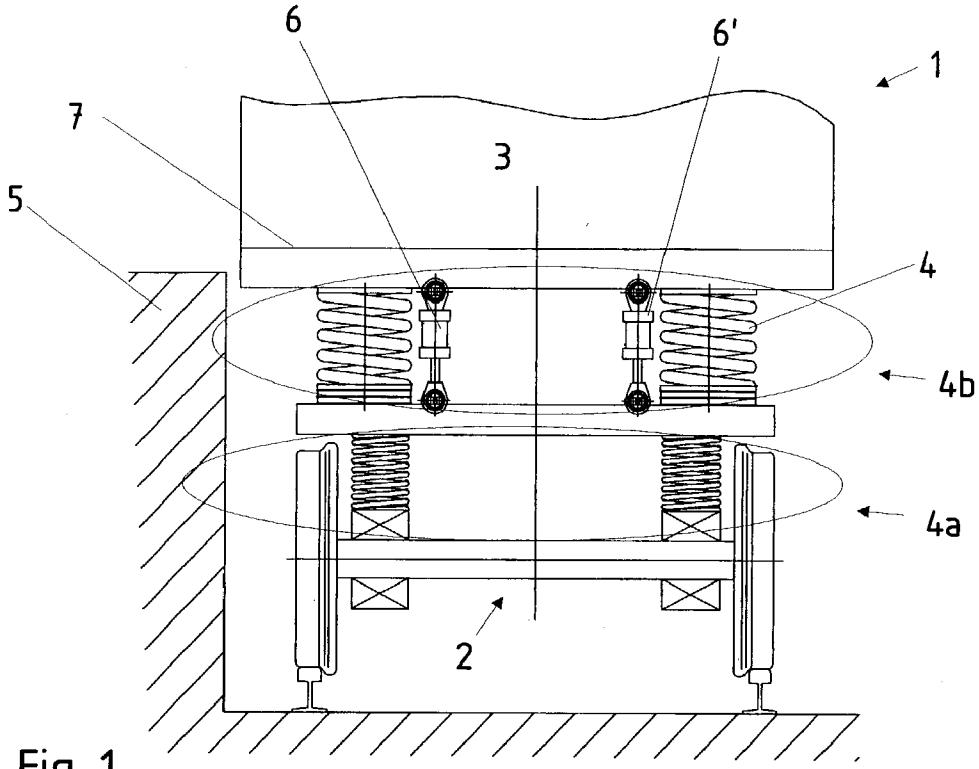


Fig. 1

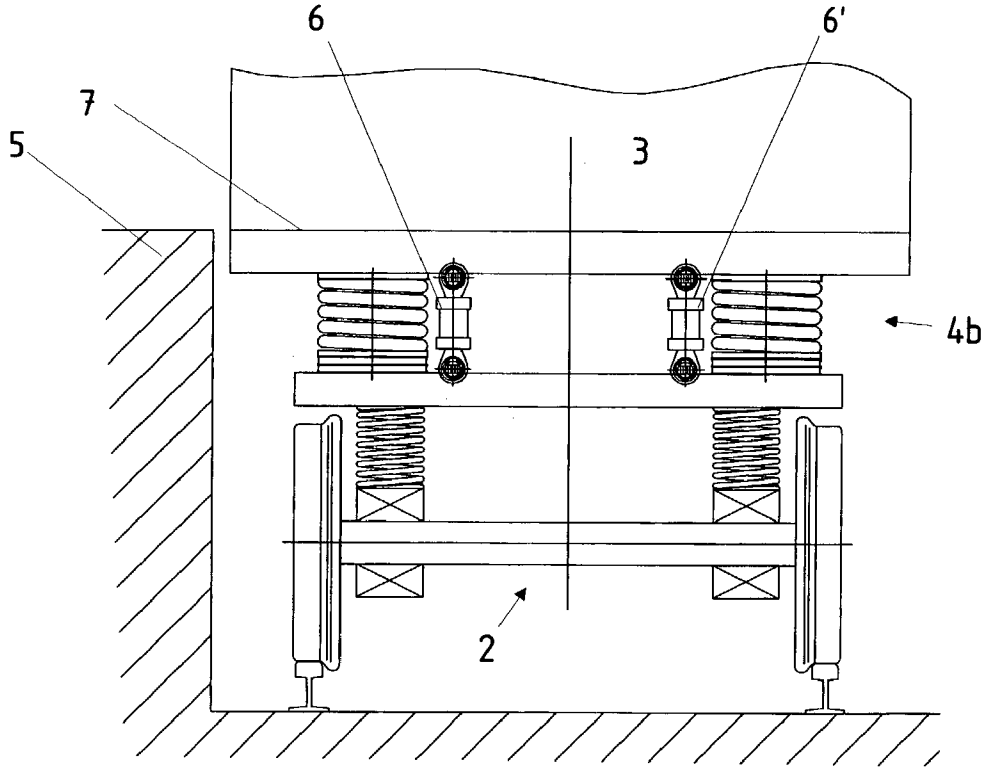


Fig. 2

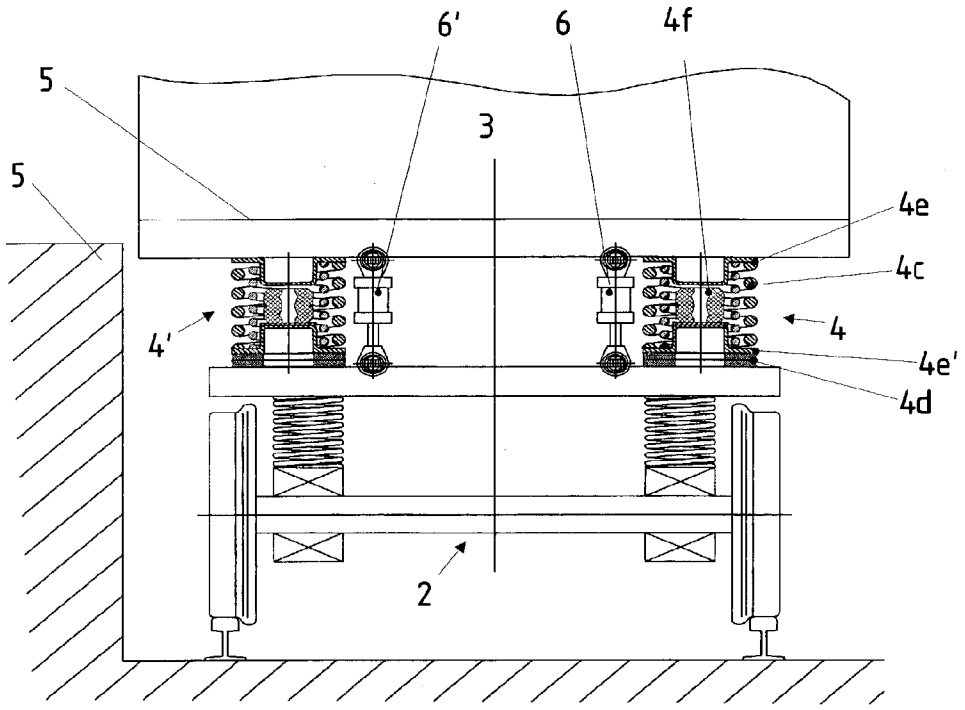


Fig. 3

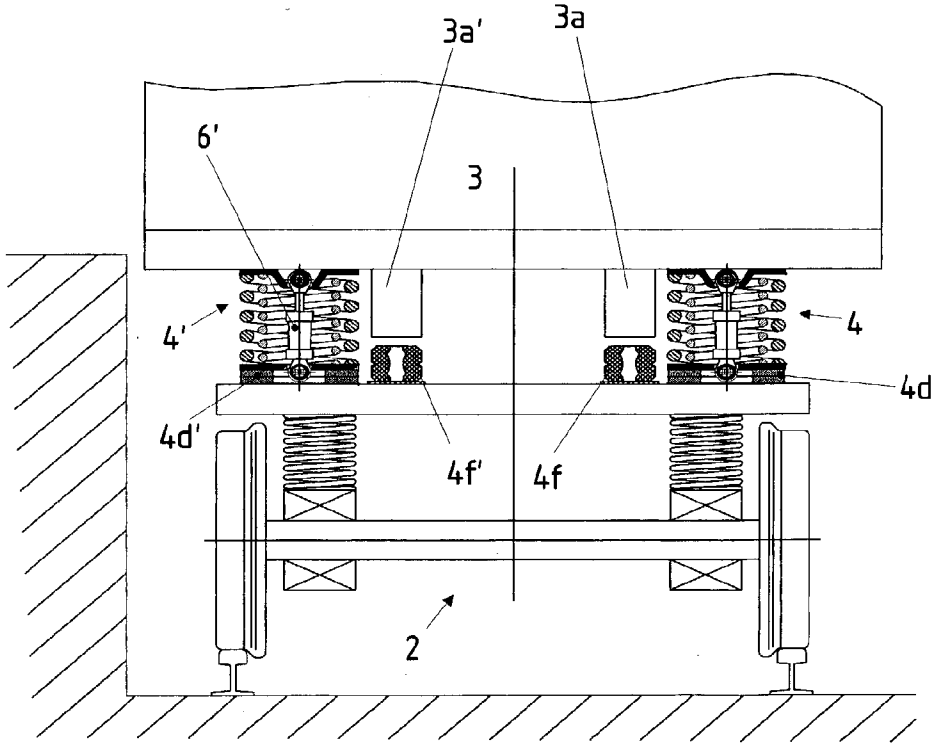


Fig. 4

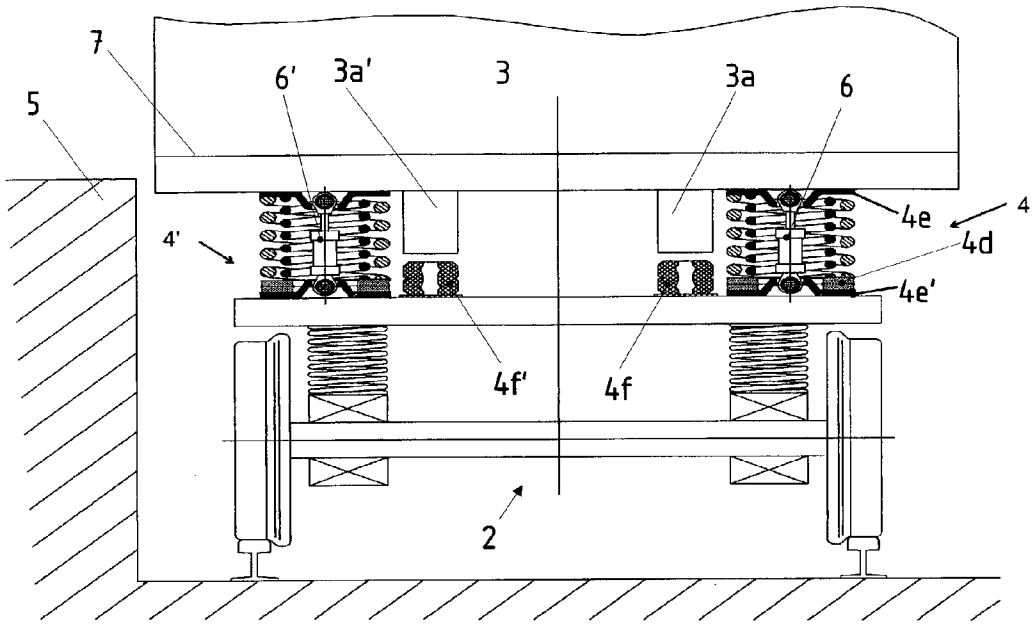


Fig. 5

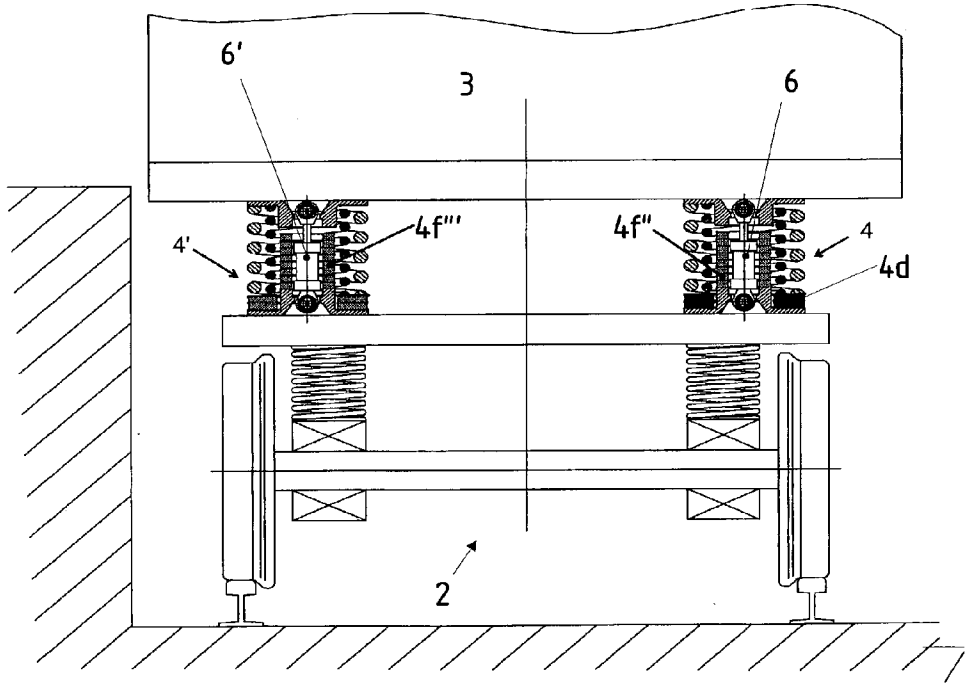


Fig. 6

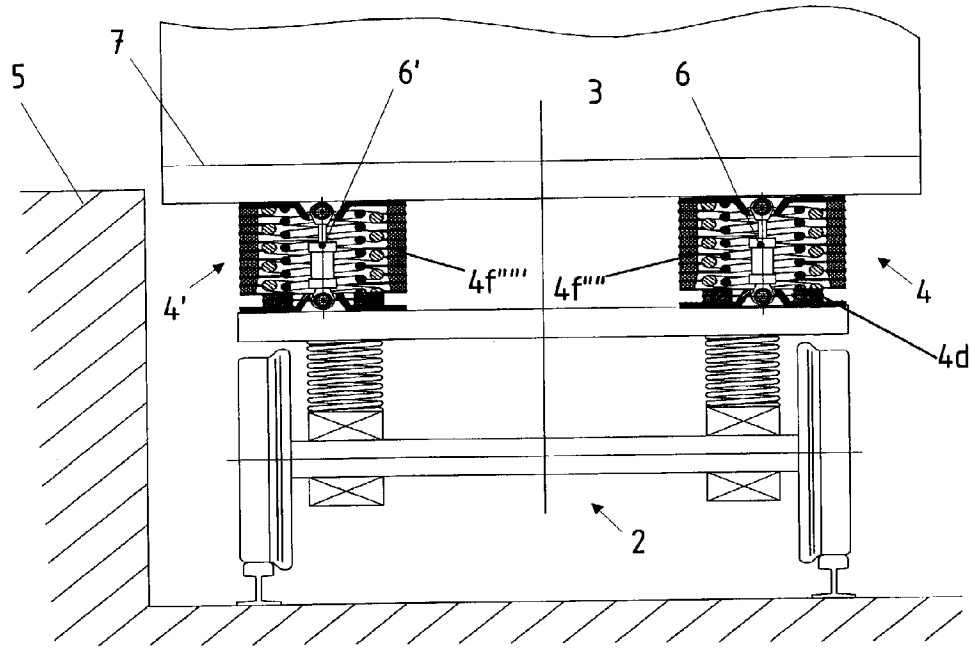


Fig. 7

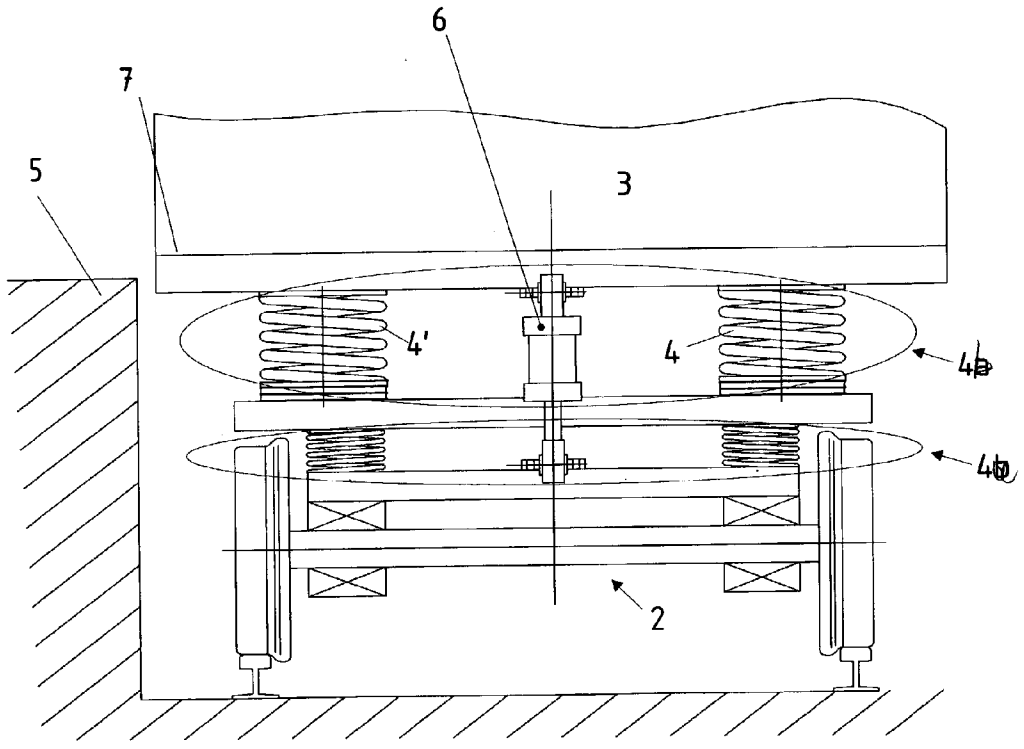


Fig. 8

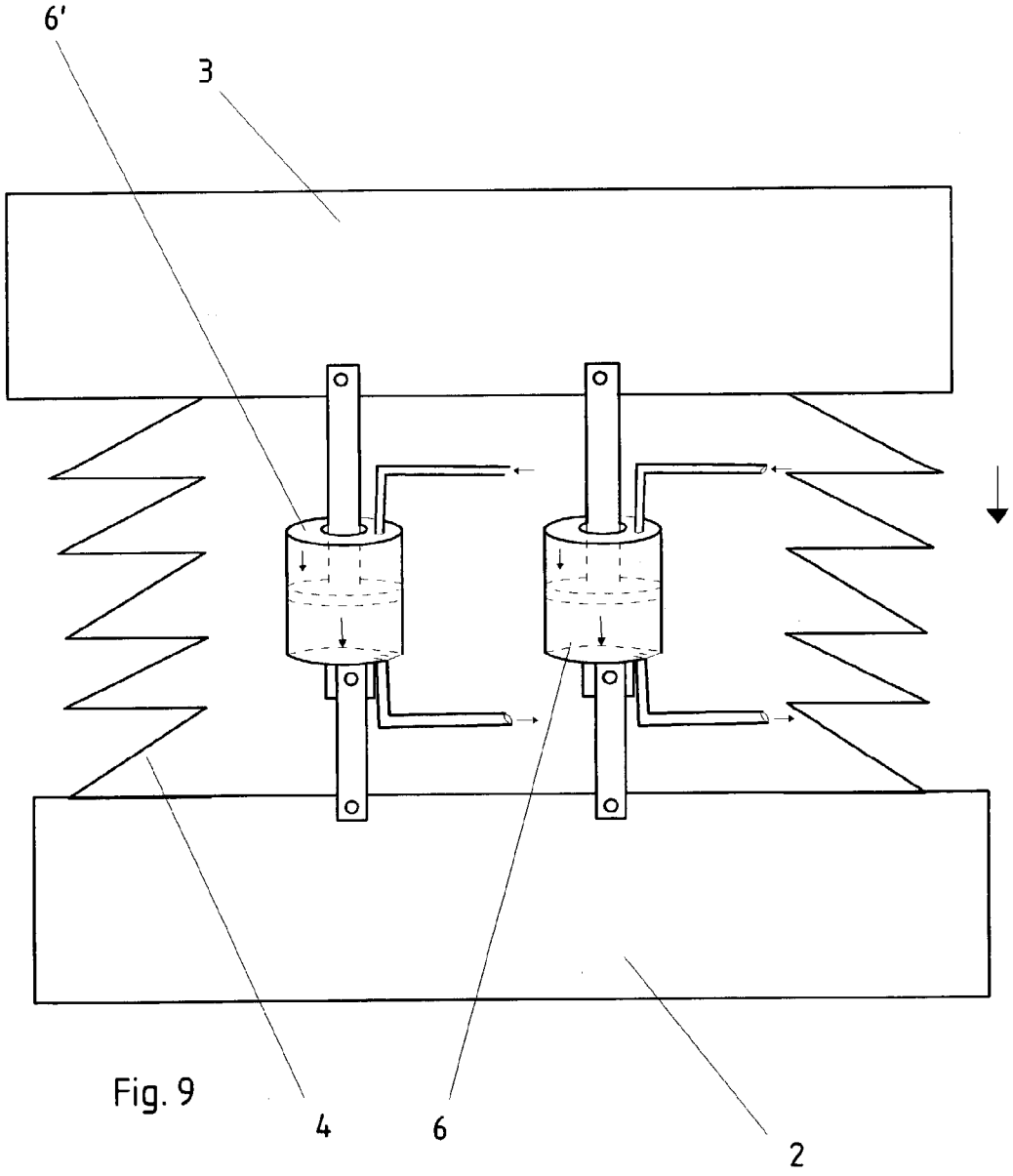


Fig. 9

LEVEL CONTROL FOR A RAIL-MOUNTED VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from provisional application No. 60/376,057 filed Apr. 26, 2002.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to a rail vehicle with a sub-frame and a wagon body disposed above it, wherein at least between the wagon body and the sub-frame at least one spring stage is provided.

[0004] 2. Description of the Related Art

[0005] In rail vehicles of the above-mentioned type it can be the case that when entering into a station the level of the floor in the wagon body comes to lie higher than the floor level of the station. By reason of the difference in level between the station and the upper surface of the floor of the wagon body a step may be formed in the transition region between the rail vehicle and the station.

[0006] Especially in rail vehicles which serve to transport people, these steps can constitute a considerable safety risk for passengers, for which reason a level adjustment may be carried out. To this end, the wagon body is normally lowered by reducing the dynamic spring travel in an active spring disposed between the wagon body and the sub-frame. However, the reduction in the dynamic spring travel of the active spring has the inherent risk that if the level adjustment arrangement fails, there will no longer be sufficient dynamic spring travel to ensure safe travel operation. In the event of a failure in conventional level adjustment arrangements, travel operation is therefore no longer possible. In order to avoid the problem just mentioned, some known level adjustment arrangements for rail vehicles have a passive emergency spring in addition to the active spring, which emergency spring should ensure sufficient resilience in the wagon body if the active spring fails.

[0007] A rail vehicle of this type is disclosed by, for example DE 198 15 197 C1. The known rail vehicle has a support actuator which can be altered in length in the vertical direction and is disposed between a wagon body and a sub-frame. An emergency spring is disposed concentrically to the support actuator in order to keep the support device operating with sufficient travel comfort if the support actuator fails or is overloaded.

[0008] A rail vehicle of the type mentioned in the introduction is disclosed, for example in WO94/22702 A1. The known rail vehicle has a hydraulic spring leg which is disposed between the wagon body and the sub-frame. In order to lower the wagon body, the dynamic spring travel of the active spring leg can be reduced by draining oil in a spring chamber. In the event of a loss of pressure, the vehicle can be lowered onto an emergency spring as is also known from DE 198 15 197 C1. A disadvantage with this design is, as in all other known level adjustment systems which also use an emergency spring in addition to an active spring, that the spring travel of the active spring is limited "downwards" in the direction of the sub-frame by the emergency spring, for which reason it may be the case that it is not possible to lower the wagon body all the way to the floor level of a station, for example when people are getting on and off.

BRIEF SUMMARY OF THE INVENTION

[0009] It is therefore an object of the invention to create a rail vehicle with which it is possible to ensure both safe entry and exit of passengers in the region of a station and also level adjustment which is not critically affected by a failure.

[0010] This object is achieved in accordance with the invention with a rail vehicle of the type mentioned in the introduction in that between the wagon body and the sub-frame at least one actuator is provided which is arranged to bring the wagon body from a raised travel position into a lowered load/unload position against a restoring force produced by the spring stage, and to keep it in the load/unload position, wherein the wagon body is raised into a travel position by the restoring force upon deactivation or failure of the actuator.

[0011] By means of the solution in accordance with the invention the vertical distance between the wagon body and the sub-frame can be varied within a large band width in a stationary rail vehicle. In the invention, the spring stage disposed between the wagon body and sub-frame can be compressed by the actuator and the wagon body can therefore be lowered to a desired level. The wagon body can be returned to the travel position by a restoring force, which is produced by the spring stage, by release of the actuator.

[0012] The movement of the actuator into the load/unload position can advantageously be limited by a stop.

[0013] Furthermore, the rail vehicle can be arranged to measure the vertical distance between the upper surface of a floor of the wagon body and a floor of the station, wherein a control device can be provided which is arranged to control the movement of the actuator into the load/unload position using the measured vertical distance.

[0014] The actuator can be hydraulic, electrical, mechanical or pneumatic in nature.

[0015] Furthermore, the spring stage can comprises [sic] at least one fail-safe passive spring, wherein this spring can be formed as a steel or rubber spring. The spring stage is advantageously a primary and/or secondary spring stage of the rail vehicle.

[0016] Furthermore, when the actuator is hydraulic, the actuator can also be formed as a vertical damper of the rail vehicle.

[0017] The invention with all further advantages is explained in more detail hereinunder with the aid of a number of non-limiting exemplified embodiments which are illustrated in the attached drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0018] **FIG. 1** illustrates a frontal view of a first embodiment of a rail vehicle in accordance with the invention with a wagon body in a travel position;

[0019] **FIG. 2** illustrates a frontal view of the rail vehicle of **FIG. 1** with a wagon body in a load/unload position;

[0020] **FIG. 3** illustrates a frontal view of a partial section of a second embodiment of a rail vehicle in accordance with the invention with a wagon body in a travel position;

[0021] **FIG. 4** illustrates a frontal view of a partial section of a third embodiment of a rail vehicle in accordance with the invention;

[0022] **FIG. 5** illustrates a frontal view of a partial section of a fourth embodiment of a rail vehicle in accordance with the invention;

[0023] **FIG. 6** illustrates a frontal view of a partial section of a fifth embodiment of a rail vehicle in accordance with the invention;

[0024] **FIG. 7** illustrates a frontal view of a partial section of a sixth embodiment of a rail vehicle in accordance with the invention;

[0025] **FIG. 8** illustrates a frontal view of a partial section of a seventh embodiment of a rail vehicle in accordance with the invention;

[0026] **FIG. 9** illustrates an exemplified embodiment of an actuator.

DETAILED DESCRIPTION OF THE INVENTION

[0027] In accordance with **FIGS. 1 and 2** a rail vehicle **1** in accordance with the invention has a sub-frame **2** and a wagon body **3**. Between the wagon body **3** and the sub-frame **2** at least one spring stage **4***a*, **4***b* is disposed. The spring stage **4***a*, **4***b* can be a primary **4***a* and/or secondary spring stage **4***b* depending on the construction type of the rail vehicle **1**. Furthermore, the spring stage **4***b* can be formed in a manner known per se as an active hydraulic spring, pneumatic spring etc., wherein, however, at least one further passive spring **4'** is provided.

[0028] During a halt in a station **5**, one or a plurality of actuators **6**, **6'** can be used to draw the wagon body **3** towards the sub-frame **2** into a load/unload position, as shown in **FIG. 2**, against a restoring force which is produced by the spring stage **4***b*, in which load/unload position the level of a floor upper surface **7** of a floor extending in the wagon body **3** lies approximately at the level of the footway of the station **5**. The restoring force is then produced by the passive spring **4'**.

[0029] The actuator **6**, **6'** can be, for example hydraulic, electrical, mechanical or pneumatic in nature. The actuator **6** or actuators **6**, **6'** can be arranged on the rail vehicle **1** under consideration of the respective structural or constructional properties of the rail vehicle **1** so that retrofitting of existing rail vehicles **1** is possible. In the case of a hydraulic actuator the actuator or actuators **6**, **6'** can also be formed as vertical dampers on the rail vehicle **1**.

[0030] When the suspension **4***b* has an active spring this spring can be made to act as a passive spring. For example, in the case of an active hydraulic spring the behaviour of a passive spring can be forced by non-drainage of oil during its compression. If the spring stage **4***b* is purely passive the wagon body **3** is lowered in the station **5** substantially only by the actuator **6**, **6'**.

[0031] However, it is also possible to lower the wagon body level in a manner which is known per se, for example by oil draining of an active spring, wherein the actuator **6**, **6'** in this case only becomes active when the wagon body **3** sits on a passive emergency spring and the level of the floor upper surface **7** still lies above the station level. In this case the actuator **6**, **6'** draws the wagon body **3** towards the sub-frame **2** against the restoring force of the emergency spring. The passive emergency spring is therefore compressed beyond its fixedly set "travel expansion" which normally cannot be passed statically. Upon release of the actuator **6**, **6'** the emergency spring can expand again and lift the wagon body **3** into a permissible travel position. The passive emergency spring is preferably formed as a rubber and/or steel spring.

[0032] If the suspension **4***b* behaves in an exclusively passive manner during lowering of the wagon body **3**, the difference in the state of the suspension **4***b* between the load/unload position and the travel position is merely that in the load/unload state the suspension **4***b* is pre tensioned with respect to the travel position by the actuator **6**, **6'**. Therefore in a position which is lowered with respect to a travel position illustrated in **FIG. 1 a** restoring force acts upon the wagon body **3** in the direction of the permissible travel position.

[0033] In the case of passive suspension **4***b* the restoring force changes in dependence upon the deflection of the actuator **6**, **6'**. By means of the association between the restoring force and actuator deflection it is ensured that, as already described above in the event of a failure in the actuator **6**, **6'**, the wagon body **3** can be returned to the starting position, ie. to the travel position. By means of the solution in accordance with the invention safe travel operation is ensured even if the level adjustment arrangement fails.

[0034] Upon release of the actuator **6**, **6'** the wagon body **3** is raised to the travel position by the suspension **4***b*. If the actuator **6**, **6'** fails when the wagon body **3** is in the lowered position, the wagon body **3** is raised to the travel position. In contrast to the known level adjusters, the wagon body **3**, in this embodiment of the invention, therefore does not fall "downwards" towards the sub-frame **2** in the event of a failure in the level adjustment arrangement or in the actuator **6**, **6'**, as already mentioned in the introduction, but moves "upwards" into the travel position.

[0035] The actuator **6**, **6'** is preferably in a "non-powered" state in travel so that substantially no forces produced by the actuator **6**, **6'** and directed towards the sub-frame **2** act upon the wagon body **3**. However, in principle it is possible for low forces to be exerted on the wagon body **3** by the actuator **6**, **6'** during a journey ie. in travel.

[0036] In order to limit the movement of the actuator **6**, **6'** into the load/unload position a fixed stop (not shown herein) can be provided for the actuator **6**, **6'**. This embodiment of the invention is especially advantageous when all stations **5** on a line travelled by the vehicle **1** are at substantially the same level with respect to the level of the track.

[0037] On the other hand, if the level of the stations **5** varies, the rail vehicle **1** can be arranged to determine the vertical distance between the floor upper surface **7** of the wagon body **3** and a floor of a station **5**, wherein a control device, for example an appropriate microcomputer, can be provided which is arranged to control the movement of the actuator **6**, **6'** into the load/unload position with the aid of the measured vertical distance.

[0038] In accordance with **FIG. 3** each passive spring **4, 4'** can be assigned to an actuator **6, 6'**, wherein each actuator **6, 6'** can be disposed besides the respective spring **6, 6'**. In order to limit the movement of the wagon body **3** towards the sub frame, each spring **4, 4'** can comprise a stop **4***f*, **4***f'* made of rubber. Each of the springs **4, 4'** can comprise two spring discs **4***e*, **4***e'*, between which a coil spring **4***c* is disposed. Further a rubber-layer spring **4***d* can be disposed between the sub frame **2** and the spring disc **4***e'* near to the sub frame **2**.

[0039] The actuator **6, 6'** can also be disposed inside the respective spring **4, 4'** as shown in **FIG. 4**. Further the rubber-stops **4***f*, **4***f'* can be arranged outside the springs **4, 4'**. In order to limit the movement of the wagon-body **3** towards the sub frame **2**, the wagon body **3** can comprise means **3***a*, **3***a'* interacting with the rubber stops **4***f*, **4***f'*.

[0040] According to **FIG. 5**, the rubber layer spring **4***d* can also be disposed between the coil spring **4***c* and the lower spring **4***d* disc **4***e'*, so that the rubber layer spring **4***d* can be expanded by the actuator **6, 6'**.

[0041] In accordance with **FIG. 6** the rubber stop **4***f''*, **4***f'''* and the actuator **6, 6'** can be disposed inside the spring **4, 4'**.

[0042] In the embodiment of the invention shown in **FIG. 7** the rubber-stop **4***f*, **4***f'* is build around the coil spring **4***c*.

[0043] According to **FIG. 8** the rail vehicle can comprise just one actuator **6** to bring the wagon body **3** from a raised travel position into a lowered load/unload position. In the embodiment shown the primary spring stage **4***a* and the secondary spring stage **4***b* can be tensioned by the actuator **6**.

[0044] In accordance with **FIG. 9** the actuator **6, 6'** can be formed as a hydraulic actuator **6, 6'**. The small arrows show the direction of distribution of the force in the actuator **6, 6'** while the wagon body **3** is being pulled down into the load/unload position. In contrast, the large arrow shows the direction of movement of the wagon body **3**.

I claim:

1 Rail vehicle **(1)** with a sub-frame **(2)** and a wagon body **(3)** disposed above it, wherein at least between the wagon body **(3)** and the sub-frame **(2)** at least one spring stage **(4)** is provided, characterised in that between the wagon body **(3)** and the sub-frame **(2)** at least one actuator **(6, 6')** is provided which is arranged to bring the wagon body **(3)** from a raised travel position into a lowered load/unload position against a restoring force produced by the at least one spring stage **(4***a*, **4***b*), and to keep it in the load/unload position, wherein the wagon body **(3)** is raised into a travel position by the restoring force upon deactivation or failure of the actuator **(6, 6')**.

2 Rail vehicle as claimed in claim 1, characterised in that the movement of the actuator **(6, 6')** into the load/unload position is limited by a stop.

3 Rail vehicle as claimed in claim 1 characterised in that it is arranged to determine the vertical distance between a floor upper surface **(7)** of the wagon body **(3)** and a floor of the station **(5)**, wherein a control device is provided which is arranged to control the movement of the actuator **(6, 6')** into the load/unload position using the measured vertical distance.

4 Rail vehicle as claimed in claim 1, characterised in that the actuator **(6, 6')** is an electrical and/or mechanical actuator.

5 Rail vehicle as claimed in claim 1, characterised in that the actuator **(6, 6')** is a hydraulic and/or pneumatic actuator.

6 Rail vehicle as claimed in claim 1, characterised in that the spring stage **(4***a*, **4***b*) has at least one fail-safe passive spring.

7 Rail vehicle as claimed in claim 6, characterised in that the at least one fail-safe passive spring is formed as a steel or rubber spring.

8 Rail vehicle as claimed in claim 1, characterised in that the spring stage **(4***a*, **4***b*) is a primary and/or secondary spring stage of the rail vehicle **(1)**.

9 Rail vehicle as claimed in claim 1, characterised in that the actuator **(6, 6')** is formed as a vertical damper of the rail vehicle.

* * * * *