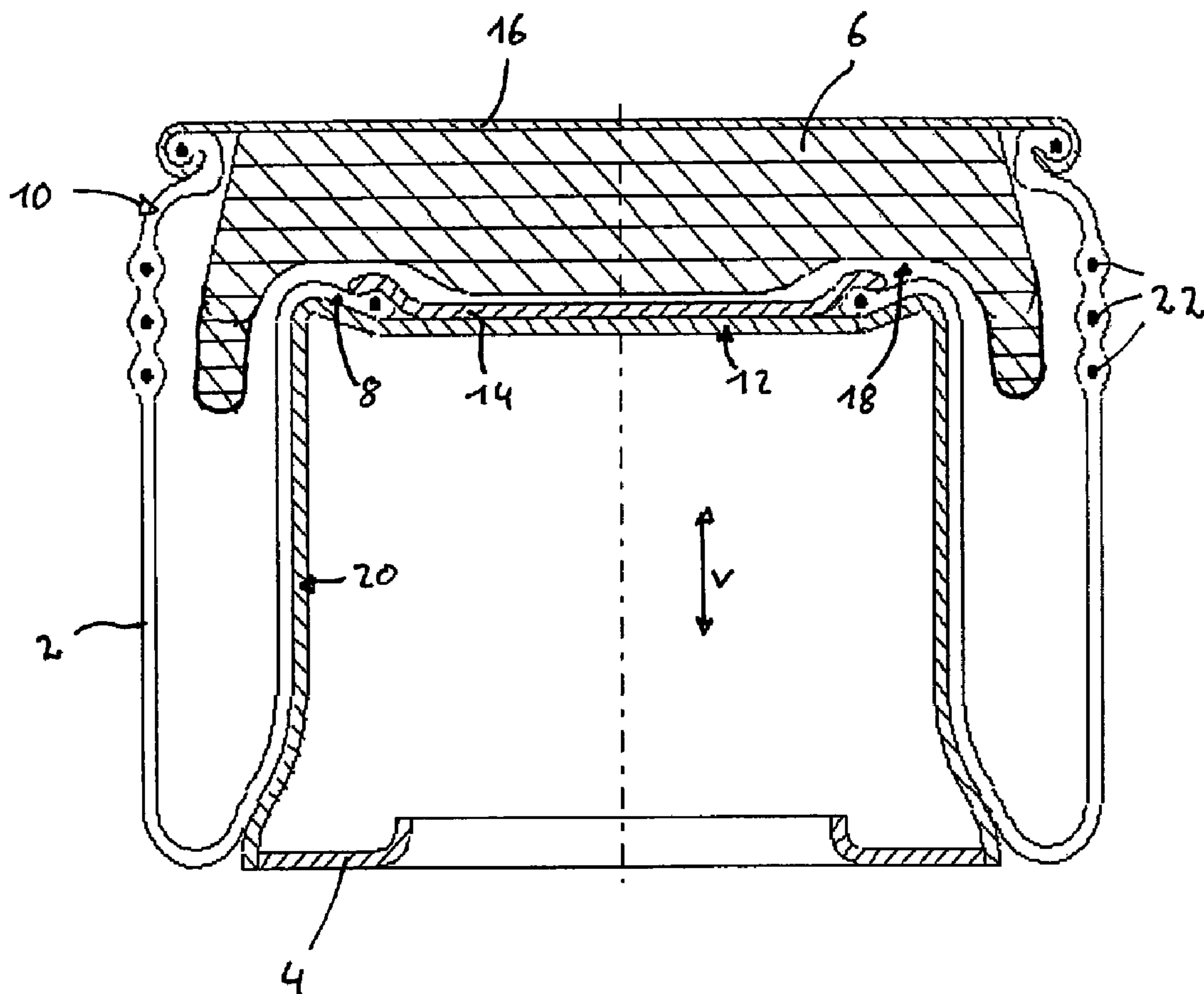




(86) Date de dépôt PCT/PCT Filing Date: 2007/08/07
(87) Date publication PCT/PCT Publication Date: 2008/02/14
(45) Date de délivrance/Issue Date: 2011/07/19
(85) Entrée phase nationale/National Entry: 2008/12/09
(86) N° demande PCT/PCT Application No.: EP 2007/006978
(87) N° publication PCT/PCT Publication No.: 2008/017459
(30) Priorité/Priority: 2006/08/08 (DE10 2006 037 034.1)

(51) Cl.Int./Int.Cl. *B60G 11/27* (2006.01),
B60G 7/04 (2006.01), *F16F 9/05* (2006.01)
(72) Inventeur/Inventor:
WEBER, KARSTEN, DE
(73) Propriétaire/Owner:
SAF-HOLLAND GMBH, DE
(74) Agent: RIDOUT & MAYBEE LLP

(54) Titre : RESSORT PNEUMATIQUE POUR UN VEHICULE
(54) Title: AIR SPRING FOR A VEHICLE



(57) Abrégé/Abstract:

An air spring for a vehicle, in particular for a commercial vehicle, comprising an air bellows (2) which has an axle-side region (8) and a superstructure-side region (10), which regions are movable with respect to each other between a first, adjacent position and a

(57) **Abrégé(suite)/Abstract(continued):**

second, spaced-apart position, a plunger (4) which is arranged on the axle-side region (8) of the air bellows (2), a fastening section (16, 24) in order to fasten the superstructure-side region (10) of the air bellows (2) to a support element of the vehicle, and a displacement element (6) which is arranged on the fastening section (16, 24) of the air bellows (2), wherein the displacement element (6) essentially fills the space between the plunger (4) and the fastening section (16, 24) in the first position of the air bellows (2).

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG(19) Weltorganisation für geistiges Eigentum
Internationales Büro(43) Internationales Veröffentlichungsdatum
14. Februar 2008 (14.02.2008)

PCT

(10) Internationale Veröffentlichungsnummer
WO 2008/017459 A1(51) Internationale Patentklassifikation:
B60G 11/27 (2006.01) **F16F 9/05** (2006.01)
B60G 7/04 (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2007/006978

(22) Internationales Anmeldedatum:
7. August 2007 (07.08.2007)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2006 037 034.1 8. August 2006 (08.08.2006) DE(71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme
von US): **SAF-HOLLAND GMBH** [DE/DE]; Haupt-
strasse 26, 63856 Bessenbach (DE).

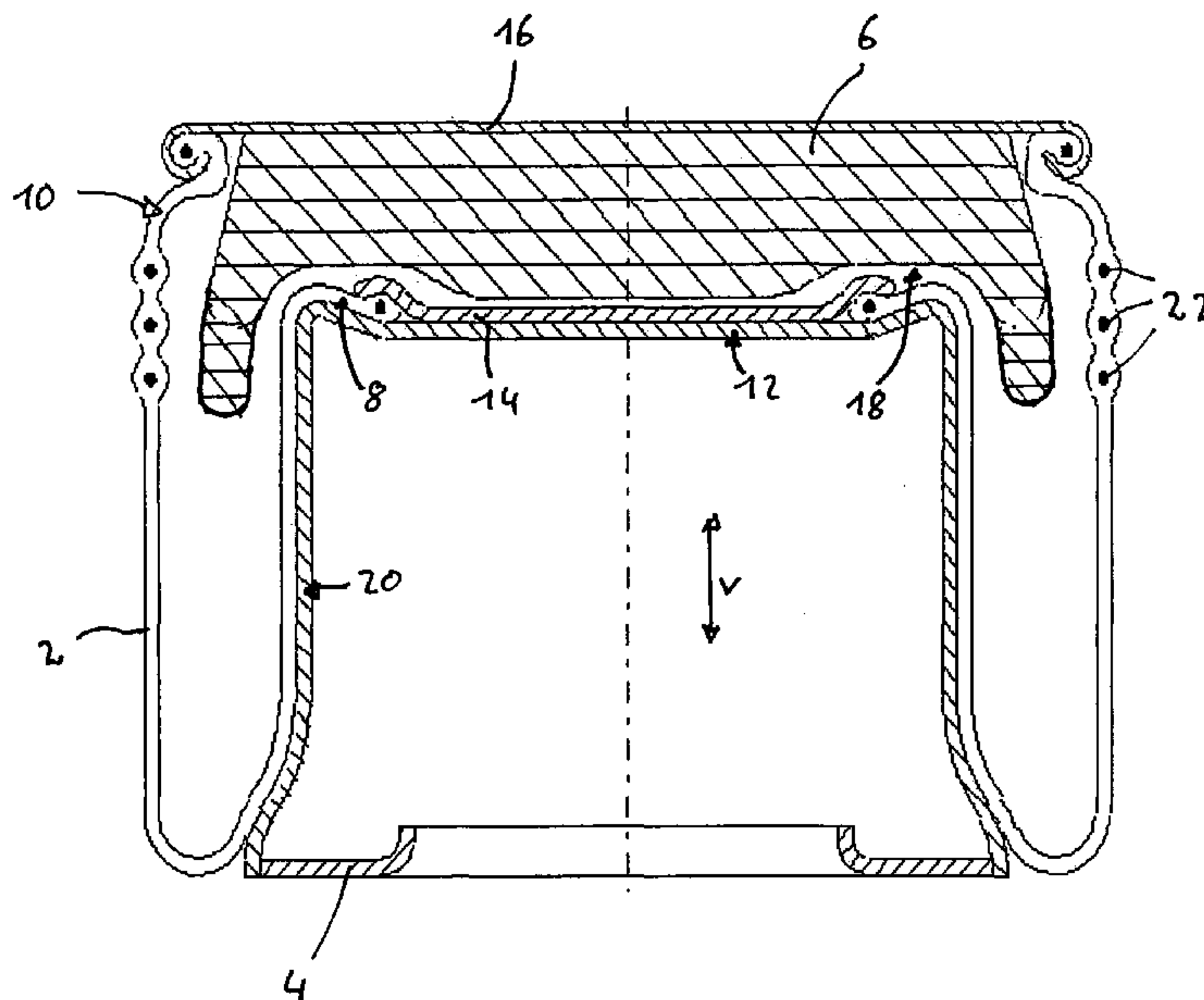
(72) Erfinder; und

(75) Erfinder/Anmelder (nur für US): **WEBER, Karsten**
[DE/DE]; Glattbacher Überfahrt 11a, 63741 Aschaff-
enburg (DE).(74) Anwalt: **MÜLLER SCHUPFNER**; Bavariaring 11,
80336 München (DE).(81) Bestimmungsstaaten (soweit nicht anders angegeben, für
jede verfügbare nationale Schutzrechtsart): AE, AG, AL,
AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA,
CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE,
EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID,
IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC,
LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN,
MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH,
PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV,
SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN,
ZA, ZM, ZW.(84) Bestimmungsstaaten (soweit nicht anders angegeben, für
jede verfügbare regionale Schutzrechtsart): ARIPO (BW,
GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG,
ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU,
TJ, TM), europäisches (AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC,

[Fortsetzung auf der nächsten Seite]

(54) Title: AIR SPRING FOR A VEHICLE

(54) Bezeichnung: LUFTFEDER FÜR EIN FAHRZEUG



(57) Abstract: An air spring for a vehicle, in particular for a commercial vehicle, comprising an air bellows (2) which has an axle-side region (8) and a superstructure-side region (10), which regions are movable with respect to each other between a first, adjacent position and a second, spaced-apart position, a plunger (4) which is arranged on the axle-side region (8) of the air bellows (2), a fastening section (16, 24) in order to fasten the superstructure-side region (10) of the air bellows (2) to a support element of the vehicle, and a displacement element (6) which is arranged on the fastening section (16, 24) of the air bellows (2), wherein the displacement element (6) essentially fills the space between the plunger (4) and the fastening section (16, 24) in the first position of the air bellows (2).

[Fortsetzung auf der nächsten Seite]

WO 2008/017459 A1



MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— *mit internationalem Recherchenbericht*

(57) Zusammenfassung: Luftfeder für ein Fahrzeug, insbesondere für ein Nutzfahrzeug, umfassend einen Luftbalg (2), der einen achsseitigen (8) und einen aufbauseitigen (10) Bereich aufweist, welche zueinander zwischen einer ersten, benachbarten Position und einer zweiten, beabstandeten Position bewegbar sind, einen Tauchkolben (4), der an dem achsseitigen Bereich (8) des Luftbalgs (2) angeordnet ist, einen Befestigungsabschnitt (16, 24), um den aufbauseitigen Bereich (10) des Luftbalgs (2) an einem Trägerelement des Fahrzeugs zu befestigen, und ein Verdrängungselement (6), das an dem Befestigungsabschnitt (16, 24) des Luftbalgs (2) angeordnet ist, wobei das Verdrängungselement (6) in der ersten Position des Luftbalgs (2) den Raum zwischen dem Tauchkolben (4) und dem Befestigungsabschnitt (16, 24) im wesentlichen ausfüllt.

Specification

Air spring for a vehicle

The present invention pertains to an air spring for a vehicle, especially for a commercial vehicle, as well as a vehicle axle system with an essentially rigid axle body, in which the air spring is integrated.

5

Air spring systems for vehicles, especially for commercial vehicles or trucks, are familiar in the prior art. They basically consist of a pneumatic system with controls and an air bellows or an air spring, basically consisting of a plunger, an air spring bellows, a bumper element and a cover plate, wherein the plunger can plunge into the air spring bellows for a height adjustment. It is desirable that the functioning of the air spring is not impaired by loading the vehicle (e.g., by means of a crane). Thus, it is customary to lower the vehicle until the plunger strikes against a bumper element, so that the air spring bellows is essentially fully retracted. Next, blocking of an air intake inside the air spring bellows results in the air spring bellows basically supporting the axles when the vehicle is raised. As the vehicle is raised further, however, the axles pull the plungers of the air spring bellows down somewhat on account of their weight, so that a partial vacuum is produced inside them, which prevents further rebounding of the axles. Yet the problem here is that, due to the large difference in pressure between the interior of the air spring bellows and its surroundings, the air spring bellows has a tendency to become crumpled or constricted. This means that when the vehicle is put down once more, parts of the air spring bellows can become crimped or jammed and it will thus become damaged and can no longer work properly. Solutions for this problem are known in the prior art. Thus, it is known, for example, how to provide a divided plunger, whose lower part separates from the air spring bellows when the axle is lowered (i.e., external lifting of the vehicle) and thus does not drag it along. Likewise known are so-called splitter arrangements, for example, from EP 0 446 709 B1, in which the cover plate of the air spring bellows is not

10

15

20

25

rigidly connected to the vehicle frame, but instead guided on a movable rocker arm. Finally, it is known from the prior art how to prevent a complete rebounding of the axle means of catch cables, although these also prevent a complete lifting of the vehicle by means of the air spring bellows.

5

Thus, the problem of the present invention is to provide an air spring for a vehicle, especially a commercial vehicle, as well as a vehicle axle system in which the above-mentioned crimping effect and the associated disadvantages are prevented.

- 10 According to the invention, an air spring is provided for a vehicle, especially for a commercial vehicle, comprising an air bellows or air spring bellows, which has an axle-side region and a superstructure-side region, which regions are movable with respect to each other between a first, adjacent position and a second, spaced-apart position, a plunger which is arranged on the axle-
- 15 of the air bellows to a support element of the vehicle, and a displacement element essentially fills the space between the plunger and the fastening section in the first position of the air bellows.
- Thus, the air spring can be provided for a vehicle, which is designed, in particular, as a commercial vehicle, a truck, a trailer, etc. The air bellows is advantageously cylindrical in shape in its ground state, when it is not influenced by external forces, i.e., it preferably has a hoselike
- 20 shape, in particular. The air bellows advantageously has an axle-side region, i.e., a region provided advantageously at its distal end that is designed to be mounted on the vehicle at the axle side. Accordingly, the air bellows likewise preferably has a superstructure-side region, i.e., a distal end thereof, which is basically opposite the axle-side region and designed to be mounted on the vehicle at the superstructure side. The axle-side region and

- 3 -

the superstructure-side region can move relative to each other between a first, adjacent position and a second, spaced-apart position. The movement of the two distal regions of the air bellows advantageously occurs basically in a linear fashion, but it can likewise be a movement along a curve, which has a slight curvature. The direction of movement in this case corresponds to the spring direction. As a rule, the movement of the plunger does not exactly follow a straight line, but rather a slightly curved line, since the air spring bellows is generally used so that its axle-side region moves on a circular orbit, which is defined by the longitudinal arm of the axle. In the second, spaced-apart position, the air bellows has an essentially cylindrical configuration. In the first, adjacent position, axle-side and superstructure-side region are arranged with the minimum possible spacing from each other. In this case, the air bellows basically has a configuration consisting of at least two essentially coaxially arranged cylindrical surfaces, since the plunger with the axle-side region of the air bellows fastened to it plunges into the air bellows. In other words, the plunger is thus arranged on the axle-side region of the air bellows in such a way that a movement of the plunger results in a corresponding movement of the axle-side region of the air bellows. Opposite this, the superstructure-side region of the air bellows is arranged or fastened to a support element or frame element of the vehicle via a fastening section. The fastening section can be a single piece in configuration and/or integrated with the air bellows, so that the fastening section is part of the air bellows. In this configuration, the air bellows is thus cylindrical in its ground state, and at least one end face is closed off preferably air-tight by the fastening section. In one preferred embodiment, however, the fastening section is configured separate from the air bellows and connected to it preferably in air-tight manner. The displacement element is arranged on the fastening section of the air bellows in such a way that it is located inside the air bellows, i.e., in the space surrounded by the air bellows. Advantageously, the displacement element is dimensioned so that, in the first position of the air bellows, when the air bellows advantageously encloses the least volume, it basically fills up the space between the plunger and the fastening element looking in the direction of the spring. The displacement element can also advantageously be configured as a support and/or bumper element, in order to transmit the gravity force of the vehicle superstructure onto the

- 4 -

vehicle axle system when the air bellows is totally emptied. Thanks to the displacement element, the structural space between the distal end of the plunger and the fastening section is advantageously filled in the first position of the air bellows, so that the remaining residual volume is very small in relation to the total volume of the air bellows in its second position. This is especially advantageous, for thus the force needed to again extend the air bellows against the atmospheric pressure acting from the outside is increased such that it lies considerably above the force caused by the mass of the axle. In other words, because of the very small residual volume in the air bellows brought about by the displacement element in its first position, the ratio of the volume change to change the mutual spacing of the axle-side and superstructure-side region and thus the force needed to space apart the axle-side and superstructure-side region advantageously becomes large. This dictates, in particular, the distance by which the plunger is drawn downward until an equilibrium of weight prevails when the vehicle is lifted. Thanks to the air spring of the invention, this distance is advantageously kept small, so that the stiffness of the side wall in the superstructure-side region of the air bellows can be configured smaller.

Preferably, the displacement element has a geometrical configuration essentially in the shape of a cone. In other words, the displacement element can be configured essentially in the shape of a truncated cone. Of course, the displacement element in its cross section viewed essentially perpendicular to the spring direction can subtend an essentially circular area, but it can also subtend an angular or polygonal area. The displacement element can be arranged in the air spring so that its tapering region faces the plunger.

Especially advantageously, however, the tapering region of the displacement element is fastened on the fastening section of the air bellows. Consequently, the region of larger cross section is facing the plunger. This conical configuration facilitates the retraction, i.e., the positioning of the air bellows in the first position, if at the moment of the lowering there exists a horizontal lateral offset between plunger and fastening section, i.e., plunger and fastening section are not lined up with each other along the spring

- 5 -

direction. As a rule, the air spring is provided so that piston and fastening section are precisely one above the other at the working point (i.e., driving height), that is, they are lined up with each other along the spring direction, so that the axis of the plunger points in the direction of the normal to the fastening section or they are aligned. In the lowered
5 condition, i.e., the first position of the air bellows, the circular path on which the plunger moves on the longitudinal arm of the axle produces an angle and a center offset between plunger and fastening section. Due to the conical shape of the displacement element, this offset is compensated in such a way that a frictionless movement into the air bellows is made possible.

10

The displacement element can advantageously be configured with rotational symmetry. However, to allow for the angle and the offset, the displacement element can likewise be asymmetrical in configuration, i.e., basically formed by two ground surfaces not running parallel to each other, so that the displacement element has the shape of a wedge. A
15 double mirror symmetry configuration can also be advantageous.

20

Moreover, preferably the surface of the displacement element facing the plunger is at least partly concave in configuration. Thus, the surface of the plunger facing the displacement element can have, for example, an essentially annular recess. Alternatively
or additionally, however, the surface of the displacement element facing the plunger can be configured concave overall, especially advantageously it can have a recessed spherical surface configuration. In this way, in particular, it is possible to position the plunger axially in relation to the displacement element when the plunger strikes against the displacement element, i.e., to position it in a plane perpendicular to the spring direction.

25

30

Especially advantageously, the displacement element at least partly encloses the plunger in the first position of the air bellows. In other words, the plunger is at least partly surrounded by the displacement element. Especially favorably in particular, the displacement element is arranged at least partly between the outer circumferential wall of the plunger and the superstructure-side region of the air bellows or a region adjoining the

- 6 -

latter. Thus, advantageously, the residual volume of the air bellows is further reduced in its first position. With a concave configuration of the displacement element, the displacement element basically takes over the function of a kind of cover, which covers or encloses or surrounds or spans the distal end of the plunger facing the displacement
5 element and at least a part of the adjoining lateral circumferential wall of the plunger when the air spring is retracted (i.e., first position of the air bellows).

Advisedly, the displacement element has an essentially curved, preferably round circular cross section shape. Thus, the cross section is defined essentially perpendicular to the
10 spring direction. Especially advantageously, the cross section shape of the displacement element corresponds essentially to that of the air bellows.

Also advisedly the displacement element is formed from a material which can rebound. This is especially advantageous for an air bellows in the first position, when the
15 displacement element is preferably lying against the plunger and thus the gravity force produced by the superstructure of the vehicle is conveyed directly across displacement element and plunger to the vehicle axle system. This assures at least some residual spring action in the system.

20 Preferably, the displacement element consists of a material whose density is essentially at least 1.1 kg/m^3 , preferably at least 1.2 kg/m^3 . Especially advantageously, the displacement element consists of a material whose density is greater than the density of the fluid or gas supplied to the air bellows. This advantageously assures that the gas located in the air bellows is displaced by the displacement element. Additionally or
25 alternatively, the displacement element can also be configured essentially hollow, in which case the shell of the displacement element is fashioned basically fluid or gas-tight.

Preferably, the fastening section is configured as a cover plate arranged at the distal superstructure-side region of the air bellows. The cover plate is advantageously fastened

- 7 -

to the air bellows in such a way that a fluid or gas-tight connection is provided between cover plate and air bellows.

The fastening section and the displacement element can be configured as separate
5 elements. Advantageously, however, fastening section and displacement element can be configured as one part or one piece.

In another preferred embodiment, the fastening section is configured as a cover cylinder arranged on the distal superstructure-side region of the air bellows, whose side wall is
10 basically rigid. Thus, the fastening section or cover cylinder is essentially fashioned as a container or pot and it receives at least part of the plunger in its interior in the first position of the air bellows. In other words, a side wall of the cover cylinder in the first position of the air bellows encloses at least part of the plunger. At the edge of the cover cylinder, the superstructure-side region of the air bellows is preferably fastened.
15 Consequently, a portion of the air bellows in the upper, superstructure-side region is replaced by a rigid part, i.e., the cover cylinder. Consequently, this region cannot be crimped or constricted, due to the rigid or stiff side wall. In other words, the cross section in this region remains essentially constant, regardless of the loading condition.

20 In another preferred embodiment, the air bellows has stiffening elements, at least in the superstructure-side region, in order to heighten the radial stiffness of the air bellows. The stiffening elements can be configured as a carcass ply, a reinforcement ply, rings of steel or steel braiding, which is inserted or vulcanized into the material of the air bellows. In this way, a radial stiffness is assured without limiting the axial and lateral mobility of the
25 air bellows. In particular, this counteracts any constricting or bulging in the direction of the center of the air bellows.

Also preferably the air bellows has at its end or adjacent to the axle-side region a first engaging means, which is designed to engage with a second engaging means of the
30 plunger. Thus, one can provide an air spring for a vehicle, especially a commercial

- 8 -

vehicle, comprising an air bellows, which has an axle-side and a superstructure-side region, and a plunger, which is arranged on the axle-side region of the air bellows, and the air bellows has at or adjacent to the axle-side region a first engaging means, which is designed to engage with a second engaging means of the plunger, which is fastened on or adjacent to the distal end of the plunger, where the air bellows is fastened. In this way, one can prevent the inner part of the bellows, lying against the plunger (i.e., the axle-side region) from sliding upward or being pulled upward past the wall of the plunger in the first position of the air bellows when the vehicle is lifted. This is especially advantageous, since the creases that would otherwise be formed on the one hand would counteract the formation of a vacuum and on the other hand would become jammed above the plunger when the vehicle is lowered. Also advantageously, however, the air bellows is allowed to roll down until it is fastened on the head of the plunger when the air bellows is moved into the second position.

Advisedly, the first engaging means of the air bellows is fashioned as a radial constriction, which is preferably reinforced by a support element. The radial constriction can preferably be created in such a way that a support element in the shape of a ring of steel, a steel braiding, or another stiffening material is arranged on the air bellows or inserted or vulcanized in it, so that a thickening, a bulge or a step results.

Also advisedly the second engaging means of the plunger is fashioned as a radially circumferential groove, which is preferably arranged on or adjacent to the distal end of the plunger. In other words, the groove is arranged at or adjacent to the horn of the plunger or the region of the fastening of the air bellows to the plunger. The groove, in particular, can be provided on a side wall or circumferential wall of the plunger and extend around it in a ring shape. Especially advantageously, the shape of the groove corresponds to that of the constriction of the air bellows, so that a kind of form fitting results between first and second engaging means (i.e., bellows and plunger), which prevents a slipping of the air bellows on the plunger in the spring direction when the vehicle is lifted. Advantageously, however, it is still permitted for the air bellows to roll

- 9 -

down in normal operation, i.e., a movement of the air bellows into the second position, until it is fastened on the head of the plunger.

Consequently, the first and second engaging means are preferably disengaged in the
5 second position of the air bellows.

Preferably, the ratio of the cross sectional area of the air bellows to the cross sectional area of the plunger is basically between 1.1 to 1.5, preferably essentially between 1.1 to 1.25. The cross section here is defined essentially perpendicular to the spring direction.
10 Thanks to a cross sectional area ratio of such dimension, the volume change per change in the distance of the plunger from the fastening section is large enough that the force needed to further draw apart the air bellows, basically located in the first position, against the atmospheric pressure acting from the outside, is distinctly greater than the force produced by the mass of the axles. This ensures a secure positioning or a secure holding
15 of the axle system when the vehicle is lifted.

Preferably, a valve device is provided on the air bellows in order to prevent an intake of air in the air bellows, especially in its first position. Thus, a valve device is created which prevents the working liquid or the air from flowing into the air bellows when the vehicle
20 is being lifted, so that a movement of the air bellows into the second position is basically halted.

Especially preferably, the valve device has at least one valve unit at the outlet of the air bellows. This can preferably be manually or automatically activatable.

25

Furthermore the invention provides for a vehicle axle system with an essentially rigid axle body, and at least one air spring according to the invention is arranged on the axle body.

- 10 -

Further benefits and features will emerge from the following description of preferred embodiments of the invention, making reference to the enclosed figures. These show:

Fig. 1, a cross sectional view of a first embodiment of the invented air spring.

Fig. 2, a cross sectional view of a second embodiment of the invented air spring.

Figure 1 shows a cross section view of a first embodiment of the invented air spring for a vehicle. The air spring comprises an air spring bellows or air bellows 2, a plunger 4, and a displacement element 6.

The air bellows 2 is advantageously essentially cylindrical in form and has an axle-side region 8 and a superstructure-side region 10. The axle-side region 8 lies essentially opposite the superstructure-side region 10. The air bellows 2 can be moved between a first position, shown in Fig. 1, in which the axle-side region 8 and the superstructure-side region 10 are basically standing close to each other, and a second position, in which the axle-side region 8 and the superstructure-side region 10 are so far apart from each other that the air bellows 2 has an essentially hoselike or tubular configuration. The movement of the air bellows between the first and second spaced-apart position occurs essentially along the spring direction v.

The plunger 4 preferably has an essentially cylindrical or conical configuration. The distal end 12 of the plunger 4 has a fastening means 14, to fasten the axle-side region 8 of the air bellows 2 to the plunger 4. The fastening via the fastening means 14 can occur advantageously by a wedging or clamping of a bulge provided at the axle-side distal end of the air bellows 2.

The superstructure-side region 10 of the air bellows 2, essentially opposite the axle-side region 8, is fastened to or arranged on a fastening section. The fastening section can be configured as a cover plate 16 arranged at the distal superstructure-side region 10 of the

- 11 -

air bellows 2, which closes off the air bellows 2 in the superstructure-side region 10 from the surroundings in essentially fluid- or gas-tight manner. The superstructure-side region 10 of the air bellows 2 can be fastened on a support element or frame element of the vehicle above the fastening section or the cover plate 16. Accordingly, the plunger 4 represents the fastening means of the axle-side region 8 of the air bellows 2 to the axle system of the vehicle.

The displacement element 6 is arranged on or fastened to the fastening section or the cover plate 16. Consequently, no movement of the displacement element 6 occurs during a movement of the axle-side region 8 of the air bellows 2 or the plunger 4, since the displacement element 6 is arranged essentially stationary with respect to the superstructure-side region 10 of the air bellows 2 or with respect to the fastening section or the cover plate 16. The displacement element 6 preferably has essentially the shape of a cone, and especially preferably the tapering region of the displacement element 6 is fastened to the fastening section or the cover plate 16. Thus, the region with the greater cross section of the displacement element 6 protrudes into the space enclosed by the air bellows 2, i.e., it faces the plunger 4. Especially preferably, the displacement element 6 has a concave surface geometry, so that it at least partially encloses the plunger 4 in the first position of the air bellows 2 as shown in Fig. 1. As a result, the space between plunger 4 and fastening section or cover plate 16 is advantageously filled up by the displacement element 6 so that the remaining residual volume in the air bellows 2 is as little as possible. In particular, the displacement element 6 can be concave in configuration so that a surface facing the plunger 4 has an annular recess 18, which additionally serves for the positioning of the plunger 4 in the first position of the air bellows 2. Especially preferably, the displacement element 6 at least partly protrudes into the space defined between the outer wall or circumferential wall 20 of the plunger 4 (or the axle-side region 8 basically adjacent to it and the neighboring or adjoining region of the air bellows 2) and the superstructure-side region 10 (or the region of the air bellows 2 neighboring or adjoining it), so as to further reduce the residual volume present in the first position of the air bellows 2.

In order to counteract the above-mentioned crimping effect, the air bellows 2 has stiffening elements in or neighboring the superstructure-side region 10. The stiffening elements 22 are provided in particular to heighten the radial stiffness of the air bellows 2, without restricting the axial and lateral mobility of the air bellows 2. The stiffening elements 22 can be fashioned, in particular, as rings of steel, steel braid, or another stiffening material, which is arranged on the air bellows 2, inserted into or vulcanized in it.

Another option of stiffening the outer wall of the air bellows 2 is shown in Fig. 2, where the elements identical to the first embodiment are given the same reference numbers. However, the fastening section here is configured as a cover cylinder 24 arranged at the distal superstructure-side region 10 of the air bellows 2, whose upper end facing the vehicle frame is closed, so as to have the shape of a container or pot. The side wall of the cover cylinder 24 is fashioned essentially rigid or firm and at least partly encloses the plunger 4 in the first position of the air bellows 2. Consequently, a part of the air bellows 2, namely, the outer upper region or superstructure-side region, is replaced by a rigid or firm part, so that the above-mentioned crimping effect or a constriction or bulging on account of the pressure difference between the interior of the air bellows and the surroundings is prevented.

The air bellows 2 has, at or near the axle-side region 8, a first engaging means 26, which is designed to engage with a second engaging means 28 of the plunger 4. The first engaging means 26 of the air bellows 2 is configured as a radial constriction or thickening or as a bulge or step, and is preferably strengthened by a support element 30. The support element 30 can be a ring of steel, steel braid, or another stiffening material, which is arranged on the air bellows 2, inserted into or vulcanized in it. The second engaging means 28 is shaped according to the configuration of the first engaging means 26. In particular, it is configured as a radially circumferential groove in the plunger 4, which is arranged preferably on or near the distal end 12 of the plunger 4 on the circumferential

- 13 -

wall 20. In this way, the air bellows 2 is prevented from slipping on the plunger 4 in the spring direction v when the air bellows 2 is in the first position, while still ensuring that the air bellows 2 can move down until it is secured on the fastening means 14 at the distal end 12 of the plunger 4, especially in the second position. Consequently, the first
 5 engaging means 26 and second engaging means 28 are not engaged in the second position of the air bellows 2.

10

List of reference numbers

	2	air bellows
	4	plunger
	6	displacement element
15	8	axle-side region
	10	superstructure-side region
	12	distal end
	14	fastening means
	16	cover plate
20	18	annular recess
	20	circumferential wall
	22	stiffening element
	24	cover cylinder
	26	first engaging means
25	28	second engaging means
	30	support element
	v	spring direction

1. An air spring for a vehicle, in particular for a commercial vehicle, comprising:
an air bellows, which has an axle-side region and a superstructure-side region, which regions are movable with respect to each other between a first, adjacent position and a second, spaced-apart position,
a plunger which is arranged on the axle-side region of the air bellows,
a fastening section in order to fasten the superstructure-side region of the air bellows to a support element of the vehicle, and
a displacement element which is arranged on the fastening section of the air bellows,
wherein the displacement element substantially fills the space between the plunger and the fastening section and at least partly encloses the plunger in the first position of the air bellows.
2. The air spring as claimed in claim 1, wherein the surface of the displacement element facing the plunger is partially concave in configuration.
3. The air spring as claimed in claim 1 or 2, wherein the displacement element has a curved cross section shape.
4. The air spring as claimed in claim 3, wherein the displacement element has a round circular cross section shape.
5. The air spring as claimed in any one of claims 1 to 4, wherein the displacement element is formed from a material which can rebound.
6. The air spring as claimed in any one of claims 1 to 5, wherein the displacement element consists of a material whose density is at least 1.1 kg/m^3 .
7. The air spring as claimed in any one of claims 1 to 5, wherein the displacement element consists of a material whose density is at least 1.2 kg/m^3 .

8. The air spring as claimed in any one of claims 1 to 7, wherein the fastening section is configured as a cover plate arranged at the distal superstructure-side region of the air bellows.

9. The air spring as claimed in any one of claims 1 to 8, wherein the fastening section is configured as a cover cylinder arranged on the distal superstructure-side region of the air bellows, whose side wall is rigid.

10. The air spring as claimed in any one of claims 1 to 9, wherein the air bellows has stiffening elements, at least in the superstructure-side region, in order to heighten the radial stiffness of the air bellows.

11. The air spring as claimed in any one of claims 1 to 10, wherein the air bellows has at or adjacent to the axle-side region a first engaging means, which is designed to come or be brought into engagement with a second engagement means of the plunger.

12. The air spring as claimed in claim 11, wherein the first engaging means of the air bellows is fashioned as a radial constriction.

13. The air spring as claimed in claim 12, wherein the first engaging means is reinforced by a support element.

14. The air spring as claimed in any one of claims 11 to 13, wherein the second engaging means of the plunger is fashioned as a radially circumferential groove.

15. The air spring as claimed in claim 14, wherein the second engaging means is arranged on or adjacent to the distal end of the plunger.

16. The air spring as claimed in any one of claims 11 to 16, wherein the first and second engaging means are disengaged in the second position of the air bellows.

17. The air spring as claimed in any one of claims 1 to 16, wherein the ratio of the cross sectional area of the air bellows to the cross sectional area of the plunger is between 1.1 to 1.5.
18. The air spring as claimed in claim 17, wherein the ratio is between 1.1 to 1.25.
19. The air spring as claimed in any one of claims 1 to 18, wherein a valve device is provided on the air bellows in order to prevent an intake of air in the air bellows.
20. The air spring as claimed in claim 19, wherein the valve device prevents the intake of air in the air bellows in its first position.
21. The air spring per claim 16, wherein the valve device has at least one valve unit at the outlet of the air bellows.
22. The air spring as claimed in claim 21, wherein the at least one valve unit is manually activatable.
23. The air spring as claimed in claim 21, wherein the at least one valve unit is automatically activatable.
24. A vehicle axle system comprising a rigid axle body, and at least one air spring according to any one of claims 1 to 23, wherein the at least one air spring is arranged on the axle body.

FIG. 1

