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(71) Applicant: **VÚKV a.s.**
158 00 Praha 5 (CZ)

(72) Inventors:
- **Zelingr, Milos**
  16300 Praha 6 (CZ)
- **Kural, Jan**
  11000 Praha 1 (CZ)
- **Heptner, Tomás**
  16000 Praha 6 (CZ)

(74) Representative: **Loskotova, Jarmila**
K Závetinám 727
155 00 Praha 5 (CZ)

(54) **Low construction height bogie for low-floor rail vehicles especially trams**

(57) The low building height bogie intended for low-floor vehicles especially trams is installed so that the side rotary bogie (1) is composed of one cradle (16a), always placed approximately in the middle of the bogie, and the middle bogie (2) is composed of two cradles (16b), of which each is situated between one pair of opposite wheels with common axis of rotation. The wheels (5) of the bogie (1,2) are fixed by means of pinned bearings of the axle (11), which are bent downwards in the middle part, whereas the axle (11) contains gaps (11a) intended for insertion of the primary springing system (6). The primary springing system (6) carries the bogie chassis (12a), (12b) in which there are gaps from below (12c) intended for insertion of the primary springing system (6).

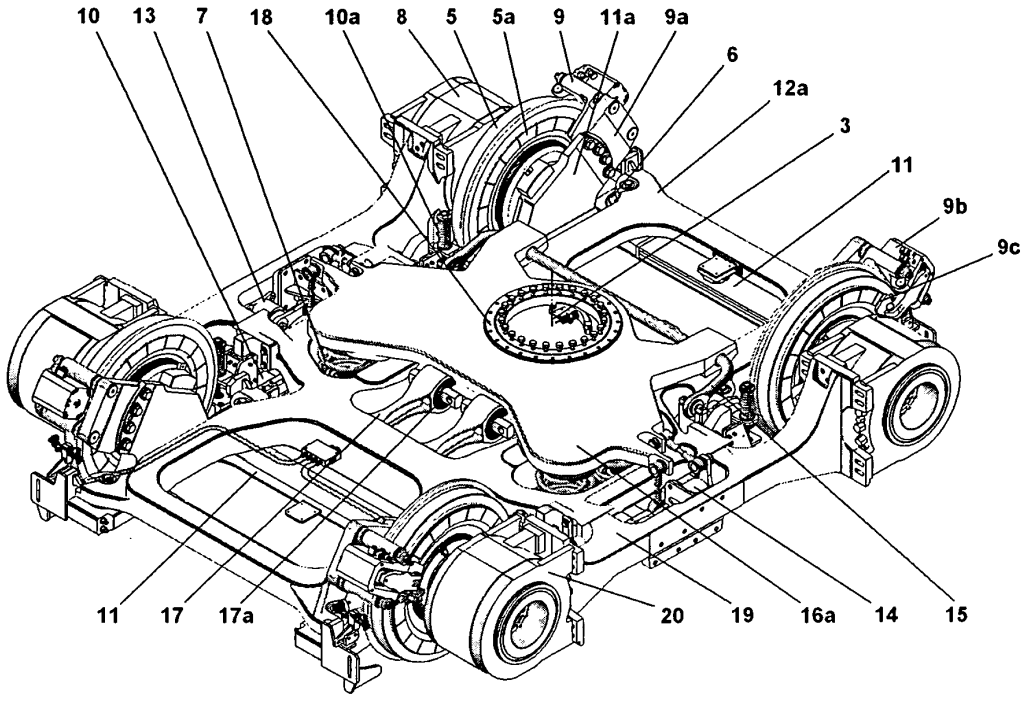

Fig. 4

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Description

Field of technology

[0001] The invention concerns the bogie of low rail vehicle for passenger traffic especially trams.

Present state of technology

[0002] Low-floor tram vehicles have nowadays been produced along most of the vehicle length, whereas, the standard floor height can (for low vehicles) be specified within the range of 350÷450 mm above the upper surface of the rail. The minimum standard width is 600 mm. To keep the height of the floor on this level, the bogies of such trams are often equipped with axles of separate wheel pairs which have the same geometrical axis of rotation, instead of the usual double wheel set pressed onto shared axles.

[0003] The separate wheel set is usually realized by a bridge of prismatic cross-section, which, in the part closest to the vehicle floor, is lowered as much as possible to the upper surface of the rail. On both ends of this prismatic bridge there are pins carrying the separately led wheels by means of bearings. The use of such a separate wheel set enables the floor to be positioned even in between the wheels themselves.

[0004] The low-floor tram rail vehicles are usually composed of more, at least three segments, whereas, under every odd segment, there is a non-rotary (i.e. vertical rotation of the bogie respectively to the vehicle chassis is possible only in a very limited scale) bogie with the pass width of Y vehicle above the bogie then reaches the standard level (according to picture 1).

[0005] The bogie of such a vehicle is usually realised so that the primary springing (i.e. vehicle chassis springing) is situated on the outer side of every wheel respectively to the longitudinal axis of the vehicle; the chassis is placed onto the primary springing in the H letter shape with a broken crossbeam running below the floor surface of the vehicle. The vehicle chassis is fixed onto the bogie chassis by means of secondary springing placed in trestle-trees of the bogie chassis or on their outer side, respectively to the longitudinal axis of the vehicle. Such a vehicle chassis composition onto the bogie enables their vertical mutual rotation only in a very short span, max 3°. That is why such a bogie is termed as "non-rotary". The inability to rotate results in accrual of the forces between the vehicle and bogie, and also between the wheels and the rail, because majority of vertical axis rotary movements of the segments above the bogie is consumed while the wheels touch the rail, which further causes higher fade rate of wheels, rails together with higher noisiness in rail bends.

[0006] In such a vehicle-bogie composition, there is no room for the spring cradle, i.e. supporting cross bar placed on the bogie chassis by means of secondary springing onto which a rotary vehicle chassis is placed. The bogie of such concept cannot be placed on the usual low-floor vehicle as a rotary one.

[0007] In case of success to properly compose the spring cradle and bogie chassis below the floor of the low-floor vehicle, it would be possible to realise a rotary bogie. In the usual composition of the rotary bogie respectively to the chassis (from the ground plan view) placed in the middle of the bogie, the wheels, and between them situated beam construction, would hinder the rotation of the bogie respectively to the vehicle chassis, so that the pass width X in the bogie part would not be acceptable, i.e. lower than the standard, (see picture 2).

[0008] At the bogie of the usual realisation, the drive composition may also represent a problem, where the drive is either composed as fully sprung, with engines situated on the side of the bogie (respectively to longitudinal axis of the vehicle) driving to wheel on that side of the bogie, or, as the individual drive of separate wheels with engines situated in close proximity of the wheels, sprung composition of engine, or directly in the wheels, non-sprung engine. In respect of optimal force flows in the drive and lowering of negative influences on the rail superstructure it is desirable for the drive to be composed individually and sprung. In that case, the engine must be situated on the outer side of the wheel (respectively to the vehicle longitudinal axis), possibly with transmission, and disc mechanical brake. Such placement of the three components on the outer side of the wheel is, due to the usual vehicle chassis widths, impossible. The rotary and non-rotary bogies of the usual realisation cannot, therefore, be used for the vehicle CZ patent 297213, where the placement of the vehicle chassis on the bogie makes it possible to keep the standard pass width of a low-floor vehicle with rotary composition of vehicle chassis onto the bogie without accrual of forces between the wheels and rails, without higher level of wheel and rail wear, together with higher noisiness.

The gist of invention

[0009] The fundamental aim of the invention was to create an bogie for a low-floor tram rail vehicle with such an organization of primary and secondary springing composition, which will enable the composition of the main parts of the bogie - axles, bogie chassis, spring cradle - together with the components of the primary and secondary springing below the vehicle floor, at the standard height for low-floor vehicles, i.e. maximum 450mm above the upper rail surface, whose basis dwells in the concept of the bogie chassis being situated in the middle part of the axle by means of springing elements of the primary springing system, e.g. steel or rubber-steel springs which are inserted from above into the middle part of the axle and from below inserted into the bogie chassis, so that the composition of the middle part of the axle and bogie chassis occupies minimum possible height, given by the building height of the middle part of the axle and bogie

chassis. The building heights are result from the solidness requirements and the necessary clearance between the axle and chassis, which is defined by the necessary up-stroke of the primary springing.

[0010] At least one spring cradle is then placed on bogie chassis by means of secondary spring system elements. The secondary springing is realised by the usual spring systems which are inserted into the bogie chassis spring holder, and which the cradle is placed on. The secondary springing is composed so that its upper part is inserted into the cradle from below and its lower part is fixed in the spring holder, which is a part of the bogie chassis and whose lower edge reaches the lower part of the middle part of the axle. Thus also, the composition of the bogie chassis and the spring cradle occupies minimum height, given only by the building height of the cradle and bogie chassis. These building height levels result from the solidness requirements and the necessary clearance between the cradle and bogie chassis conditioned by the necessary up-stroke of secondary springing, so that the upper surface of the cradle is situated in such a height so that it is possible to compose the vehicle bearing part with the floor at the height level of maximum 450 mm above the upper rail surface, i.e. within the standard height designed for the low-floor vehicles.

[0011] This part of the vehicle bogie is connected with the bogie cradle by means of vertical axis rotary bearing, which is fixed to the cradle and vehicle bogie which is inserted from above into the middle part of the cradle, so that the composition of the bogie cradle and the lower part of the vehicle occupies minimum possible height given by the building height of the cradle which is necessary for the clearance between the cradle and the lower part of the vehicle.

[0012] Besides the secondary springing, every bogie cradle is linked to the bogie chassis by means of a draw bar or a pair of draw bars, enabling the transition of longitudinal forces between the cradle and the bogie chassis, two vertical and at least one horizontal absorber, absorbing the vertical and horizontal movements within the secondary springing system, and the anti-swing stabilizer preventing the chassis from cross-swinging of the vehicle chassis in order to achieve the proper driving properties and keep the standardised vehicle gauge.

[0013] The bogie can bear one vehicle chassis if it is placed below the front or rear part of the vehicle or, it can bear two vehicle chassis in case the bogie is situated below the vehicle joint.

[0014] In case of one vehicle placement onto the bogie, the secondary springing is situated in the middle of the wheel base of the vehicle, whereas the axis of the rotary bearing, and thus also the axis of bogie rotation respectively to the vehicle chassis, lies relatively close (approx. 1/3 of the wheel base of the vehicle bogie from the middle of the rotation axis of one wheel pair of the bogie nearer to the centre of the vehicle), which minimizes the related transverse wheel movement of this wheel pair respectively to the vehicle chassis during the rotation moment of the bogie around the vertical axis of the bearing.

[0015] In case that two vehicle chassis are placed onto the bogie, the secondary springing is situated between the wheels of each pair of opposite wheels, respectively to the longitudinal axis of the vehicle, so that each cradle place from above onto the secondary springing has got the rotary bearing axis, and thus also the axis of the bogie rotation respectively to the vehicle chassis placed always geometrically in the middle of the common axis of rotation of one wheel pair, which minimizes the relative transverse movement of the particular wheel pair respectively to the vehicle chassis while moving around the vertical axis of the particular rotary bearing.

[0016] The aim of my invention is to further create an bogie for linked low-floor tram rail vehicles with such a drive organisation so that it would be possible to brake the free wheel by means of sprung drive, engine, or transmission so that the engine does not over reach the width of the vehicle chassis.

[0017] This can be achieved by two ways: either two wheels are driven on one side of the bogie respectively to the longitudinal axis of the vehicle by means of one engine fixed onto the bogie chassis, on whose shaft there is a brake disc with a brake unit. This engine drives every wheel on one side of the bogie by means of transmission equipped with gear wheels. Such a drive realisation is, from the viewpoint of its size, usable in the usual widths of vehicle chassis, whereas, the drive itself does not reach over the vehicle chassis width. In order to keep the optimal force flow within the drive, it is desirable to install every drive individually.

[0018] The wheels are then driven individually by means of engines placed on the bogie chassis on the outer side of the wheels respectively to the longitudinal axis of the vehicle. The wheel tyre itself serves as a brake disc - the brake unit is placed on the head surface of the axle and its jaws brake on the side surface of the tyre. This ensures saving of space because it is thus not necessary to install the brake disc between the wheel and the engine.

[0019] In case the bogie is composed as a regular one, which means it is not equipped by the drive, but only by brakes, the brake units are positioned the same way as with the driving bogie, where they are situated upon the axle heads and the braking is performed by the wheel tyres, or the brakes are installed as disc ones, whereas, the brake discs and brake units are situated at the outer side of the wheels.

[0020] The bogie according to the invention is possible to be used also for the single-chassis vehicles, whereas, two bogies are used in the single-cradle chassis, positioned below the front (or rear) part of the vehicle.

[0021] The bogie according to the invention is also possible to be used with multi-part low-floor tram vehicles of the regular realisation with non-rotary bogies, whereas the bogie itself is composed as a non-rotary one. To such a use, a bogie originally intended for the two vehicle chassis placement is the best choice, whereas, instead of two

cradles, the vehicle chassis is directly placed onto the secondary springing. The draw bars ensuring the transition of longitudinal forces, vertical and horizontal swing absorbers and stabilisers are then positioned between the bogie and vehicle chassis.

Figures overview

[0022] The technical realization is more closely specified in the attached drawings, where figs. 3 represents the two-part three-bogie vehicle, fig. 4 and 5 depict the bogie realisation 1 and 2. Fig. 6 presents schematic cut through the bogie; figs 7 and 8 demonstrate the width of the row above the bogie in the realization 1 and 2.

Example of invention embodiment

[0023] The bogies for multi-part low-floor tram rail vehicles, depicted on the fig 3 as two-part, which is equipped with the first side rotary bogie 1 below the front part of segment A and the second rotary bogie 1 below the rear part of segment B and one middle bogie 2 below the joint - the segment connection A and B, where on the middle bogie 2 there are both adjacent ends of vehicle chassis of segments A and B, each with a separate vertical axis of rotation 4 respectively to the bogie 2. On the side bogies 1, there are chassis A and B placed on rotary bearings with vertical axis of rotation 3 placed in a longitudinal axis of bogie in such a proximity from the middle of the common axis of one wheel pair of the bogie which is nearer to the middle part of the vehicle, so that it is possible to ensure convenient access to the driver's cabin and to the seats in the rear part of the vehicle. The above mentioned organisation of rotary axis of the bogies 1 and 2 respectively to the particular vehicle chassis ensures the minimum level of transverse movement of each wheel pair respectively to the particular vehicle chassis during mutual rotation around the axis 3 or 4, which further results in a slight blockage of the pass width W of the vehicle above the bogie 2 (compared to other rotary bogie vehicles - see picture 7), and thus the width W keeps the standard pass width. Above the bogie 1 the pass composition ensures the width which is convenient for the driver's cabin and seats access Z, respectively to the particular standard, see fig. 8. As for the side bogies 1 below the front and rear part of the vehicle, the advantage of smaller transverse wheel movement respectively to the vehicle chassis is evident only with the wheel pairs closer to the middle of the vehicle; the wheel pairs further from the middle of the vehicle show bigger span of movement respectively to the vehicle chassis. These wheel chassis, however, do not block the passenger space because they move in the front part of the vehicle below the driver's cabin and in the rear part of the vehicle below the passenger seats, or, seen from the ground plan, in the bend following trajectory of the wheel pair moving below these seats.

[0024] The composition of the bogie is to be found in the fig. 4, 5 and 6.

[0025] The bogies in realization 1 and 2 contain in the space between the separate wheel pairs 5 contain the elements of the primary 6 and secondary 7 springing. On the outer part of the wheels, or, on the level of the wheels, respectively to the longitudinal axis of the vehicle, there are drives and brakes - engines, transmissions 8, mechanical brakes 9 and rail brakes 10. Thanks to this composition, the floor even above the bogies can be kept in the low standard level, which is only slightly elevated, compared to rest of the passenger space, whereas, both these floor parts are connected with barrier-free pass by means of smoothly rising ramps, while the standard pass height of the vehicle is kept. The connection of separate vehicle chassis segments with the bogie is made so that the axis of rotation 4 of the middle bogie 2 respectively to the vehicle chassis always lie on the geometrically vertical axis running through the common axis of rotation of one of the wheel pair. Each bogie realization 2 is thus equipped with two cradles 16b, always situated between the pairs of opposite wheels with common axis of rotation, whereas, the rotary axis 3 of the side bogie 1 respectively to the vehicle chassis is situated within the longitudinal axis of the bogie, and relatively near, approx. 1/3 of the vehicle perch, representing the middle of the common axis of rotation of one wheel pair of the bogie. Each bogie realization 2 is thus equipped with one cradle 16a, always situated approximately in the middle of the bogie.

[0026] The vehicle bogie, fig. 4. 5, and 6 is organised so that the wheels 5 are fixed by means of pinned bearings on the axle 11, whose middle part is bent downwards. In the axle 11, special gaps are made 11a which serve for insertion the springs of primary springing 6. On the springs of primary springing there is the bogie chassis 12a, 12b where there are gaps 12c for insertion of the springs 6 of primary springing. Furthermore, within the chassis, there are spring holders 12d in which there are springs of the secondary springing 7. These spring holders 12d reach as low as possible so that the springs of the secondary springing 7 reached as close the upper surface of the rail as possible. The secondary springing 7 is supplemented by two vertical 13 and at least one horizontal absorber 14, absorbing the vertical and transverse movements within the secondary springing, and with the swing stabiliser 15 which hinders the transverse swing of the vehicle chassis. The absorbers 13 and 14, and the swing stabiliser 15 are mounted between the bogie chassis 12a, 12b and the cradle 16a, 16b. Each cradle 16a, 16b is, respectively to the bogie chassis 12a and 12b, lengthwise led by means of pair of draw bars 17 which are fixed to the cradle and the bogie chassis by means of joints 17a.

[0027] The spring set of the secondary springing 7 is inserted into the spring holder 12d of the bogie chassis. On the springs of the secondary springing 7 there is the cradle 16a and 16b installed from above. The cradle contains gaps 16c for insertion of the secondary springing 7. The cradle 16a, 16b is connected to the low part of

the vehicle 17 by means of the rotary bearing 18, fixed to the cradle and the lower part of the vehicle. The bearing 18 is inserted into the gap 16c from above in the middle part of the cradle. On the outer side of the bogie chassis, respectively to the longitudinal axis of the vehicle there are holders of drive units 19 on which the drive units 20 are installed - engines, or, engines with transmissions.

[0028] Each drive unit operates one wheel 5 by means of the clutch. The mechanical brake 9 stops the wheel 5 directly - the brake unit 9b is placed upon the head 11a of the axle 11 by means of the console 9a. The brake jaws 9c directly stop the tyre 5a of the wheel 5.

[0029] In the space between two wheels on the same side of the bogie, respectively to the longitudinal axis of the vehicle, there are two rail brakes 10 hung by means of flexible suspenders 10a upon the bogie chassis 12.

Industrial applicability

[0030] The presented bogie is utilizable for low-floor rail vehicles, especially trams, in realization of multi-part (segment) or one-part (segment) vehicle chassis, equipped with the rotary or non-rotary installation of the vehicle chassis upon the bogie.

Claims

1. The low construction height bogie intended for low-floor rail vehicles (especially trams), can be designed for two-segment vehicles three bogies; or protruded at least for one middle segment and one bogie, whereas the vehicle is equipped with side bogie always below the front or rear vehicle segment, and the front/rear segment on that bogie is a rotary one, the middle bogie is situated below each joint - the segment connection of the vehicle chassis with each middle chassis connected to the neighbouring vehicle chassis, each in a separate linking point, or, installed so that the vehicle contains one vehicle chassis which is equipped with two side rotary bogies for the front and rear part of the vehicle, whereas the connection of each vehicle segment with the bogie is made so that the rotation point of the middle bogie always lies geometrically on the vertical axis running through the middle of the common rotary axis of one wheel pair of the chassis, whereas the rotation point of the side chassis is situated relatively close, approx. 1/3 of the chassis perch, in the middle of the common rotation axis of one wheel pair of the chassis, and within the space between the separate wheel pairs there are the elements of the primary and secondary springing on the outer side of the chassis wheels, respectively to the longitudinal axis of the vehicle the drives and brakes (especially engines, transmissions, disc and rail brakes **characterized by the fact** that the side rotary chassis (1) is represented by one cradle (16a) always situated approximately in the middle of the chassis, and the middle chassis (2) which is created by two side cradles 16b of which each one is placed between one pair of opposite chassis wheels with the common rotary axis, which minimizes the relative transverse movement of the chassis wheels respectively to the vehicle chassis during the rotation moment of vertical rotation axis (3), or (4), which results in only a little blockage of the pass width W above the middle chassis (2), compared to other vehicles equipped with the rotary chassis.) This means that the width W is kept at the same pass measure, which causes only a slight blockage of the pass width Z towards the driver's cabin or seats in the rear part of the vehicle. The Z width thus remains within the standard range.

2. The chassis according to claim 1., **characterised by the fact** that the wheels (5) of the chassis (1, 2) are fixed by means of pinned bearings of the axle (11) which is bent downwards in the middle, whereas within the axle (11) there are gaps (11a) intended for insertion of the spring system of the primary springing (6) in which the bogie frame is inserted (12a), (12b) where the gaps are made from below (12c) intended for primary springing insertion (6).

3. The chassis, according to claim 1., **characterised by the fact** that within the chassis frame there are at least two holders (12d), where the secondary springing system is inserted (7), whereas the holders (2d) reach as low as possible so that the secondary springing system (7) is placed closest to the upper surface of the rail, whereas the secondary springing (7) is supplemented with two vertical absorbers (13) and at least one transverse absorber (14), which are absorbing the movements within the secondary springing system, and with one transverse swing stabilizer (15) limiting the transverse swinging of the vehicle chassis.

4. The chassis, according to claims 1. and 3., **characterised by the fact** that the secondary spring system (7) is inserted in the springs of the bogie chassis frame (12d). The cradle (16a), (16b) is installed onto the secondary spring system (7) from above, in which there are gaps (16c), whereas the cradle (16a), (16b) is connected with the lower part of the vehicle (17) by means of the rotary bearing (18), fixed to the cradle (16a), (16b) and to the lower part of the vehicle (17). The bearing (18) is inserted from above into the gap (16d) in the middle part of the cradle.

5. The chassis, according to the claim 1., **characterised by the fact** that each cradle (16a), (16b) is, respectively to the chassis of the bogie (12a, 12b), led by means of pair of draw bars (17), which are fixed to the cradle and the chassis by means of joints (17a).

6. The chassis, according to the claim 1., **characterised by the fact** that the outer side of the bogie chassis (12a), (12b), respectively to the longitudinal axis of the axis, contains the drive holders (19) holding the drive units (20), engines, or, engines with transmissions, whereas, each drive unit (20) drives one wheel (5).

7. The bogie, according to the claim 1, **characterised by the fact** that the wheel (5) is directly braked by means of a mechanical brake (9), whereas the head (11a) of the axle (11), by means of the console (9a) contains the brake unit (9b), whose jaws (9c) stop directly the tyre (5a) of the wheel (5)/.

8. The bogie, according to the claim 1., **characterised by the fact** that the space between two wheels (5) on one side of the bogie (12), respectively to the longitudinal axis of the vehicle, contains two rail brakes (10), hung by means of spring suspenders (10a).

9. The bogie with low building height intended for low-floor rail vehicles especially trams, **characterised by the fact** that the wheels (5) of the bogie (1,2) are installed by means of pinned bearings on the axle (11), which is bent downwards in the centre, whereas, in the axle (11) there are gaps (11 a) intended for insertion of the primary spring system (6). The primary springing system (6) contains the bogie chassis (12a), (12b) in which there are gaps (12c) intended for insertion of the primary spring system (6).

10. The bogie, according to the claim 9., **characterised by the fact** that the bogie chassis contains at least two holders (12d) holding the secondary spring system (7), whereas the holders (12d) reach as low as possible, so that the secondary spring system (7) reaches to the upper surface of the rail as low as possible. The secondary springing (7) is supplemented with two vertical absorbers (13) and at least one transverse absorber (14), which are absorbing the movements within the secondary springing system, and with one transverse swing stabilizer (15) limiting the transverse swinging of the vehicle chassis.

11. The bogie, according to the claims 9. and 10, **characterised by the fact** that the secondary spring system (7) is inserted in the spring holders (12d) within the bogie chassis. The bogie chassis and secondary spring system (7) carries the non-rotary vehicle chassis, whereas, the vertical and transverse absorbers (13) and (14) together with the swing stabilizer (15) are mounted between the bogie chassis (12a), (12b) and the vehicle chassis. The vehicle chassis, respectively to the bogie chassis (12a), (12b), is led lengthwise by means of two draw bars (17), that are fixed to the vehicle and bogie chassis by means of joints (17a).

12. The bogie, according to the claims 9., 10., and 11., **characterised by the fact** that on the outer side of the bogie chassis (12a), (12b) respectively to the longitudinal axis of the vehicle, there are drive unit holders (19) containing driving units (20), engines, or, engines with transmissions, whereas, each drive unit (20) operates one wheel (5).

13. The bogie, according to the claims 9., 10., 11., and 12., **characterised by the fact** that the mechanical brake (9) applies directly to the wheel (5), where on the head (11 a) of the axle (11). The brake unit (9b) is placed upon the head (11 a) of the axle (11) by means of the console (9a). The brake jaws (9c) directly stop the tyre (5a) of the wheel (5).

14. The bogie, according to the claim 9., 10., 11., 12., and 13., **characterised by the fact** that the space between the two wheels (5) on one side of the bogie, there are two rail brakes (10), hung by means of the spring suspenders (10a).

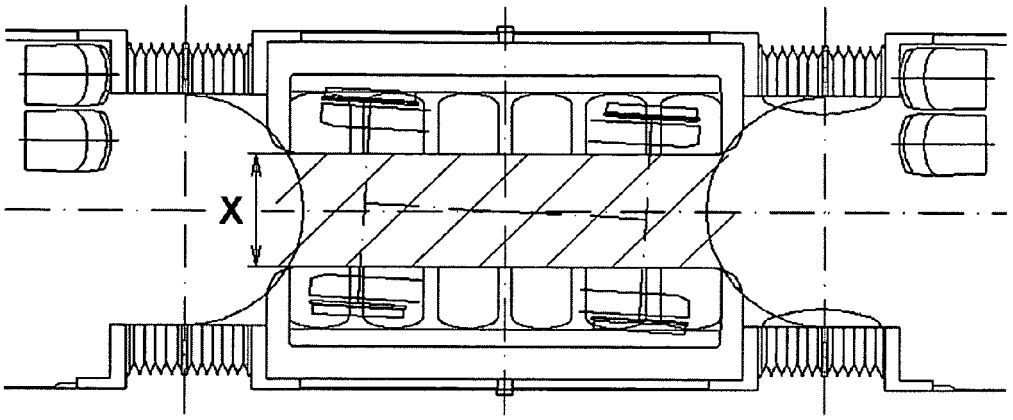

Fig. 1

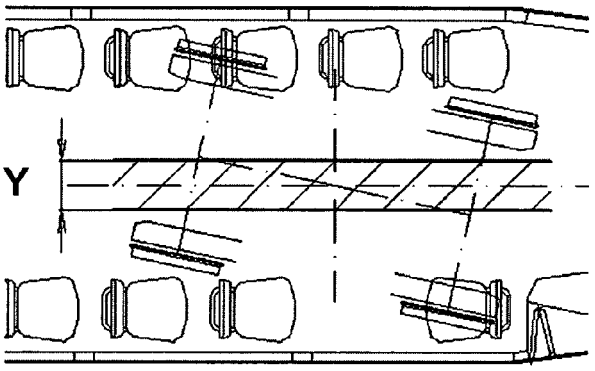

Fig. 2

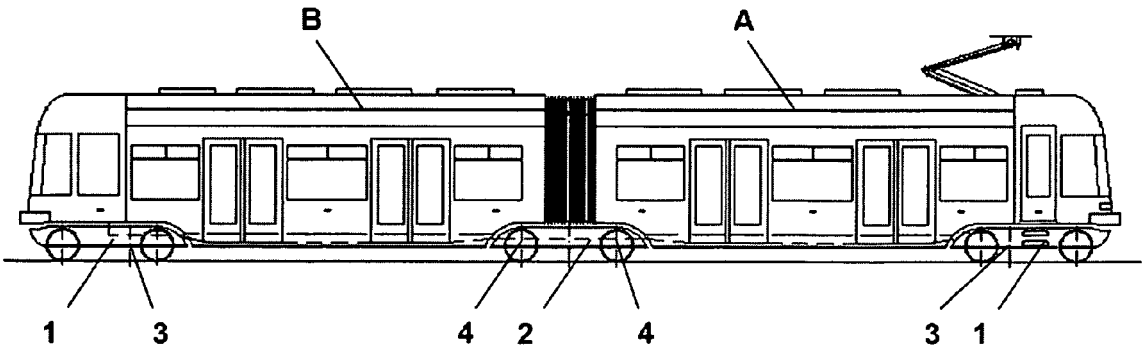

Fig. 3

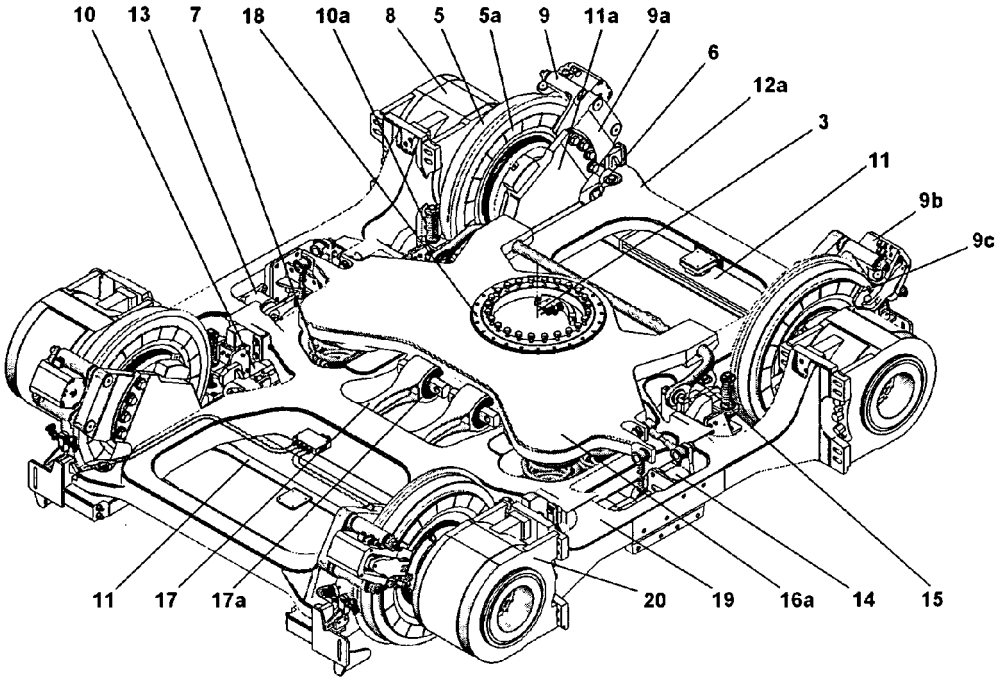
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Fig. 4

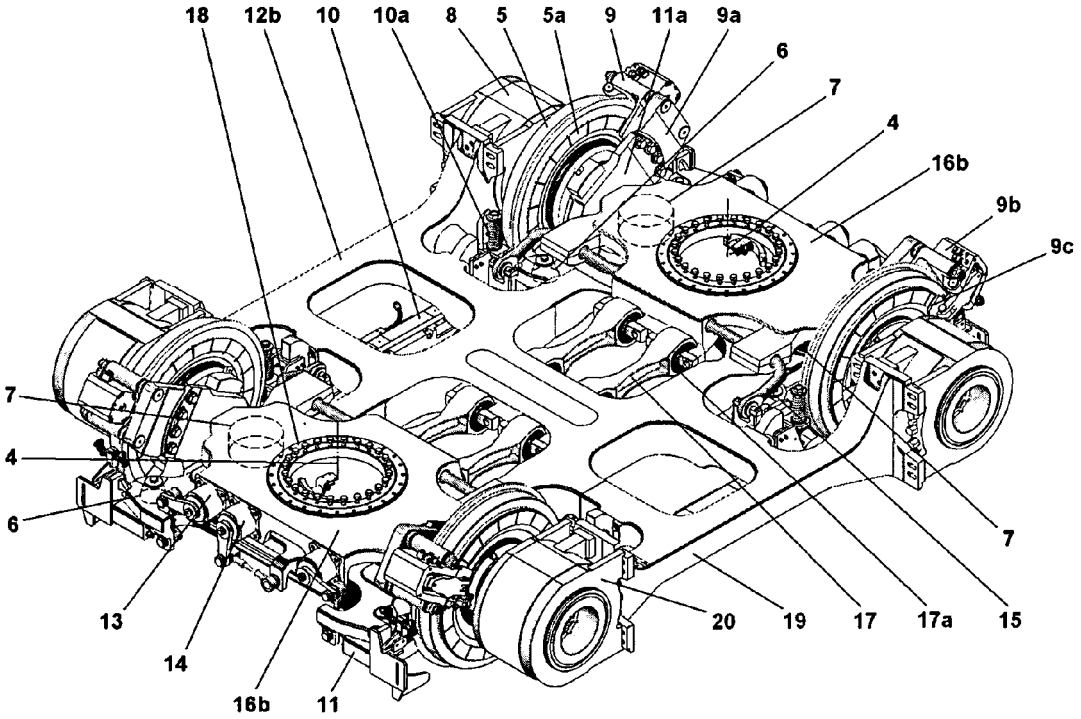
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Fig. 5

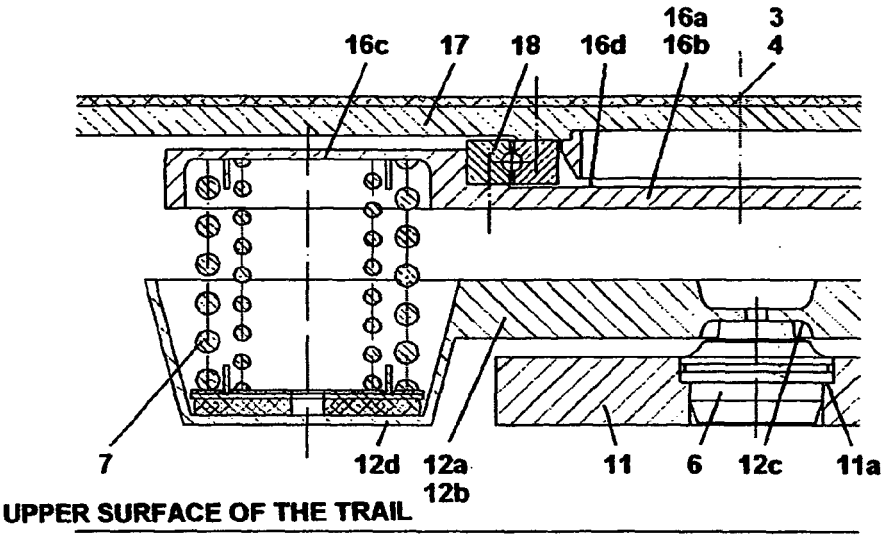

Fig. 6

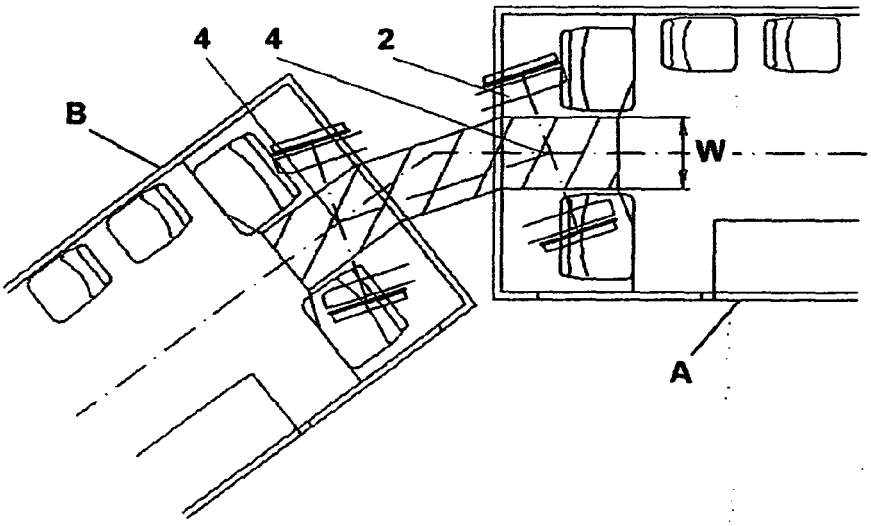

Fig. 7

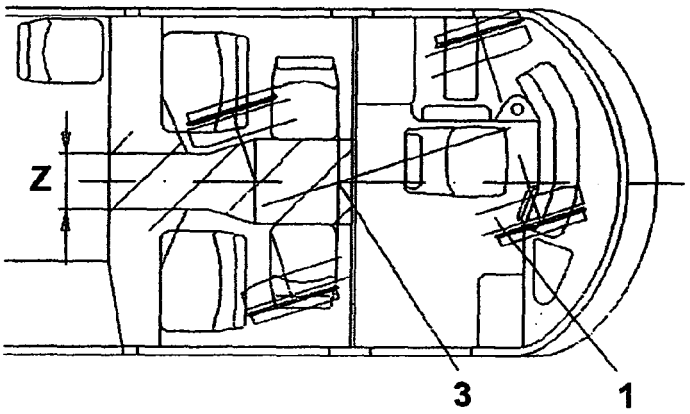

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 08 46 6019

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search	Date of completion of the search	Examiner
Munich	18 November 2008	Stelzer, Wolfgang

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X : particularly relevant if taken alone
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