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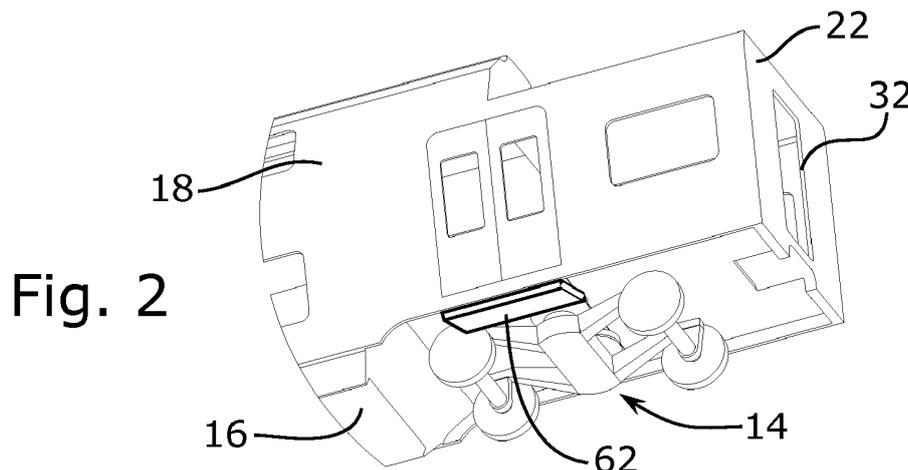
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 Amended claims in accordance with Rule 137(2) EPC.

(54) **PASSENGER CAR PROVIDED WITH A VESTIBULE LOCATED ABOVE A BOGIE AND WITH AN EXTERNAL ACCESS STEP AT A SIDE DOORWAY**

(57) A passenger car (10) for railway transportation comprises a car body (12) supported on at least one bogie (14). The car body has at least one side doorway (34) for boarding and alighting from a vestibule (36), which is located at least partially above the bogie (14) and an external access step (62) movable in a transverse direction of the passenger car (100) between a retracted position and at least one protruding position. In the retracted position, the external access step (62) is located below the vestibule (36). The bogie (14) comprises a front set

and a rear set of wheels (46), a front set and a rear set of left and right bearings (48), located between the left and right wheels (46) of the front and rear sets of left and right wheels, respectively. The doorway (34) is located between a front vertical transverse plane (400) containing a revolution axis (300) of the front set of left and right wheels (46) and a rear vertical transverse plane (400) containing a rear revolution axis (300) of the rear set of left and right wheels (46).



**Fig. 2**

## Description

### TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a passenger car for railway transportation, and more specifically to the problematic of accessing a passenger car from a platform situated at a level below a floor of a vestibule of the passenger car.

### BACKGROUND ART

[0002] Passenger cars for railway transportation are provided with one or more side doors, which can be located close to the longitudinal ends of the passenger car or distributed along its length. A door located close to an end of the passenger car offers the advantage of also allowing access to an adjacent car through an intercommunication. It enables to clearly separate the vestibule from the saloon, e.g. with a door or a partition, and to maximise the space allocated to the saloon. In a passenger car with two decks, the vestibule at the end of the passenger is often located at an intermediate level between the two decks car and gives access to a flight of stairs to the upper deck and a flight of stairs to the lower deck.

[0003] The car body of a passenger car is usually supported on one or more bogies, which are usually located close to the ends of the car body, or between cars in the case of articulated rail vehicles. In such cases, the vestibule and the side doors are often located at least partially above one of the bogies.

[0004] Side doors located above the bogies provide an additional advantage whenever the passenger car is on a curved track alongside a curved platform at a railway station: in such an instance, the side wall of the passenger car is at a distance from the platform, which varies with the curvature of the platform, and these variations are kept at a minimum at the level of the bogies.

[0005] In instances where the platform is at a low height, there may be a need to provide one or more external steps at the doorway, between the vestibule and the platform. Whenever the vestibule and the side doors are located above a bogie, it becomes challenging to find room to accommodate external steps, because of the conflicting space requirements with the bogie. One solution consists in a pivotable step, which pivots by 90° about a horizontal pivot axis between a vertical position and a horizontal position. The horizontal pivot axis is usually located below the door sill, as far as possible from the longitudinal centre plane of the car body, so as to avoid interference with the bogie when the bogie rotates relative to the car body about a vertical axis of rotation. The depth of the pivotable step, however, is limited for at least two reasons. First, any interference with the platform should be avoided before the step reaches its operational position, which involves that a safety margin has to be taken into account when defining the distance

between the pivot axis and the edge of the platform. Second, the depth of the pivotable step cannot be greater than the distance between the door sill and the pivot axis, which is directly related to the height of the external step relative to the door sill. Standards, however, usually require that the maximum height of the external step (typically 200 mm) should be less than its minimum depth (usually 240 mm). Hence, pivotable steps do not easily meet standard requirements in terms of ergonomics and passenger comfort.

### SUMMARY OF THE INVENTION

[0006] The invention aims to provide a vehicle configuration in which a side doorway located above a bogie can be provided with an external access step that has a comfortable depth.

[0007] According to a first aspect of the invention, there is provided a passenger car for railway transportation, the passenger car comprising: a car body and at least one bogie for supporting the car body. The car body is provided with a vestibule, at least one side doorway on one left or right side of the car body for boarding and alighting from the vestibule, a side door for closing the side doorway, and an external access step movable in a transverse direction of the passenger car between a retracted position and at least one protruding position. The bogie comprises a front set and a rear set of left and right wheels for rolling on left and right rails of a rail track, respectively, and a front set and a rear set of left and right bearings for guiding the front set and the rear set of left and right wheels, respectively. The doorway is located at least partially between a front vertical transverse plane containing a revolution axis of the front set of left and right wheels and a rear vertical transverse plane containing a rear revolution axis of the rear set of left and right wheels. The front and rear sets of left and right bearings are located between the left and right wheels of the front and rear sets of left and right wheels, respectively. The external access step in the retracted position is located below the vestibule, whereas in the protruding position, the external access step at least partially extends in front of the side doorway.

[0008] Because of the specific location of the bearings, the bogie has a reduced width, which provides room for the external access step in the retracted position. Hence, the depth and the height of the external access step can be defined independently from one another and can more easily meet the requirements of the operator, with given constraints in terms of platform height and passenger comfort.

[0009] In a preferred embodiment, the external access step in the retracted position is lower than an upper end of the wheels of the front and rear sets of the left and right wheels. Hence, access to the vestibule of the car body from a very low platform is still possible with only one external access step.

[0010] The motion of the external access step between

the retracted position and the protruding position is preferably a planar motion, i.e. a motion parallel to a plane, preferably a transverse vertical plane.

**[0011]** In a preferred embodiment the external access step is guided so as to remain parallel to itself between the retracted position and the protruding position. Advantageously, an actuator is provided for moving the external access step from the retracted position to any one of a plurality of operational positions between the retracted position and the extended position and for maintaining the external access step in said operational positions. Hence, the position of the external access step relative to a platform can be adjusted. In an embodiment, [CLAIM 5]. An automatic adjustment takes place on each platform, so that the gap between the external access step and the platform can be minimised.

**[0012]** The external access step can be guided in translation between the retracted position and the protruding position. Alternatively, the motion of the external access step between the retracted position and the protruding position can be a combination of rotation and translation, e.g. the motion resulting from the deformation of a parallelogram linkage.

**[0013]** Preferably, the bogie comprises a bogie frame, a primary suspension between the front and rear sets of left and right bearings and the bogie frame and a secondary suspension between the bogie frame and the car body, and the secondary suspension comprises a set of left and right vertical springs. In practice, the car body may comprise an underframe and each of the left and right vertical springs of the secondary suspension has preferably an upper end fixed in a vertical direction relative to the underframe and a lower end fixed in a vertical direction relative to the bogie frame. The vertical springs may comprise one or more of the following: pneumatic springs, helicoidal springs rubber springs.

**[0014]** In one embodiment, to provide more room for housing the external access step, a barycentre of a footprint of the set of left and right vertical springs on a horizontal plane is located within a rectangle tangential to the footprints of the sets of left and right wheels at least when the passenger car is stationary on a horizontal straight track.

**[0015]** In one embodiment, the bogie frame comprises a set of left and right longitudinal beams located between the left and right wheels of each of the sets of left and right wheels and at least one transverse beams integral with the set of left and right longitudinal beams, and the primary suspension connects the sets of left and right bearings to the left and right longitudinal beams, respectively. The bogie frame can be made in one piece of steel, cast iron or light metal, or it can be welded or otherwise assembled from several pieces.

**[0016]** The vestibule comprises a floor. In one embodiment, the car body has a lower deck and an upper deck, in which case the floor of the vestibule is preferably at an intermediate level between the lower deck and the upper deck. Alternatively, the passenger car can have a single

deck, in which case the floor is preferably flush with the deck.

**[0017]** In one embodiment, the vestibule also comprises at least one inner step, the inner step being lower than the floor, the inner step being located at the side doorway, between the floor and the side door in the closed position. Such an inner step is useful when the platform is particularly low. If necessary, the inner step is lower than an upper end of the wheels of the front and rear sets of the left and right wheels.

**[0018]** In one embodiment, the side door is a double leaf side door. Alternatively, a single leaf side door is also possible.

**[0019]** In one embodiment, the car body comprises an opposite side doorway, on an opposite left or right side of the car body for boarding and alighting from the vestibule of the car body, an opposite side door for closing the opposite side doorway, the vestibule comprising an opposite inner step, the opposite inner step being lower than the floor of the vestibule, the opposite inner step being located at the opposite side doorway, between the opposite side door and the floor of the vestibule when the opposite side door is in a closed position, transversally outward from the sets of left and right wheels of the bogie.

**[0020]** In one embodiment, the bogie is located longitudinally between two longitudinal ends of the car body. In an alternative embodiment, the bogie protrudes from a longitudinal end of the car body, so as to constitute a Jacob bogie.

## BRIEF DESCRIPTION OF THE FIGURES

**[0021]** Other advantages and features of the invention will then become more clearly apparent from the following description of a specific embodiment of the invention given as non-restrictive examples only and represented in the accompanying drawings in which:

- figure 1 is a side view of a passenger car according to one exemplary embodiment of the invention with open doors;
- figure 2 is a detail of an end section of the passenger car of figure 1 with open doors;
- figure 3 is a detail of an end section of the passenger car of figure 1 with closed doors;
- figure 4 is a schematic isometric view of a bogie of the passenger car of figure 1;
- figure 5 is a cross-section of the end section of the passenger car of figure 1, with closed doors;
- figure 6 is a cross-section of the end section of the passenger car of figure 1, with open doors and an extended external access step;

- figure 7 is a top view of the bogie of figure 4;
- figure 8 is a cross-section of the end section of the passenger car of figure 1, with open doors and an extended external access step;
- figure 9 is a schematic view of an external access step of the passenger car of figure 1 in a retracted position;
- figure 10 is a schematic view of the external access step of figure 9, in an extended position;
- figure 11 is a schematic view of a control circuit for controlling the external access step of figure 9.

[0022] Corresponding reference numerals refer to the same or corresponding parts in each of the figures.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] With reference to Figure 1, a passenger car 10 for railway transportation, comprises a car body 12 supported on a pair of bogies 14.

[0024] The car body 12 consists of an underframe 16, left and right sides 18 and a roof 20, which extend along a longitudinal axis 100 of the passenger car 10 between two opposite longitudinal ends 22 of the car body 12. The car body can be divided into two end sections 24, each comprising one of the ends 22 of the car body 12, and a median section 26 located between the end sections 24. The median section 26 accounts for more than half the overall length of the car body 12 and accommodates one or two decks 28, 30 equipped with passenger seats (not shown). One or both end sections 24 may be provided with a driver's cabin (not shown) or an end doorway 32 for accessing a neighbouring car body, as illustrated in figures 2 and 3. In this embodiment, each end section 24 is provided with two side doorways 34 on the left and right sides 18 of the car body 12 for boarding and alighting a vestibule 36 of the car body 12. The side doorways 34 are closed by double leaf side doors 38. It is to be understood that this configuration is not limitative: side doorways 34 may be provided at one end 24 only or on one side 18 only of the car body 12. Additional side doorways may be provided in the median section 26.

[0025] The vestibule 36 comprises a floor 40 and at least one inner step 42, which is lower than the floor 40 and located at the side doorway 34, between the side door 38 and the floor 36 when the side door 38 is in a closed position, as illustrated in figure 5. In the case of a double deck passenger car 10, the vestibule 36 is preferably located at intermediate height between the lower and upper decks 28, 30.

[0026] The bogies 14, illustrated in figures 4 and 7, are located each below one of the end sections 24 of the car body 12, and each at least partially below the vestibule

36. Each of the bogies 14 comprises a bogie frame 44, a front set and a rear set of left and right wheels 46 for rolling on a rail track, a front set and a rear set of left and right bearings 48 for guiding the front and rear sets of wheels 46, respectively, a primary suspension 50 between the sets of left and right bearings 48 and the bogie frame 44 and a secondary suspension 51 between the bogie frame 44 and the underframe 16 of the car body 12. The wheels 46 of each set can be independent or mounted on a common axle 54. The set of front bearings 48 is located between the left and right wheels 46 of the front set of wheels, while the set of rear bearings 48 is located between the left and right wheels 46 of the rear set of wheels.

[0027] The bogie frame 44 comprises a set of left and right longitudinal beams 56 located transversally between the left and right wheels 46 of each of the front and rear sets of wheels and at least one transverse beam 58 integral with the set of left and right longitudinal beams 56. The primary suspension 50 connects the front and rear sets of bearings 48 to the left and right longitudinal beams 56, respectively.

[0028] The secondary suspension 51 comprises a set of left and right vertical springs 52, which have an upper end fixed in a vertical direction relative to the underframe 16 and a lower end fixed in a vertical direction relative to the bogie frame 44. The vertical springs 52 may comprise one or more of the following: pneumatic springs, helical springs, rubber springs.

[0029] Viewed from above, when the passenger car 10 is stationary on a horizontal straight track 1, a barycentre 60 of a footprint of the set of left and right vertical springs 52 on a horizontal plane is located within the smallest rectangle 200 containing the footprints of the sets of left and right wheels 46, i.e. a rectangle tangential to the footprints of the sets of left and right wheels 46, as illustrated in figure 7.

[0030] With this configuration, room is provided for accommodating the inner step 42 of the vestibule 36 and an external access step 62 transversally outward from the bogie 44.

[0031] The external access step 62 is movable in translation between a retracted position (figures 3, 5 and 9) below the inner step 42 and a protruding position (figure 2, 6, 8 and 10) in front of the side doorway, below the inner step 42. The external access step 62 is moved by an actuator 64, here depicted as a motor 66 which drives a pinion 68 which engages with a rack 70 formed on the lower face of the external access step 62, while the step is guided by a runner 72. The external access step 62 may be equipped with a proximity or contact sensor 74 connected to a controller 76 for controlling the actuator 64, as schematically illustrated in figure 11.

[0032] The extendable external access step 62 fulfils two functions. When the platform 78 is low, as illustrated in figure 6, it serves as an intermediate step between the inner step 42 and the platform 78. When the platform 78 is higher than the external access step 62, as illustrated

in figure 8, the external access step 62 can still be extended so as to provide a gap filler between the inner step 42 and the platform 78.

[0033] To ensure that the wheels 46 do not collide with the external access step 62 when the bogie pivots relative to the car body 12 about a vertical pivot axis within preset boundaries, the width **W** of the external access step 62 and of the doorway 34 is preferably shorter than the distance **L** between the revolution axes 300 of the front and rear set of wheels 46. The external access step 62 and the doorway 34 are preferably between the transverse vertical planes 400 which contain the revolution axes 300.

[0034] In practice the vertical distance between the floor 40 of the vestibule 36 and the inner step 42 is between 150 mm and 250 mm, as well as the vertical distance between the inner step 42 and the external access step 62.

[0035] In an alternative embodiment, at least one of the bogies is a Jacob bogie, which protrudes from a longitudinal end of the car body and is located partially below the vestibule.

## Claims

1. A passenger car (10) for railway transportation, the passenger car (10) comprising:

- a car body (12), the car body being provided with a vestibule (36), at least one side doorway (34) on one left or right side of the car body (12) for boarding and alighting from the vestibule (36), a side door (38) for closing the side doorway (34), and an external access step (62) movable in a transverse direction of the passenger car (100) between a retracted position and at least one protruding position, wherein the external access step (62) in the protruding position at least partially extends in front of the side doorway (34), and
- at least one bogie (14) for supporting the car body, the bogie (14) comprising a front set and a rear set of left and right wheels (46) for rolling on left and right rails of a rail track (1), respectively, and a front set and a rear set of left and right bearings (48) for guiding the front set and the rear set of left and right wheels (44), respectively,

### characterised in that:

- the doorway (34) is located at least partially between a front vertical transverse plane (400) containing a revolution axis (300) of the front set of left and right wheels (46) and a rear vertical transverse plane (400) containing a rear revolution axis (300) of the rear set of left and right wheels (46),
- the front and rear sets of left and right bearings

(48) are located between the left and right wheels (46) of the front and rear sets of left and right wheels, respectively, and  
 - the external access step (62) in the retracted position is located below the vestibule (36).

2. The passenger car (10) of claim 1, wherein the external access step (62) in the retracted position is lower than an upper end of the wheels (46) of the front and rear sets of the left and right wheels (46).
3. The passenger car (10) of any one of the preceding claims, wherein the external access step (62) is guided so as to remain parallel to itself between the retracted position and the protruding position.
4. The passenger car (10) of claim 3, further comprising an actuator for moving the external access step (62) from the retracted position to any one of a plurality of operational positions between the retracted position and the extended position and maintaining the external access step (62) in said operational positions.
5. The passenger car (10) of claim 4, further provided with a sensor for detecting a position of a platform or a contact between the external access step (62) and the platform or a proximity of the external access step (62) to the platform, and a controller for controlling the actuator based on a signal of the sensor.
6. The passenger car (10) of any one of claims 3 to 5, wherein the external access step (62) is guided in translation between the retracted position and the protruding position.
7. The passenger car (10) of any one of the preceding claims, wherein the bogie (14) comprises a bogie frame (44), a primary suspension (50) between the front and rear sets of left and right bearings (48) and the bogie frame (44) and a secondary suspension (51) between the bogie frame (44) and the car body (12), and the secondary suspension (51) comprises a set of left and right vertical springs (52).
8. The passenger car (10) of claim 7, wherein a barycentre (60) of a footprint of the set of left and right vertical springs (52) on a horizontal plane is located within a rectangle (200) tangential to the footprints of the sets of left and right wheels (46) at least when the passenger car is stationary on a horizontal straight track (1).
9. The passenger car (10) of any one of claims 7 to 8, wherein the bogie frame (44) comprises a set of left and right longitudinal beams (56) located between the left and right wheels (46) of each of the sets of left and right wheels (46) and at least one transverse

beams (48) integral with the set of left and right longitudinal beams (56), and the primary suspension (50) connects the sets of left and right bearings (48) to the left and right longitudinal beams (56), respectively.

10. The passenger car (10) of any one of the preceding claims, wherein the vestibule (36) comprises a floor (40) and at least one inner step (42), the inner step (42) being lower than the floor (40), the inner step (42) being located at the side doorway (34), between the floor (40) and the side door (38) in the closed position.

11. The passenger car (10) of claim 10, wherein the inner step (42) is lower than an upper end of the wheels (46) of the front and rear sets of the left and right wheels (46).

12. The passenger car (10) of any one of the preceding claims, wherein the side door (38) is a double leaf side door.

13. The passenger car (10) of any one of the preceding claims, wherein the car body (12) has a lower deck (28) and an upper deck (30) and a floor (40) of the vestibule (36) is at an intermediate level between the lower deck (30) and the upper deck (30).

14. The passenger car (10) of any one of the claims 1 to 12, wherein the bogie (14) is located longitudinally between two longitudinal ends (22) of the car body (12).

15. The passenger car (10) of any one of the claims 1 to 12, wherein the bogie (14) protrudes from a longitudinal end (22) of the car body (12).

Amended claims in accordance with Rule 137(2) EPC.

1. A passenger car (10) for railway transportation, the passenger car (10) comprising:

- a car body (12), the car body being provided with a vestibule (36), at least one side doorway (34) on one left or right side of the car body (12) for boarding and alighting from the vestibule (36), and a side door (38) for closing the side doorway (34), wherein the vestibule (36) comprises a floor (40) and at least one inner step (42), the inner step (42) being lower than the floor (40), the inner step (42) being located at the side doorway (34), between the floor (40) and the side door (38) in the closed position and the car body is further provided with an external access step (62) movable in a transverse direction of the passenger car (10) between a retracted position and at least one protruding po-

sition, wherein the external access step (62) in the protruding position is lower than the inner step (42) and at least partially extends in front of the side doorway (34), and

- at least one bogie (14) for supporting the car body, the bogie (14) comprising a front set and a rear set of left and right wheels (46) for rolling on left and right rails of a rail track (1), respectively, and a front set and a rear set of left and right bearings (48) for guiding the front set and the rear set of left and right wheels (44), respectively,

- the doorway (34) is located at least partially between a front vertical transverse plane (400) containing a revolution axis (300) of the front set of left and right wheels (46) and a rear vertical transverse plane (400) containing a rear revolution axis (300) of the rear set of left and right wheels (46),

**characterised in that:**

- the front and rear sets of left and right bearings (48) are located between the left and right wheels (46) of the front and rear sets of left and right wheels, respectively, and

- the inner step (42) and the external access step (62) in the retracted position are located transversally outward from the bogie and the external access step (62) in the retracted position is located below the inner step (42) of the vestibule (36).

2. The passenger car (10) of claim 1, wherein the external access step (62) in the retracted position is lower than an upper end of the wheels (46) of the front and rear sets of the left and right wheels (46).

3. The passenger car (10) of any one of the preceding claims, wherein the external access step (62) is guided so as to remain parallel to itself between the retracted position and the protruding position.

4. The passenger car (10) of claim 3, further comprising an actuator for moving the external access step (62) from the retracted position to any one of a plurality of operational positions between the retracted position and the protruding position and maintaining the external access step (62) in said operational positions.

5. The passenger car (10) of claim 3, further provided with a sensor for detecting a position of a platform or a contact between the external access step (62) and the platform or a proximity of the external access step (62) to the platform, and a controller for controlling the actuator based on a signal of the sensor.

6. The passenger car (10) of any one of claims 3 to 5, wherein the external access step (62) is guided in translation between the retracted position and the protruding position. 5
7. The passenger car (10) of any one of the preceding claims, wherein the external access step (62) is guided in translation in a direction perpendicular to a longitudinal vertical plane of the car body between the retracted position and the protruding position. 10
8. The passenger car (10) of any one of the preceding claims, wherein the bogie (14) comprises a bogie frame (44), a primary suspension (50) between the front and rear sets of left and right bearings (48) and the bogie frame (44) and a secondary suspension (51) between the bogie frame (44) and the car body (12), and the secondary suspension (51) comprises a set of left and right vertical springs (52). 15  
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9. The passenger car (10) of claim 5, wherein a barycentre (60) of a footprint of the set of left and right vertical springs (52) on a horizontal plane is located within a rectangle (200) tangential to the footprints of the sets of left and right wheels (46) at least when the passenger car is stationary on a horizontal straight track (1). 25
10. The passenger car (10) of any one of claims 5 to 6, wherein the bogie frame (44) comprises a set of left and right longitudinal beams (56) located between the left and right wheels (46) of each of the sets of left and right wheels (46) and at least one transverse beams (48) integral with the set of left and right longitudinal beams (56), and the primary suspension (50) connects the sets of left and right bearings (48) to the left and right longitudinal beams (56), respectively. 30  
35
11. The passenger car (10) of any one of the preceding claims, wherein the inner step (42) is lower than an upper end of the wheels (46) of the front and rear sets of the left and right wheels (46). 40
12. The passenger car (10) of any one of the preceding claims, wherein the side door (38) is a double leaf side door. 45
13. The passenger car (10) of any one of the preceding claims, wherein the car body (12) has a lower deck (28) and an upper deck (30) and a floor (40) of the vestibule (36) is at an intermediate level between the lower deck (30) and the upper deck (30). 50
14. The passenger car (10) of any one of the claims 1 to 10, wherein the bogie (14) is located longitudinally between two longitudinal ends (22) of the car body (12). 55
15. The passenger car (10) of any one of the claims 1 to 10, wherein the bogie (14) protrudes from a longitudinal end (22) of the car body (12).

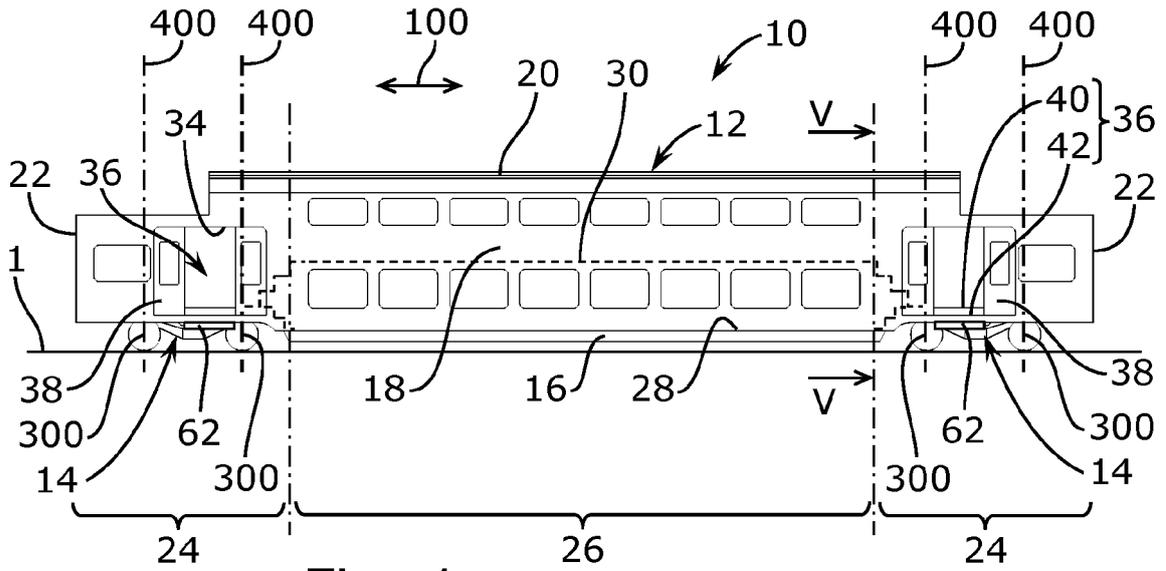


Fig. 1

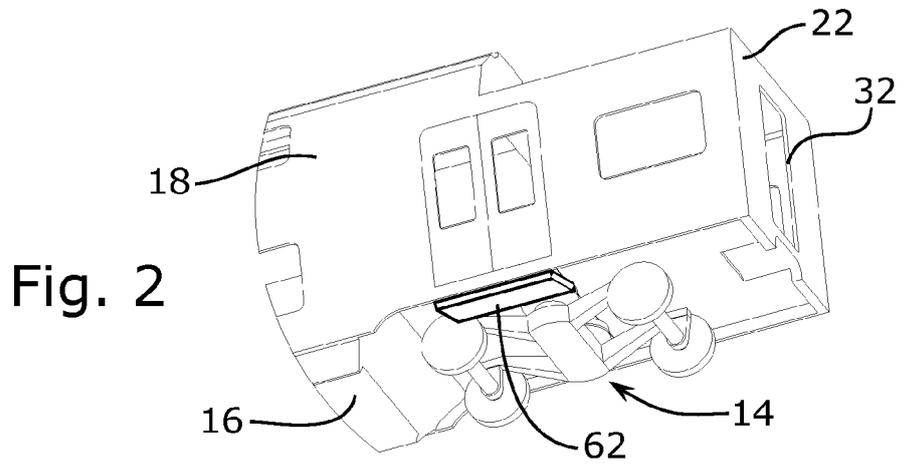


Fig. 2

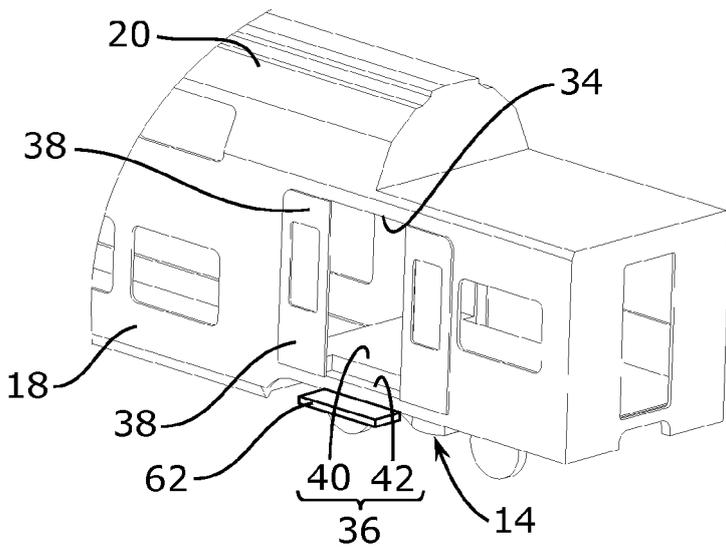
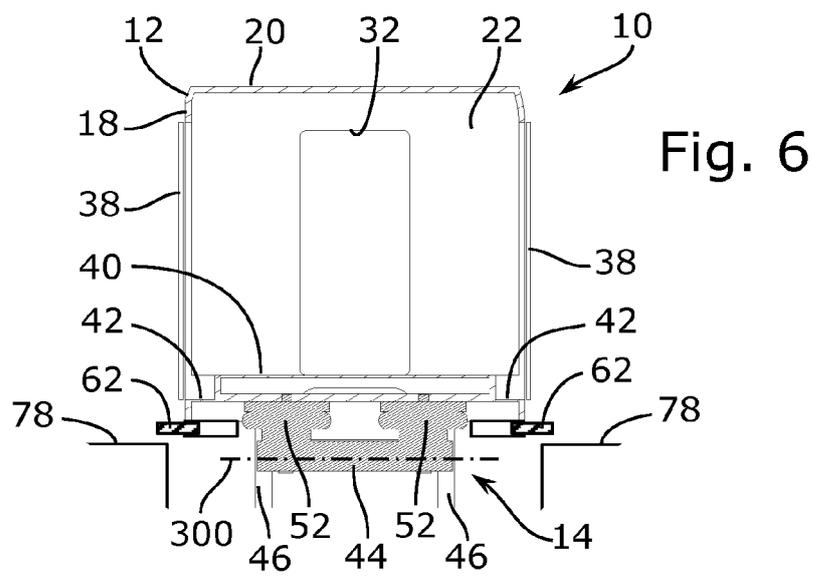
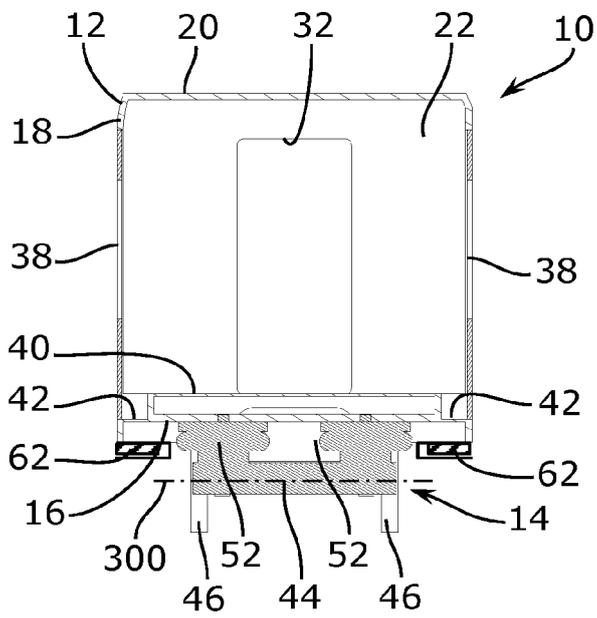
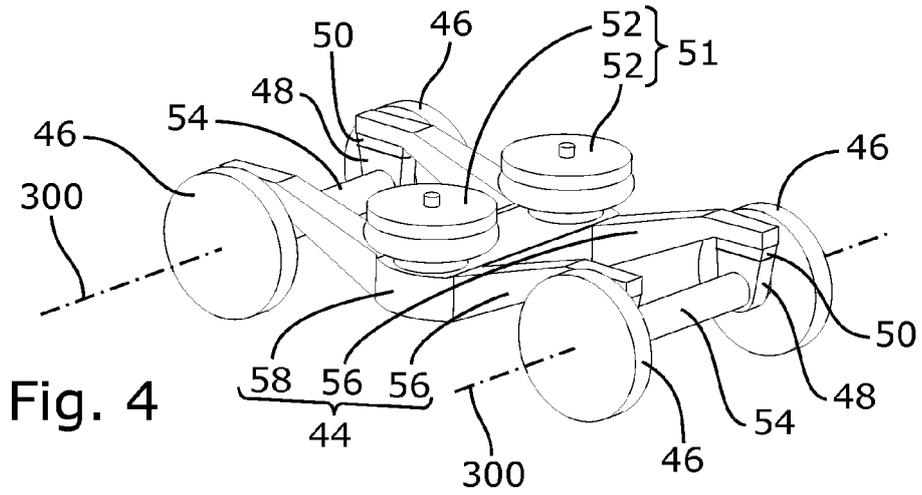


Fig. 3



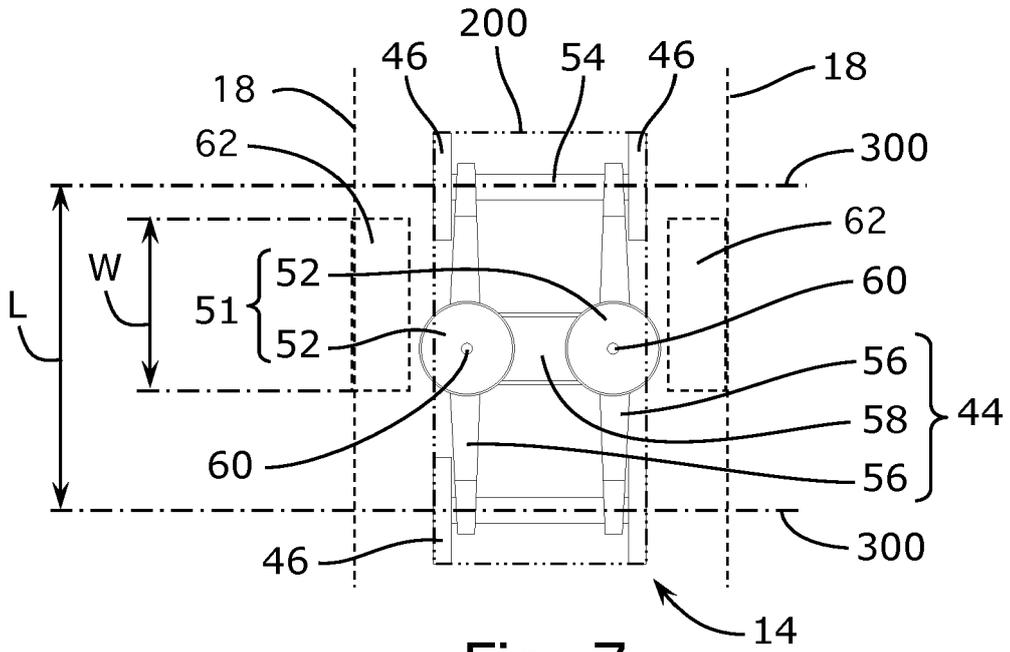


Fig. 7

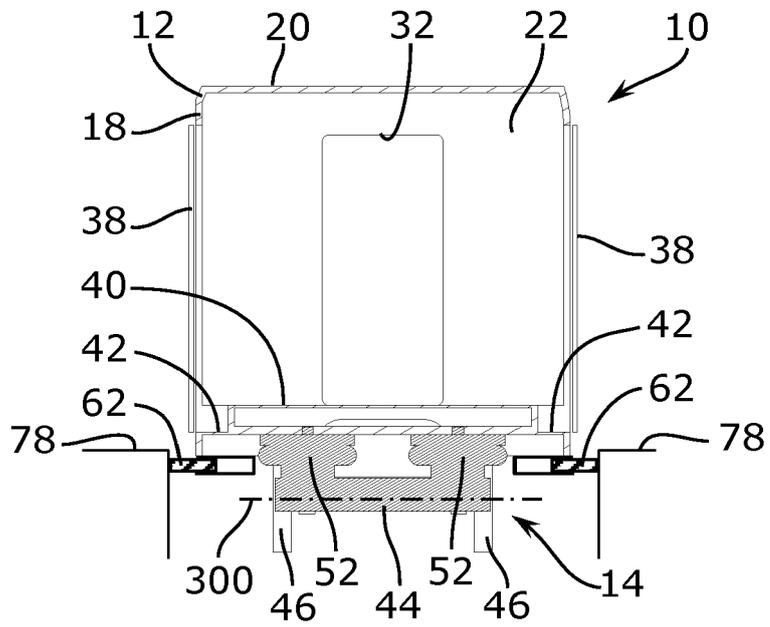


Fig. 8

Fig. 9

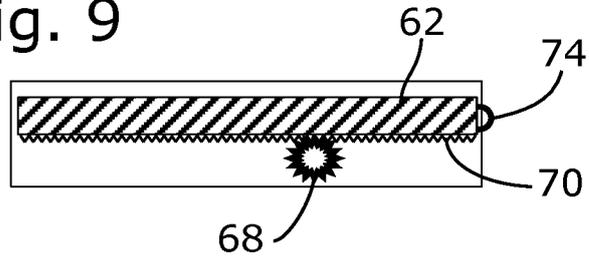


Fig. 10

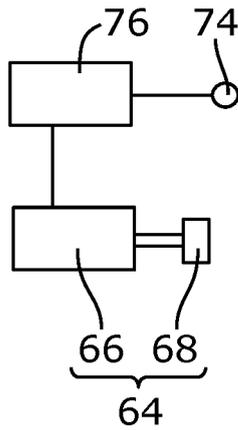
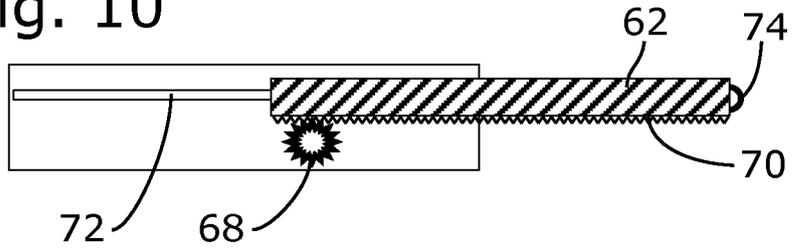


Fig. 11



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