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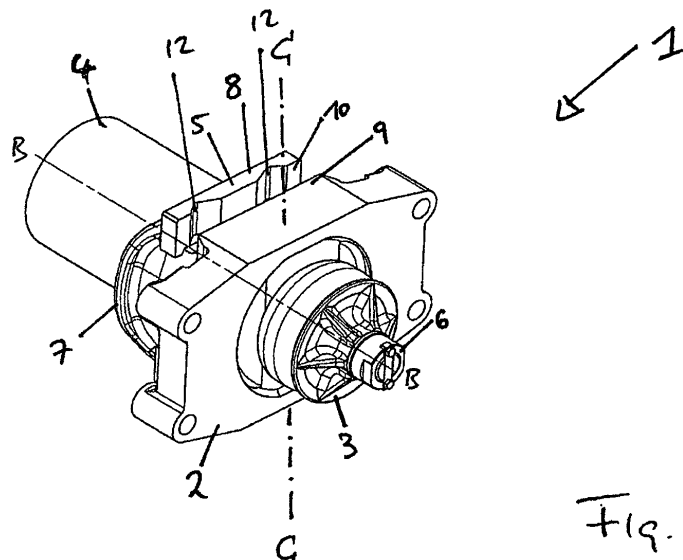
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(54) **Connection device suitable to connect a coupler rod or a connection rod to a car of multi-car vehicle**

(57) The invention relates to a connection device (1) suitable to connect a coupler rod or a connection rod to a car of a multi-car vehicle, whereby the connection device has a bearing bracket (2), an end section (3) of a coupler rod or a connection rod, whereby the end section (3) is pivotably connected to the bearing bracket (2) in such a manner that the end section (3) can pivot relative to the bearing bracket (2) about a pivot axis (C-C) that is perpendicular to the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod, a stopper (5) fixedly or pivotably connected to the end section, an elastic element, whereby upon application of force along the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod the elastic element is compressed, whereby in a first driving condition, which is de-

finied by a first position of the end section relative to the bearing bracket (2), a surface section (10) of the stopper (5) comes into contact with a surface section (11) of the bearing bracket (2), if the application of force along the longitudinal axis (B-B) of the end section (3) of the connection rod or coupler rod deforms the elastic element, wherein the bearing bracket (2) and/or the stopper (5) has a recess (12) such that in a second driving condition that is different from the first driving condition in that the end section (3) has a second position relative to the bearing bracket (2), the surface section (10) of the stopper (5) moves passed the surface section (11) of the bearing bracket (2), if a force along the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod is applied and the elastic element is deformed.



**Fig. 1**

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## Description

**[0001]** The invention relates to a connection device suitable to connect a coupler rod or a connection rod to a car of a multi-car vehicle and to a multi-car vehicle having such a connection device.

**[0002]** From DE 10 2008 030 284 B4 a connection device suitable to connect a connection rod for a car of a train is known. This connection rod has a bearing bracket that contains a support bearing plate ("Stützlagerplatte"). An end section of the connection rod is pivotably connected to the bearing bracket by way of a bearing integrated into the support bearing plate. The end section of the connection rod can pivot relative to the support bearing plate of the bearing bracket about a pivot axis that is perpendicular to the longitudinal axis of the end section of the connection rod. A stopper is provided by way of the connection rod end plate ("Kuppelstangenendplatte"). This stopper is fixedly connected to the end section. An elastic element is provided by way of the pressure side rubber disc ("Druckseitige Federscheibe"). This elastic element is arranged between the stopper and the bearing bracket. The embodiments described in DE 10 2008 030 284 B4 disclose different ways of arranging the elastic element between the stopper and the bearing bracket and suggest for a swing plate ("Richtgelenkschwingeplatte") to be arranged either between the elastic element and the support bearing plate or to be arranged between the stopper and the elastic element. From EP 1 407 953 B1 a connection device suitable to connect a connection rod to a car of a train is known. This connection has a bearing bracket in form of the support bearing plate ("Stützlagerplatte"). An end section of the connection rod is pivotably connected to the support bearing plate in such a manner that the end section can pivot relative to the support bearing plate about a pivot axis that is perpendicular to the longitudinal axis of the connection rod. A stopper is provided by way of a rectifying joint plate ("Richtgelenkplatte"). This stopper is fixedly connected to the end section. By way of rubber elements ("Federplattendämpfungselement") an elastic element is arranged between the stopper and the bearing bracket, whereby upon application of a force along the longitudinal axis of the connection rod, the elastic member is compressed, whereby in a first driving condition, which is defined by a first position of the end section relative to the bearing bracket, a surface section ("Abstütz- und Kippunkt 10") comes into contact with a surface section of the bearing bracket, if the application of force along the longitudinal axis of the connection rod or coupler rod deforms the elastic element. In the embodiment shown in Fig. 5, EP 1 407 953 B1 describes the bearing bracket to have a recess. In this embodiment, the surface section that comes into contact with the surface section of the stopper is arranged at the bottom part of the recess, while the elastic element is in contact with a surface section of the bearing bracket next to the recess.

**[0003]** In the design known from EP 1 407 953 B1, it

is disadvantageous that the distance between the longitudinal axis of the connection rod and the surface section of the bearing bracket that comes into contact with the surface section of the stopper cannot be increased without limiting the angle that the end section of the connection rod can pivot from a normal driving condition, which is considered to be the driving condition in which the train travels along a straight line in a flat plane. The further the surface section of the bearing bracket that comes into contact with the surface section of the stopper is moved away from the longitudinal axis of the end section in the normal driving condition, the smaller the angle will be that the end section can pivot out of this normal driving condition until the surface section of the stopper comes into contact with the surface section of the bearing bracket and will start to provide a rectifying momentum directed to pivot the end section back into the normal driving condition. For trains that run on tracks with bends with small radii of curvature, which at the same time means that the end section needs to pivot out of the normal driving condition with substantial pivot angles, this means that the surface section of the bearing bracket that comes into contact with the surface section of the stopper has to be placed closer towards the longitudinal axis of the end section in the normal driving condition. Otherwise, a rectifying momentum will already be created when the train follows the track in a curve with a small radius of curvature. On the other hand, it is desired to move the surface section of the bearing bracket that comes into contact with the surface section of the stopper as far away from the longitudinal axis in the normal driving condition as possible. The larger the distance between the surface section of the bearing bracket that comes into contact with the surface section of the stopper is from the longitudinal axis of the end section in the normal driving condition, the larger the rectifying momentum will be.

**[0004]** Given this background, the problem to be solved by the invention is to provide for an improved connection device that especially allows for a large rectifying momentum to be created and at the same time allows the connection device to be used in trains that are used on tracks with small radii of curvature.

**[0005]** This problem is solved by the connection device according to claim 1 as well as with the multi-car vehicle according to claim 10 that has such a connection device. Further improved embodiments are described in the subordinate claims and the description following hereafter.

**[0006]** The invention is based on the idea to provide the bearing bracket and/or the stopper with a recess that allows the surface section of the stopper that in the first driving condition and upon the application of force along the longitudinal axis of the end section would come into contact with the bearing bracket to move past the surface section of the bearing bracket in a second driving condition that is different from the first driving condition in that the end section has a second position relative to the bearing bracket. In providing the bearing bracket and/or the stopper with such a recess, it is prevented that the spe-

cific surface section of the stopper comes into contact with the surface section of the bearing bracket in the second driving condition and it is thereby prevented that these two surfaces are used to create a rectifying momentum in the second driving condition.

**[0007]** The invention can be implemented by either creating no rectifying momentum at all in the second driving condition. Alternatively, the invention can be put into practice by providing the bearing bracket and/or the stopper with further surface sections, which come into contact with each other in the second driving condition, wherein one of these surface sections can be one of those used in the first driving condition (this surface now being paired with a different surface of the counterpart).

**[0008]** The invention relates to a connection device suitable to connect a coupler rod or a connection rod to a car of a multi-car vehicle. Multi-car vehicles are known in different designs and in different forms of adaptation for uses.

**[0009]** Multi-car vehicles, for example, railway-bound trains (street cars and subway-trains also being considered as such trains) are known and are known for the purpose of transporting passengers as well as transporting goods. Further types of multi-car vehicles can be magnetic railway trains or can be buses (road buses as well as buses travelling on fixed tracks). A car of a multi-car vehicle can be a self-supporting car, whereby the car has sufficient wheels that are placed at sufficient locations such that the car can stand by itself without being supported by other cars, for example a three-wheeled car, a four wheeled car or a car with even more wheels placed at suitable locations. A car of a multi-car vehicle can also be of the non-self-supporting type, whereby the car has no wheels or only wheels provided in such a number or arranged at such a place that the car cannot stand by itself, but is vertically supported by at least one neighbouring car.

**[0010]** To form the multi-car vehicles, individual cars of the vehicle are connected to one another by means of a connection device. The connection device can be provided for different types of purposes. In multi-car vehicles where only one or only several of the total of cars is driven, the connection devices are provided so that a driven car can drive a non-driven car and thus ensure that the complete vehicle travels with the same speed. Connection devices are also distinguished between those connection devices that allow for an easy decoupling of the cars, whereby easy decoupling is understood to be accomplished within a couple of minutes, or for what is called "semi-permanent" coupling of the cars, for which decoupling of the cars takes efforts and usually involves the vehicle to have been transported to a specific work shop. Trains, for example, can have coupler-heads as part of their connection devices. These coupler-heads can, for example, be so called "automatic couplers" that allow decoupling within minutes. The coupler-heads are connected to coupler rods, which are connected to the car of the train. In an alternative design of a train, two neigh-

bouring cars are connected by a connection rod without the use of a coupler-head.

**[0011]** The connection device according to the invention has a bearing bracket. In the German-speaking literature on trains, the bearing bracket also is referred to as "Lagerbock". The term bearing bracket as used in the description of the invention is, however, not limited to what the skilled person understands to be a "Lagerbock". A "Lagerbock" is only seen as a specific, preferred embodiment of a bearing bracket according to the invention. The bearing bracket provides that part of the connection device relative to which an end section of the coupler rod or the connection rod can pivot. This can be achieved by parts of the car that form a fixed part of the car, for example by a part of the underframe of a car of a train. In a preferred embodiment, the bearing bracket is suitable to be detachably connected to a part of the car, for example a part of the underframe of the car. This can, for example, be achieved by providing the bearing bracket with holes suitable to take up screws with which the bearing bracket could be screwed to a part of the car, for example a part of the underframe of the car. It is also feasible to use different means to connect a bearing bracket to the car, for example to weld the bearing bracket to the car or to glue the bearing bracket to the car. The connection device according to the invention has an end section of a coupler rod or a connection rod, whereby the end section is pivotably connected to the bearing bracket in such a manner that the end section can pivot relative to the bearing bracket about a pivot axis that is perpendicular to the longitudinal axis of the end section the coupler rod or the connection rod. The description of the invention refers to the end section of a coupler rod or a connection rod to highlight that the invention predominantly deals with the way of attaching the end of the coupler rod or connection rod to the car and that the applicability of the invention is not substantially influenced by the type and specific design of the coupler rod or connection rod used. Furthermore, designs are known, where the end section of a coupler rod or a connection rod is provided as a separate piece of a multi-piece coupler rod or a multi-piece connection rod. For example, the design known from EP 1 407 953 B1 shows a connection rod end piece ("Kuppelstangenendzugteil") that is attached to the remaining part of the connection rod. The invention can thus be implemented into an existing connection as a retro-fit-solution by keeping a coupler rod or a connection rod unchanged and to retro-fit a new end section to such a coupler rod or connection rod that makes use of the invention. Therefore, the description speaks of an end section of a coupler rod or a connection rod. At the same time, the invention is not limited to connection devices that have the end section of a coupler rod or a connection rod as a separable piece of multi-piece coupler rod or a multi-piece connection rod. The invention for example also relates to designs where the end section of a coupler rod or a connection rod forms a fixed part of a solid bar. In a preferred embodiment, the

connection device also has a coupler rod or a connection rod, preferably a multi-piece coupler rod or a multi-piece connection rod with the end section being a piece of the respective multi-piece design. For those embodiments that have multi-piece coupler rods or multi-piece connection rods, the term end section is not to be understood in a limited way to only relate to those section that can be separated from a basic body. The end section of a coupler rod or a connection rod is to be understood to encompass at least those parts of a coupler rod or a connection rod that extend from the bearing bracket to the stopper that forms part of the invention.

**[0012]** The pivotable connection of the end section to the bearing bracket can be provided by a hole in the bearing bracket through which the end section passes and which preferably has chamfered sections like the designs shown in Fig. 1, 4 and 5 of EP 1 407 953 B1. The pivotable connection between the bearing bracket and the end section can also be provided by ball bearings set into a bearing bracket or spherical rubber elements like the one shown in Fig. 2 and 3 of EP 1 407 953 B1 set into the bearing bracket. Also a design like the one shown in EP 1 312 527 B1 can be provided as bearing bracket, whereby the element that holds the joint pin ("Gabel") would be considered to form part of the bearing bracket and the elements that are inserted into this bracket would be considered as the end section of the coupler rod or connection rod. In such a design, the thus defined end section would be pivotably connected to the bearing bracket by way of the bearing ("Lager 5", sphero-elastical element). As indicated in Fig. 2 of EP 1 312 527 B1, the end section can pivot about the bearing bracket by  $\pm 5^\circ$  in a vertical plane and by  $\pm 30^\circ$  in a horizontal plane (Fig. 1).

**[0013]** The end section can pivot relative to the bearing bracket about a pivot axis that is perpendicular to the longitudinal axis of the end section of the coupler rod or connection rod. In case of doubt, the longitudinal axis of the end section of the coupler rod or connection rod is considered to be the longitudinal axis of coupler rod or connection rod.

**[0014]** Embodiments of the connection device can be provided, where the pivot axis is orientated in such a direction that in the intended orientation that the connection device will take when built into the multi-car vehicle, the pivot axis has a vertical or has a horizontal orientation. In a preferred embodiment, the end section can pivot relative to the bearing bracket about several pivot axes, preferably about a horizontal pivot axis and about a vertical pivot axis and even more preferred about a multitude of pivot axes, whereby in a preferred embodiment, the multitude of pivot axes all lie in the same plane that is perpendicular to the longitudinal axis of the end section of the coupler rod or connection rod.

**[0015]** The connection device according to the invention has a stopper that is fixedly or pivotably connected to the end section. The stopper can, for example, be of the basic design of any of the "Richtgelenkplatten" shown in any of the Fig. 1 to 5 of EP 1 407 953 B1. Likewise,

the stopper can be of the basic design of a "Kuppelstangenendplatte 3" as disclosed in any of the Fig. 1 to 5 of DE 10 2008 030 284 B4. In such embodiments the stopper is fixedly connected to the end section. Alternatively, the stopper is pivotably connected to the end section, for example like the "Richtgelenkschwingeplatte 9" in the embodiment of Fig. 2 of the DE 10 2008 030 284 B4. In a preferred embodiment of a stopper being pivotably connected to the end section, the stopper is connected to the end section in such a manner that it can pivot only about a limited pivot angle relative to the end section. As described further below, a surface section of the stopper will be made to come into contact with a surface section of the bearing bracket in certain driving conditions in order to create a rectifying momentum that will apply a force on the end section in the direction of moving the end section back into a predetermined normal position. To create this rectifying momentum, the pivotable movement of the stopper relative to the end section (if the stopper is designed pivotably connected to the end section) must have a limit which does not allow the stopper to pivot further relative to the end section than this limit in order to allow for the transmittal of forces to create the rectifying momentum and to avoid the stopper from pivoting away from this limit at the time of creating the rectifying momentum.

**[0016]** In a preferred embodiment, the stopper is of a design that allows the stopper to be connected to the end section. For example, the stopper can have the design of a plate or a cup. The stopper can, however, also be provided by a part of the end section of the coupler rod or the connection rod itself, for example like the element "Anschlag der Kupplungsstange 25" of EP 1 925 523 B1. The stopper could also be provided by a bar attached, for example welded, to the outer circumference of a coupler rod or a connection rod.

**[0017]** The connection device according to the invention has an elastic element preferably arranged between the stopper and the bearing bracket, whereby upon application of force along the longitudinal axis of the coupler rod or connection rod the elastic element is compressed. In a preferred embodiment, the elastic element is provided by rubber elements, preferably by ring-shaped rubber elements that encompass a part of the end section of the coupler rod like, for example the "druckseitige Federscheibe 6" shown in DE 10 2008 030 284 B4. The elastic element can, however, also be provided by hydraulic elements, for example damper elements provided between the stopper and the bearing bracket. The elastic member need not be arranged to be in direct physical contact with the stopper and the bearing bracket. As shown in the designs of Fig. 1, 3 and 5 of DE 10 2008 030 284 B4, designs are possible, where other elements, for example a 'Richtgelenkschwingeplatte 9' is arranged between the elastic element and the bearing bracket. Also in designs like in EP 1 925 523 B1, the arrangement of the elastic element between the stopper and the bearing bracket for the present invention is understood to mean that a lon-

gitudinal force applied along the longitudinal axis of the end section flows through or past (as in EP 1 925 523 B1, Fig. 3) the stopper and then through the elastic element and then in to the bearing bracket.

**[0018]** According to the invention in a first driving condition, which is defined by a first position of the end section relative to the bearing bracket, a surface section of the stopper comes into contact with a surface section of the bearing bracket, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element. In a preferred embodiment, the connection device according to the invention has a normal driving condition, which is understood to be the orientation of the end section relative to the bearing bracket that the end section will take when the connection device is built into the multi-car vehicle and the multi-car vehicle travels along a straight line in a flat plane. This normal driving condition can be understood as the first driving condition. Given, however, that the connection device is preferably used in the context of creating a rectifying momentum in driving condition where the end section has pivoted out of the normal driving condition with the aim to move the end section back into the normal driving position, the first driving condition is preferably understood to be a driving condition, where the end section has pivoted away from the normal driving condition about the pivot axis.

**[0019]** Due to the elastic element the surface section of the stopper element and the surface section of the bearing bracket are preferably kept distanced from each other in driving conditions where only forces below a predetermined magnitude are applied along the longitudinal axis of the end section of the coupler rod or connection rod. However, if a force of a predetermined magnitude or above is applied along the longitudinal axis of the end section of the coupler rod or connection rod, the elastic element will be deformed by such an extent that the surface section of the stopper comes into contact with a surface section of the bearing bracket. This contact will take place at a distance relative to the point of pivotable connection to the bearing bracket (for example the hole in the bearing bracket through which the end section passes) and thus at a distance from the point at which the longitudinal axis of the end section of the coupler rod or connection rod intersects the bearing bracket. Based on the principle of "actio and reactio", the same force that is applied from the surface section of the stopper element onto the surface section of the bearing bracket due to the force along the longitudinal axis being applied is applied from the surface section of the bearing bracket onto the surface section of the stopper. This force applied from the surface section of the bearing bracket onto the surface section of the stopper also provides a rectifying momentum onto the stopper and the end section connected to the stopper. The rectifying momentum will be of the magnitude of the force applied from the surface section of the bearing bracket to the surface section of the stopper multiplied by the distance from the point of pivotable

connection of the end section (the point where the longitudinal axis of the end section intersects the bearing bracket) to the bearing bracket to the point of contact between the surface section of the stopper and the surface section of the bearing bracket. As also explained in EP 1 925 523 B1 with reference to the Fig. 5, 6 and 7 such a rectifying momentum tends to move the end section back into the normal driving condition.

**[0020]** The level of force that needs to be applied to bring the surface section of the stopper into contact with the surface section of the bearing bracket depends on the elasticity of the elastic element. The skilled person does choose by appropriately selecting the elasticity of the elastic element at which driving conditions the rectifying momentum is created. In a preferred embodiment, the rectifying momentum is only created at force levels acting along the longitudinal axis of the end section that occur during crash scenarios, for example forces acting along the longitudinal axis of the coupler rod above 800 kN

**[0021]** According to the invention, the bearing bracket and/or the stopper has a recess such that in a second driving condition that is different from the first driving condition in that the end section has a second position relative to the bearing bracket, the surface section of the stopper passes the surface section of the bearing bracket. The invention could thus also be explained in the sense that according to the invention the surface section of the stopper and/or the surface section of the bearing bracket that come into contact in the first driving condition are of such limited extent that the second driving condition, which is preferably a driving condition where the end section has pivoted relative to the bearing bracket about an even larger angle, cannot come into contact with each other but move past each other. Using a recess on the bearing bracket and/or the stopper provides the skilled person with the opportunity to provide a tailor-made solution for each multi-car vehicle and the specific conditions, in which the multi-car vehicle is to be used. The size and shape of the recess as well as its positioning along the stopper (in the direction perpendicular to the longitudinal axis of the rod) are one factor that influence for which swivel angles a rectifying momentum is provided (contact between the surface section of the stopper and the surface section of the bearing bracket) and for which swivel angles the presence of the recess will prevent a rectifying moment to be created. Likewise, the stroke of deformation of the elastic element and the elasticity of the elastic element influence how close the stopper comes to the bearing bracket for one given level of force of a force acting along the longitudinal axis of the rod.

**[0022]** If for example it is desired that for a given level of force with a given stroke and elasticity of the elastic element and a given length of the stopper and a given length of the bearing bracket in the direction perpendicular to the longitudinal axis of the rod in the normal driving condition the stopper and bearing bracket are not to come into contact with each other and do not do so if the rod

is in the straight line orientation, but would do so in a swivelled position because of the length of the stopper and the length of the bearing bracket, the recess according to the invention can easily be placed where the stopper would contact the bearing bracket in the swivelled position. This would lead to a design, where upon application of a force larger than the given level, stopper and bearing bracket could interact to create a rectifying momentum (the larger force would bring them into contact at lower swivel angles), but at force levels of the given level or below, the rod can swivel about larger angles without creating a rectifying moment. Thus conditions can for example take place, if a train enters into a curve while braking (= application of force along the longitudinal axis of the rod) and driving along the curve makes the rod swivel relative to the bearing bracket.

**[0023]** The design of Fig. 5 of the EP 1 925 523 B1 differs from the invention. In the upper part of Fig. 5, the bearing bracket is shown to have a recess. However, the surface section of the bearing bracket that comes into contact with the surface section of the stopper in this embodiment is provided at the bottom of the recess. The surface sections of the bearing bracket that are higher up than the bottom of the recess cannot come into contact with the respective surface section of the stopper. They only come into contact with the elastic element in form of the ring-shaped rubber element ("Federplattendämpfungselement 6"). The recess in the bearing plate shown in the upper part of Fig. 5 terminates at a further edge. The connection device shown in this Fig. 5 is, however, designed in such a manner that the respective surface section of the stopper that comes into contact with the surface section of the bearing bracket and the bottom of the recess in the first driving condition cannot move past the bottom of the recess and cannot move clear of the edge at the end of the recess. Thus, in any position that the end section can take relative to the bearing bracket as it pivots upwards about the pivot axis in Fig. 5 of EP 1 925 523 B1, the surface section of the stopper will come into contact with the surface section of the bearing bracket at the bottom of the recess.

**[0024]** As described above, the force to be applied along the longitudinal axis of the end section of the coupler rod or connection rod necessary to move the surface section of the stopper past the surface section of the bearing bracket is determined by the choice of the elasticity of the elastic element.

**[0025]** In a preferred embodiment, the connection device is designed in such a manner that for a first group of driving conditions, which group is defined by a first set of pivot angles between the longitudinal axis of the end section of the coupler rod or connection rod, the surface section of the stopper comes into contact with the surface section of the bearing bracket, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element. In a preferred embodiment, a normal driving condition is defined and pivot angles are understood to be the angles

that the longitudinal axis of the end section of the coupler rod or connection rod in the respective driving condition deviates from the orientation of the longitudinal axis of the end section of the coupler rod or connection rod in the normal driving condition. In a preferred embodiment, in the normal driving condition, the longitudinal axis of the end section of the coupler rod or connection rod is at 90° to bearing bracket. In a preferred embodiment, the above mentioned first set of pivot angles is the set of pivot angles between a minimum pivot angle and a maximum pivot angle. The minimum pivot angle preferably is 0° which means that the first set of pivot angles also includes the normal driving condition. This means nothing else than that the surface sections on the stopper and on the bearing bracket are such arranged and of such extend that also in the normal driving condition the surface section of the stopper and the surface section of the bearing bracket come into contact, if a force is applied along the longitudinal axis of the end section that suitably compresses the elastic element. In a preferred embodiment, the maximum angle of the first set of pivot angles is 20°, preferably 15°, even more preferred 10°.

**[0026]** In a preferred embodiment, in the second driving condition the pivot angle between the longitudinal axis and the end section of the coupler rod or connection rod is larger than any of the pivot angles of the first set. This means that for a first set of driving condition, where the end section has pivoted away from a normal driving condition only for a few degrees, the connection device according to the invention upon the application of force along the longitudinal axis leads to the surface section of the stopper coming into contact with the surface section of the bearing bracket and thus a rectifying momentum being created, while the connection device according to the invention in this preferred embodiment for larger angles either provides no rectifying momentum at all, because the surface section of the stopper moves past the surface section of the bearing bracket, or creates a rectifying momentum by providing other surfaces of the stopper and the bearing bracket that can interact in that second driving condition (whereby one of the surface sections can be the one of those surface sections that interact in the first driving condition and is simply paired to another surface section compared to the surface section used for contact in the first driving condition on its counterpart).

**[0027]** In a preferred embodiment the connection device according to the invention the stopper has a further surface section, such that in the second driving condition the further surface section of the stopper comes into contact with the surface section of the bearing bracket, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element. In a further development of this embodiment or in an alternative embodiment the bearing bracket has a further surface section, such that in the second driving condition the further surface section of the bearing bracket comes into contact with the surface section of the stopper, if the application of force along the longitu-

dinal axis of the end section of the connection rod or coupler rod deforms the elastic element. This design allows for a stepwise approach, where the end section is allowed to swivel freely about the pivot axis through the angles of the second driving condition without any surface of the stopper making contact with a surface of the bearing bracket, if no force is applied along the longitudinal axis of the end section, but to allow for a rectifying momentum to be created, if a force is applied along the longitudinal axis of the end section and the respective surface of the stopper provided for this driving condition comes into contact with the respective surface of the bearing bracket provided for this driving condition, while for a different driving condition a different pair of surfaces is provided to create the rectifying moment.

**[0028]** In a preferred embodiment a neighbouring surface section of the stopper that neighbours the surface section of the stopper that in the first driving condition comes into contact with the surface section of the bearing bracket, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element, in a cross section perpendicular to the pivot axis has a curved contour. Preferably the neighbouring surface has the shape of a surface section of a sphere. This allows for three-dimensional pivot movements of the rod relative to the bearing bracket. Alternatively the neighbouring surface can be a flat surface that is slanted relative to a plane perpendicular to the longitudinal axis of the rod. This facilitates the stopper to glide along the bearing bracket. In a further development of this embodiment or as an alternative, a neighbouring surface section of the bearing bracket that neighbours the surface section of the bearing bracket that in the first driving condition comes into contact with the surface section of the stopper, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element, in a cross section perpendicular to the pivot axis has a curved contour. Preferably the neighbouring surface has the shape of a surface section of a sphere. This allows for three-dimensional pivot movements of the rod relative to the bearing bracket. This allows for three-dimensional pivot movements of the rod relative to the bearing bracket. Alternatively the neighbouring surface can be a flat surface that is slanted relative to a plane perpendicular to the longitudinal axis of the rod.

**[0029]** In a preferred embodiment the end section of coupler rod or connection rod has a position relative to the bearing bracket that is intended for straight line travel of the multi-car vehicle along a flat plane and in that in this driving condition in a cross section perpendicular to the pivot axis, the shortest distance between a line parallel to the longitudinal axis of the end section of the coupler rod or connection rod and offset relative to the longitudinal axis of the end section of the coupler rod or connection rod in the direction of the pivot axis and the point of transition from the surface section of the bearing bracket to the neighbouring surface section of the bearing

bracket is larger than 110mm, preferably larger than 120mm and even more preferred larger than 130mm and preferably equal to 150mm. In this embodiment the surface sections that come into contact would also be offset from the longitudinal axis in the direction of the pivot axis. The larger the distance, the larger the rectifying moment that is created. Especially preferred, this distance is smaller than 250mm, especially preferred smaller than 200mm and especially preferred smaller than 170mm. This leads to an embodiment that can be easily arranged in the underframe of a normal car of a train without the need to substantially re-design the underframe of the car.

**[0030]** In a preferred embodiment the surface section of the stopper that in the first driving condition comes into contact with the surface section of the bearing bracket, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element, in a cross section perpendicular to the pivot axis has the contour of a straight line. In a further development of this embodiment or as an alternative the surface section of the bearing bracket that in the first driving condition comes into contact with the surface section of the stopper, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element, in a cross section perpendicular to the pivot axis can have the contour of a straight line. Providing the surfaces with essentially plane surface geometries ensures that the surface meet each other in the desired driving condition, because the area of possible contact is increased. The surface can be orientated in a plane parallel to the pivot axis. The surfaces can be orientated in a vertical plane. The surfaces can also be orientated in a plane at an angle to the pivot axis.

**[0031]** In a preferred embodiment the end section passes through the bearing bracket. Alternatives are feasible, where the end section terminates at the bearing bracket. This will reduce the length of the connection device according to the invention and minimizes the room that needs to be provided for the connection device on the car. However, passing the end section through the bearing bracket allows for additional elastic elements to be provided that dampen pulling forces that act along the longitudinal axis of the connection rod or coupler rod. Such elastic elements can be provided between an end plate of the end section and the bearing bracket. In a preferred embodiment, the end of the end section is arranged on one side of the bearing bracket and the stopper is arranged on the opposite side of the bearing bracket.

**[0032]** The connection device according to the invention is preferably used to connect a car of a multi-car vehicle with a neighbouring car.

**[0033]** The multi-car vehicle according to the invention has a connection device according to the invention that connects on car of the multi-car vehicle to a neighbouring car. The multi-car vehicle can be of different designs and in different forms of adaptation for uses. The multi-car vehicle, for example, can be a railway-bound train (street-

cars and subway-trains also being considered as such trains), which can be used for transporting passengers as well as adapted for transporting goods. Further possible types of the multi-car vehicle according to the invention can be magnetic railway trains or can be busses (road busses as well as busses traveling on fixed tracks). A car of a multi-car vehicle can be a self-supporting car, whereby the car has sufficient wheels that are placed at sufficient locations such that the car can stand by itself without being supported by other cars, for example a three-wheeled car, a four-wheeled car or a car with even more wheels placed at suitable locations. A car of a multi-car vehicle can also be of the non-self-supporting type, whereby the car has no wheels or only wheels provided in such number or arranged at such a place that the car cannot stand by itself but is vertically supported by at least one neighbouring car. To form the multi-car vehicle, the individual cars of the vehicle are connected to one another by means of a connection device. The connection device can be provided for different types of purposes. In multi-car vehicles where only one or only several of the total of cars is driven, the connection devices are provided so that the driven car can drive a non-driven car and thus ensure that the complete vehicle travels with the same speed. Connection devices are also distinguished between those connecting devices that allow for easy decoupling of the cars, whereby easy decoupling is understood to be accomplished within a couple of minutes or for what is called "semi-permanent" coupling of the cars, for which decoupling of the cars takes efforts and usually involves the vehicle to have been transported to a specific workshop. Trains, for example, can have coupler-heads as part of their connection devices. These coupler-heads can, for example be so called "automatic couplers" that allow decoupling within minutes.

**[0034]** The invention will now be explained with reference to Fig. that only show exemplary embodiments. In the Fig.

**Fig. 1** shows a perspective, schematic view of a connection device according to the invention in a normal driving condition as seen from a first view point;

**Fig. 2** shows a perspective, schematic view of the connection device of Fig. 1 in a normal driving condition as seen from a second view point;

**Fig. 3** shows a top view from above onto the connection device of Fig. 1 in a normal driving condition;

**Fig. 4** shows the top view from above onto the connection device of Fig. 3 in a normal driving condition when a force has been applied along the longitudinal axis of the end section of the rod;

**Fig. 5** shows a sectional view of the connection device of Fig. 3 along the line A-A in Fig. 3;

**Fig. 6** shows a sectional view of the connection device of Fig. 4 along the line A-A in Fig. 4;

**Fig. 7** shows a top view from above onto the connection device of Fig. 3 in different driving condition to the normal driving condition;

**Fig. 8** shows the top view from above onto the connection device of Fig. 3 in different driving condition to the normal driving condition when a force has been applied along the longitudinal axis of the end section of the rod;

**Fig. 9** shows a top view from above onto the connection device of Fig. 3 in yet a different driving condition to the normal driving condition and

**Fig. 10** shows the top view from above onto the connection device of Fig. 3 in yet a different driving condition to the normal driving condition when a force has been applied along the longitudinal axis of the end section of the rod.

**[0035]** The connection device 1 shown in Fig. 1 has a bearing bracket 2 that can be connected to a car of a multi-car vehicle. The connection device 1 also has an end section 3 of a rod 4. Depending on which type of multi-car vehicle the connection device 1 is used for, the rod 4 can be a coupler rod with a coupler head (not shown) being connected to the free end (not shown) of the rod 4. Equally as good the rod 4 can be a connection rod with the free end (not shown) of the rod 4 being connected to a neighbouring car (not shown) of the multi-car vehicle, possibly by a further connection device according to the invention.

**[0036]** The end section 3 is pivotably connected to the bearing bracket 2 in such a manner that the end section 3 can pivot relative to the bearing bracket 2 about a pivot axis C-C that is perpendicular to the longitudinal axis B-B of the end section 3. The pivotable connection is obtained by the end section 3 passing through a hole in the bearing bracket 2, the hole being surrounded by chamfered surfaces 20 (see Fig. 5 and 6) that allow for the swivel movement. The end section 3 can not only pivot about the pivot axis C-C, but any other pivot axis that intersects the pivot axis A-A and is in the plane perpendicular to the longitudinal axis B-B. This is provided for by the chamfered surfaces 20 essentially providing a truncated cone-shaped surface with the hole in the bearing bracket being the top.

**[0037]** The connection device 1 has a stopper 5. The end section 3 extends from the end 6 of the end section 3 through the bearing plate to the stopper 5. The stopper is a separate piece to the end section 3, but fixedly connected to the end section 3 (see Fig. 5 and 6). The stopper 5 is made up of two vertically extending brackets 7 and two horizontally extending brackets 8.

**[0038]** In the space between the stopper 5 and the bearing bracket 2 an elastic element 21 is arranged that is a donut shaped rubber element. The size of the elastic element 21 and the rigidity of the elastic element keeps the end section 3 (and thus the stopper 5 fixedly connected to the end section 3) distanced from the bearing bracket 2 in the manner shown in Fig. 1. Upon application

of force along the longitudinal axis B-B of the end section 3 the elastic element 21 is compressed. This allows the stopper 5 to move closer towards the bearing bracket 2. If the force of a predetermined strength is applied along the longitudinal axis B-B of the end section 3, the stopper 5 comes into contact with the bearing bracket 2 (see Fig. 4, Fig. 6, Fig. 8, Fig. 10). In the driving condition shown in Fig. 1, 2, 3, 4, 5, 6, which is the driving condition intended for the multi-car vehicle to travel along a straight line on a flat plane (normal driving condition) and thus defines the position of the end section 3 relative to the bearing bracket 2 for this normal driving condition, the brackets 8 come into contact with brackets 9 of the bearing bracket 2. More precisely, a surface section 10 of the stopper 5 comes into contact with a surface section 11 of the bearing bracket 2.

**[0039]** As can be seen in Fig. 1, the surface section 10 of the stopper 5 in a cross section perpendicular to the pivot axis C-C has the contour of a straight line. Likewise the surface section 11 of the bearing bracket 2 in a cross section perpendicular to the pivot axis C-C has the contour of a straight line. Due to the extend of the surface section 10 and the surface section 11 provided by their straight line cross-section, parts of a surface section 10 come into contact with parts of a surface section 11 even for driving conditions where the end section 3 has pivoted about the pivot axis C-C for predetermined angles, preferably small angles (see Fig. 7,8). Thus, for a first group of driving conditions, which group is defined by a first set of pivot angles between the longitudinal axis B-B of the end section and the bearing bracket 2 that deviate from the 90° condition (normal driving condition shown in Fig. 1) the surface section 10 of the stopper 5 comes into contact with the surface section 11 of the bearing bracket 2, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element. If the end section 3 pivots counterclockwise in the view shown in Fig. 2, the surface sections 10 arranged towards the right of the longitudinal axis B-B in Fig. 2 will come into contact with the surface sections 11 arranged on the right of the longitudinal axis B-B (see Fig. 7, 8). If the end section 3 pivots clockwise in the view shown in Fig. 2, the surface sections 10 arranged towards the left of the longitudinal axis B-B in Fig. 2 will come into contact with the surface sections 11 arranged on the left of the longitudinal axis B-B.

**[0040]** The stopper 5 has recesses 12. The recesses 12 are arranged such that in a second driving condition (see Fig. 9, 10) that is different from the first driving conditions (Fig. 1 to 8) in that the end section 3 has a second position relative to the bearing bracket 2, the surface section 10 of the stopper 5 moves passed the surface section 11 of the bearing bracket 2, if a force along the longitudinal axis B-B of the end section 2 and the elastic element is deformed. In the second driving condition, the pivot angles between the longitudinal axis B-B of the end section and the bearing bracket 2 that deviate from the 90° condition (normal driving condition shown in Fig.1) are

larger than the pivot angles of the first driving conditions (Fig. 1 to 8). If the end section 3 pivots about the pivot axis B-B about a larger degree such that (when seen in direction of the longitudinal axis B-B) the recess 12 comes into alignment with the surface section 11 of the bearing bracket 2 and if in this driving condition a longitudinal force is applied along the longitudinal axis B-B, the surface section 11 will be taken up by the recess 12 and the surface section 10 of the stopper 5 will pass the surface section 11 (compare Fig. 9 to Fig. 10).

**[0041]** A neighbouring surface section 13 of the bearing bracket 2 that neighbours the surface section 11 of the bearing bracket 2 in a cross section perpendicular to the pivot axis C-C has a curved contour. This facilitates the movement of the surface section 10 past the surface section 11. The neighbouring surface section 13 will come into contact with one of the walls 14 that delimit the recess 12.

**[0042]** In the normal driving condition shown in Fig. 1 to 6 in a cross section perpendicular to the pivot axis C-C, the shortest distance C between a line parallel to the longitudinal axis B-B of the end section 3 and offset relative to the longitudinal axis B-B in the direction of the pivot axis C-C and the point 15 of transition from the surface section 11 of the bearing bracket 2 to the neighbouring surface section 13 of the bearing bracket 2 is larger than 110mm, namely 150mm.

**[0043]** In the driving conditions that belong to the first group of driving conditions (each of these driving conditions being what is also referred to as "a first driving condition" in this description) at least one of the surface sections 10 of the stopper 5 comes into contact with at least one of the surface sections 11 of the bearing bracket 2, if the application of force along the longitudinal axis B-B of the end section 3 deforms the elastic element (Fig. 4, 6, 8). If upon contact the force is continued to be applied, a rectifying momentum is generated that is directed to move the end section 3 back towards the normal driving condition. The rectifying momentum can be about the pivot axis C-C, if the end section 3 has only pivoted about the pivot axis C-C. In such a driving condition, the two surface sections 10 arranged on one side of the plane that contains the pivot axis C-C and the longitudinal axis B-B will come into contact with the two surface sections 11 arranged on the same side of this plane. Driving conditions are also feasible, where the end section pivots about the pivot axis C-C and about a further axis in the plane perpendicular to the longitudinal axis B-B that contains the pivot axis C-C. In such a driving condition it is possible that only one surface section 10 comes into contact with one surface section 11, for example the ones arranged in the top right quadrant. In such a driving condition, a rectifying moment about the pivot axis C-C and a rectifying momentum about an axis perpendicular to the pivot axis C-C and perpendicular to the longitudinal axis B-B would be created.

**[0044]** In a driving condition, where the end section 3 has pivoted about the pivot axis C-C for more than the

angles that form the first group, the surface 10 will move past the surface 11 (Fig. 9, 10) and thus no rectifying momentum will be created. The connection device according to the invention thus prevents a rectifying momentum to be created by the interaction of the surface section 10 and the surface section 11 in driving conditions with larger pivot angles and thus allows the multi-car vehicle to move around bends with small radius of curvature while at the same time providing for a substantial distance C that will lead to a rectifying momentum of a substantial size being created for the driving conditions with smaller pivot angles.

## Claims

1. Connection device (1) suitable to connect a coupler rod or a connection rod to a car of a multi-car vehicle, whereby the connection device has

- a bearing bracket (2),
- an end section (3) of a coupler rod or a connection rod, whereby the end section (3) is pivotably connected to the bearing bracket (2) in such a manner that the end section (3) can pivot relative to the bearing bracket (2) about a pivot axis (C-C) that is perpendicular to the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod,
- a stopper (5) fixedly or pivotably connected to the end section (3),
- an elastic element, whereby upon application of force along the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod the elastic element is compressed, whereby in a first driving condition, which is defined by a first position of the end section (3) relative to the bearing bracket (2), a surface section (10) of the stopper (5) comes into contact with a surface section (11) of the bearing bracket (2), if the application of force along the longitudinal axis (B-B) of the end section (3) of the connection rod or coupler rod deforms the elastic element,

**characterized in that**

the bearing bracket (2) and/or the stopper (5) has a recess (12) such that in a second driving condition that is different from the first driving condition **in that** the end section (3) has a second position relative to the bearing bracket (2), the surface section (10) of the stopper (5) has passed the surface section (11) of the bearing bracket (2).

2. Connection device according to claim 1, **characterized in that** for a first group of driving conditions, which group is defined by a first set of pivot angles between the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod, the surface

section (10) of the stopper (5) comes into contact with the surface section (11) of the bearing bracket (2), if the application of force along the longitudinal axis (B-B) of the end section (3) of the connection rod or coupler rod deforms the elastic element.

3. Connection device according to claim 2, **characterized in that** in the second driving condition the pivot angle between the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod is larger than any of the pivot angles of the first set.
4. Connection device according to any one of claims 1 to 3, **characterized in that** the stopper has a further surface section, such that in the second driving condition the further surface section of the stopper comes into contact with the surface section of the bearing bracket and/or **in that** the bearing bracket has a further surface section, such that in the second driving condition the further surface section of the bearing bracket comes into contact with that surface section of the stopper that would come into contact with the bearing bracket in the first driving condition, if the application of force along the longitudinal axis of the end section of the connection rod or coupler rod deforms the elastic element.
5. Connection device according to any one of claims 1 to 4, **characterized in that** a neighbouring surface section of the stopper that neighbours the surface section of the stopper that in the first driving condition comes into contact with the surface section of the bearing bracket has a curved contour and/or **in that** a neighbouring surface section (13) of the bearing bracket (2) that neighbours the surface section (11) of the bearing bracket (2) that in the first driving condition comes into contact with the surface section (10) of the stopper (5) has a curved contour.
6. Connection device according to claim 5, **characterized by** a normal driving condition in which the end section (3) coupler rod or connection rod takes a position relative to the bearing bracket (2) that is intended for straight line travel of the multi-car vehicle on a flat plane and in that in this normal driving condition in a cross section perpendicular to the pivot axis (C-C), the shortest distance (C) between a line parallel to the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod and offset relative to the longitudinal axis (B-B) of the end section (3) of the coupler rod or connection rod in the direction of the pivot axis (C-C) and the point (15) of transition from the surface section (11) of the bearing bracket (2) to the neighbouring surface section (13) of the bearing bracket (2) is larger than 110mm.
7. Connection device according to any one of claims 1 to 6, **characterized in that** the surface section (10)

of the stopper (5) that in the first driving condition comes into contact with the surface section (11) of the bearing bracket (2), if the application of force along the longitudinal axis (B-B) of the end section (3) of the connection rod or coupler rod deforms the elastic element, in a cross section perpendicular to the pivot axis (C-C) has the contour of a straight line and/or **in that** the surface section (11) of the bearing bracket (2) that in the first driving condition comes into contact with the surface section (10) of the stopper (5), if the application of force along the longitudinal axis (B-B) of the end section of the connection rod or coupler rod deforms the elastic element, in a cross section perpendicular to the pivot axis (C-C) has the contour of a straight line.

8. Connection device according to any one of claims 1 to 7, **characterized in that** the end section (3) passes through the bearing bracket (2) and **in that** the end (6) of the end section (3) is arranged on one side of the bearing bracket (2) and **in that** the stopper (5) is arranged on the opposite side of the bearing bracket (2).
9. Use of a connection device according to any one of claims 1 to 8 in a multi-car vehicle.
10. Multi-car vehicle with a connection device according to any one of claims 1 to 8, whereby a first car of the multi-car vehicle is connected to a neighbouring car of the multi-car vehicle by means of the connection device.

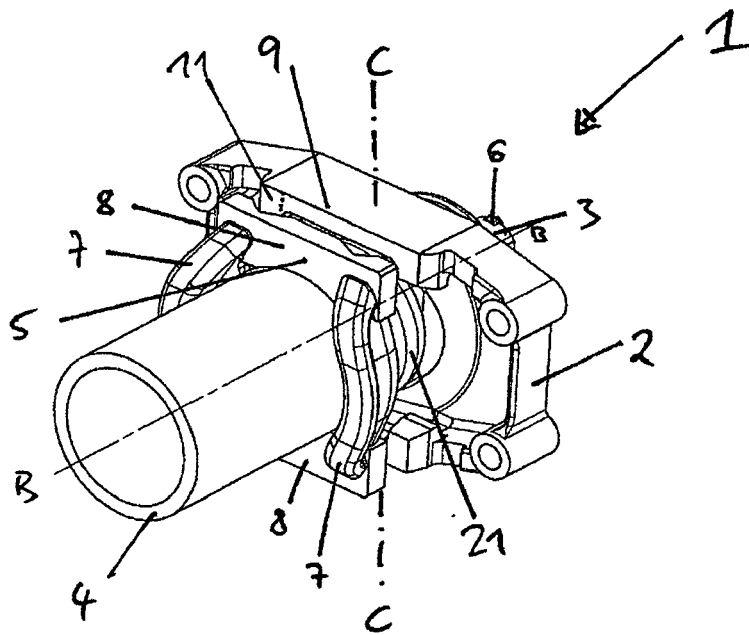
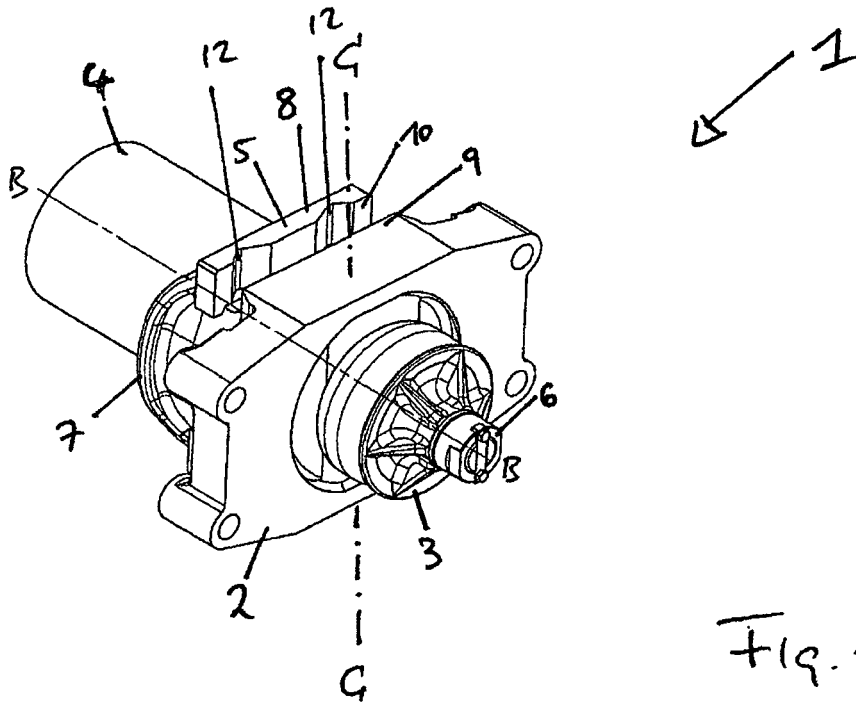
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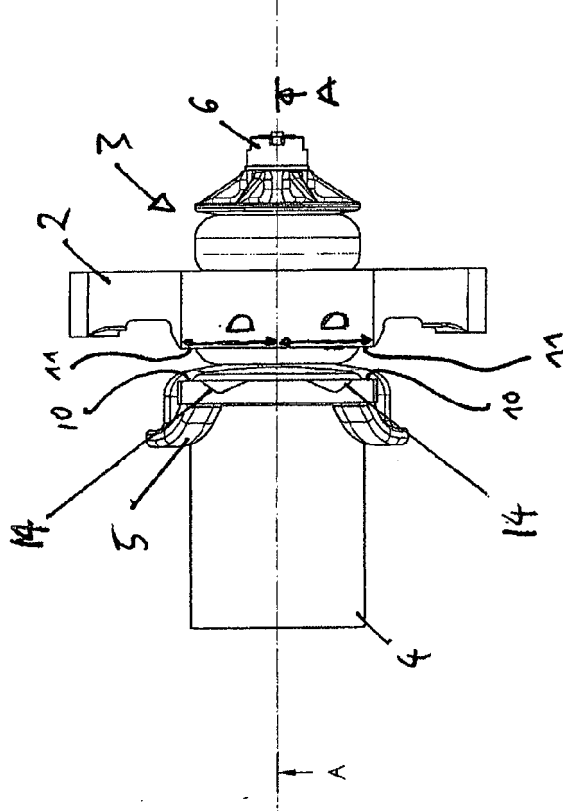
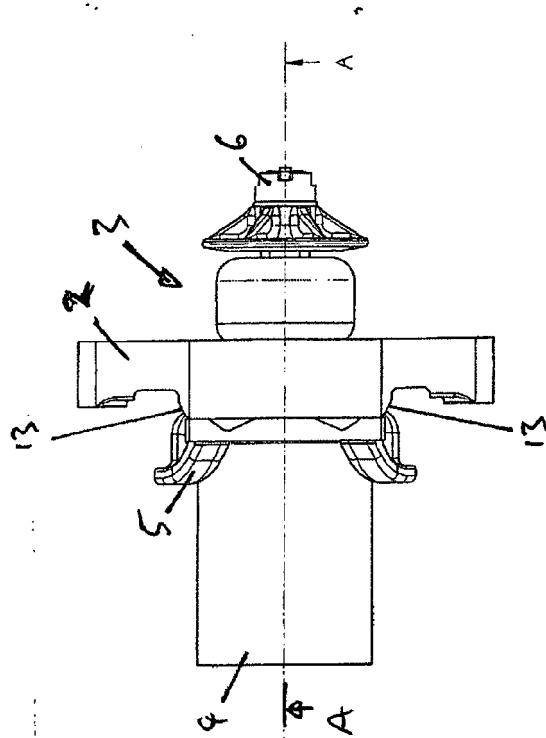
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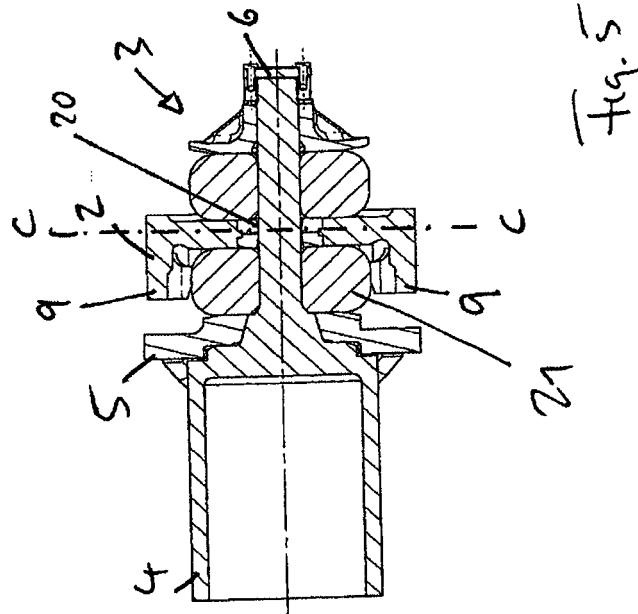
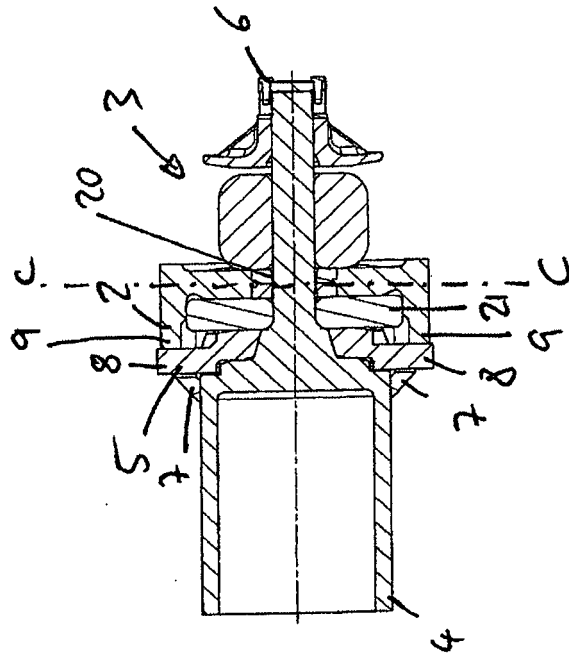
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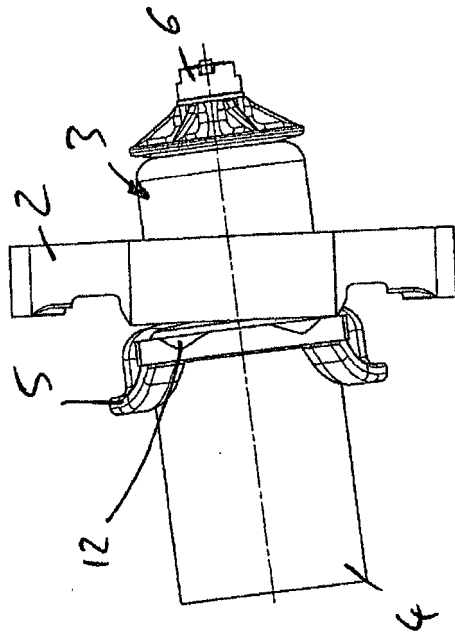


Fig. 8

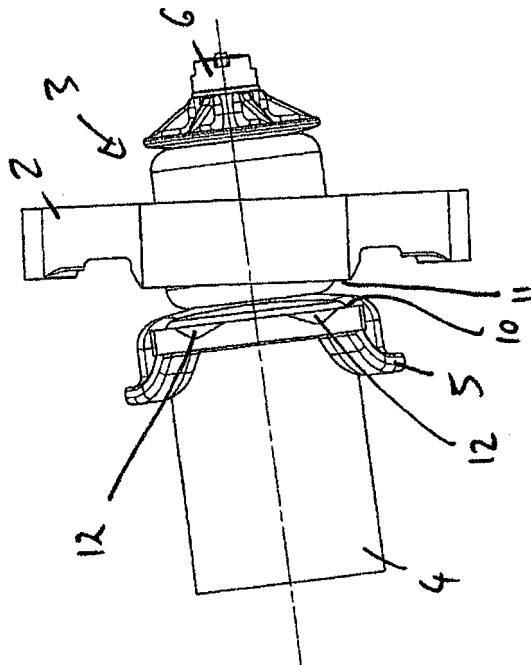


Fig. 7

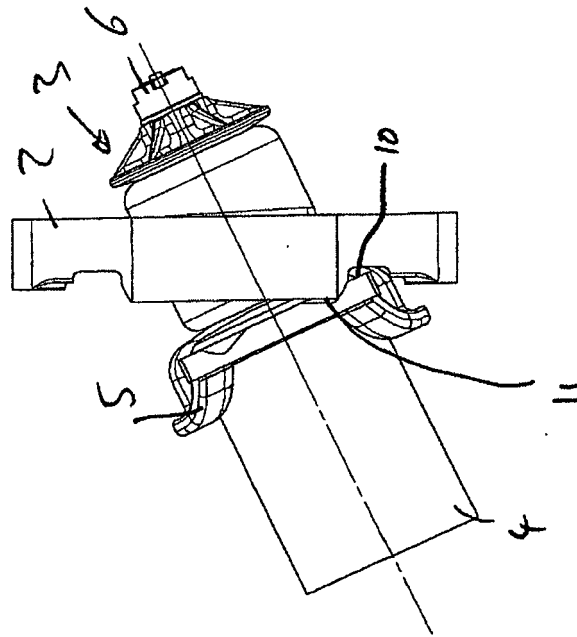


Fig. 10

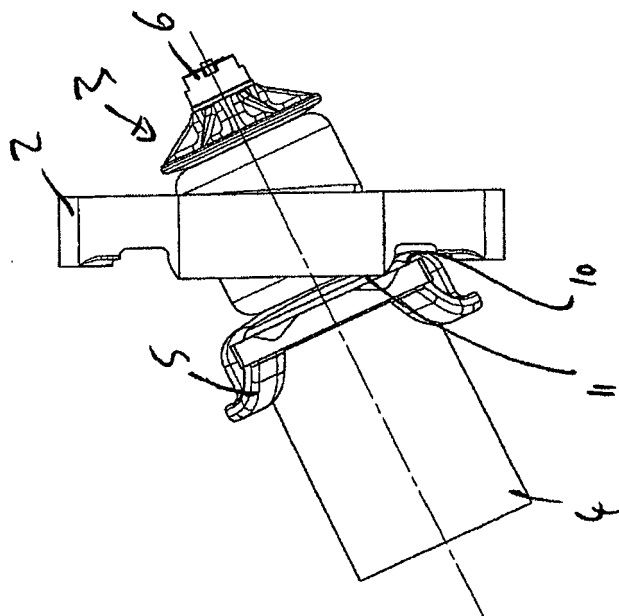


Fig. 9



## EUROPEAN SEARCH REPORT

 Application Number  
EP 14 00 3426

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                   |                                                   |                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                     | Relevant to claim                                 | CLASSIFICATION OF THE APPLICATION (IPC) |
| X,D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | EP 1 407 953 B1 (BARTEL MANFRED [DE])<br>17 September 2008 (2008-09-17)<br>* the whole document * | 1-10                                              | INV.<br>B61G9/06<br>B61G9/24            |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | WO 2013/087208 A1 (EGO INTERNAT B V [NL])<br>20 June 2013 (2013-06-20)<br>* the whole document *  | 1-10                                              |                                         |
| A,D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | DE 10 2008 030284 B4 (SIEMENS AG [DE])<br>7 April 2011 (2011-04-07)<br>* the whole document *     | 1-10                                              |                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 2 113 542 A (DEAN ALBERT G)<br>5 April 1938 (1938-04-05)<br>* the whole document *             | 1-10                                              |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                   |                                                   | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                   |                                                   | B61G                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |                                                   |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   | Date of completion of the search<br>11 March 2015 | Examiner<br>Awad, Philippe              |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                   |                                                   |                                         |

EPO FORM 1503 03/02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 00 3426

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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11-03-2015

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                       | Publication<br>date                                                              |
|-------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| EP 1407953 B1                             | 17-09-2008          | DE 10246428 A1<br>EP 1407953 A1                                                                                  | 22-04-2004<br>14-04-2004                                                         |
| -----                                     | -----               | -----                                                                                                            | -----                                                                            |
| WO 2013087208 A1                          | 20-06-2013          | WO 2013087206 A1<br>WO 2013087207 A1<br>WO 2013087208 A1                                                         | 20-06-2013<br>20-06-2013<br>20-06-2013                                           |
| -----                                     | -----               | -----                                                                                                            | -----                                                                            |
| DE 102008030284 B4                        | 07-04-2011          | CN 102076546 A<br>DE 102008030284 A1<br>EP 2300298 A1<br>RU 2011103206 A<br>US 2011094988 A1<br>WO 2010000566 A1 | 25-05-2011<br>31-12-2009<br>30-03-2011<br>10-08-2012<br>28-04-2011<br>07-01-2010 |
| -----                                     | -----               | -----                                                                                                            | -----                                                                            |
| US 2113542 A                              | 05-04-1938          | NONE                                                                                                             |                                                                                  |
| -----                                     | -----               | -----                                                                                                            | -----                                                                            |

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- DE 102008030284 B4 [0002] [0015] [0017]
- EP 1407953 B1 [0002] [0003] [0011] [0012] [0015]
- EP 1312527 B1 [0012]
- EP 1925523 B1 [0016] [0017] [0019] [0023]