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(54) **Running gear unit with adjustable wheel contact force**

(57) The present invention relates to a running gear unit for a rail vehicle, comprising at least one wheel unit (103.1, 103.2) and a magnetic circuit device (111) for a magnetic circuit arrangement (112), the at least one wheel unit (103.1, 103.2) being configured to contact a part of a rail (110.1) of a track to be travelled on with a contact force acting between the at least one wheel unit (103.1, 103.2) and the rail (110.1). The magnetic circuit arrangement (112) has an activated state and a deactivated state. The magnetic circuit device (111) is configured to participate in generating, in the activated state, a magnetic flux in a magnetic circuit (113; 213) of the magnetic circuit arrangement (112) to increase the contact force compared to the deactivated state. The magnetic circuit device (111) is configured such that at least a part of the at least one wheel unit (103.1, 103.2) and the part of the rail (110.1) contacted by the at least one wheel unit (103.1, 103.2), at least in the activated state, forms a part of the magnetic circuit (113).

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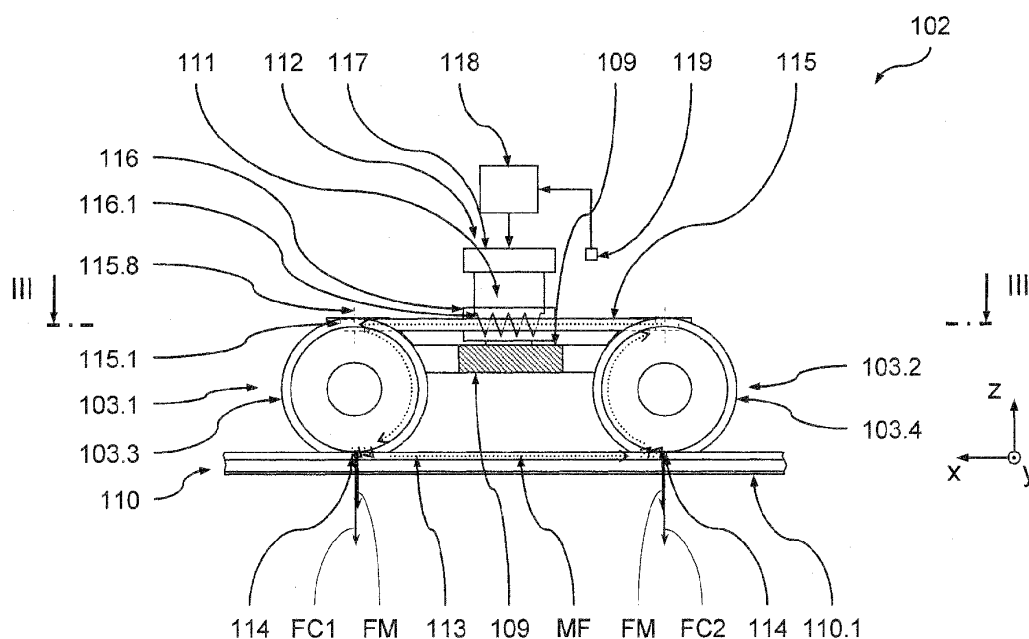


Fig. 2

Description

[0001] The present invention relates to a running gear unit for a rail vehicle, comprising at least one wheel unit and a magnetic circuit device for a magnetic circuit arrangement, the at least one wheel unit being configured to contact a part of a rail of a track to be travelled on with a contact force acting between the at least one wheel and the rail. The magnetic circuit arrangement has an activated state and a deactivated state, the magnetic circuit device being configured to participate in generating, in the activated state, a magnetic flux in a magnetic circuit of the magnetic circuit arrangement to increase the contact force compared to the deactivated state. The present invention further relates to a rail vehicle comprising such a running gear unit as well as to a corresponding method of adjusting a contact force acting between a wheel of a wheel unit and a part of a rail of a track to be travelled on.

[0002] In many situations during operation of a rail vehicle, in particular under certain environmental conditions (such as rain or snow), a generally lubricating substance gets caught between a wheel of the vehicle's running gear and the associated rail of the track currently travelled. In these situations (in order to achieve transmission of a given traction moment or braking moment) there is a general need to compensate for the reduction in the coefficient of friction present between the rail and the wheel due to the lubricating substance.

[0003] Known rail vehicles use different approaches in order to deal with this problem, i.e. to minimize the loss in power transmission via the wheel to rail contact. One approach is to optimize moment transmission (during traction and/or braking) using a control which tries to largely avoid slip between the wheel and the rail at the contact location in order to be able to take advantage of the generally higher coefficient of static friction (compared to the generally lower coefficient of kinetic friction). However, such an approach, obviously, is bound to the limitations set by the actual contact situation.

[0004] Another approach used in known braking systems is the implementation of wheel to rail adhesion independent brake systems such as magnetic track brakes, eddy current brakes, etc. However, obviously, such systems are unsuitable for compensating for the loss in traction power transmission.

[0005] Another approach is to influence the coefficient of friction present between the rail and the wheel. For example, widely used so called sanding devices apply a friction enhancing material (typically sand or the like) to the rail slightly ahead of the wheel. Such an approach, however, has the disadvantage that wear of both the wheel and the rail is increased to a certain extent which, obviously, is generally undesirable.

[0006] A further approach is to increase the contact force between the rail and the wheel to compensate for the loss in power transmission due to the reduction in the coefficient of friction present between the rail and the wheel. A straightforward variant of this approach is to

increase the axle load of the driven wheel units of the vehicle (up to the maximum axle load allowed by the infrastructure), if needed even by adding ballast. Nevertheless, obviously, heavier vehicles have apparent disadvantages in terms of cost, energy consumption and wear of the whole system (vehicle and track components).

[0007] A further approach is known from generic running gear units such as described in DE 20 12 388 A1, DE 199 40 046 A1 and EP 1 048 542 A2. Here, magnetic circuit devices (in a manner similar to conventional magnetic track brakes) are mounted between two wheel units of the running gear and are spatially closely associated to the rail to achieve a certain magnetic flux in the part of the rail adjacent to the magnetic circuit device. Magnetic attraction forces acting between the magnetic circuit device and the rail are, in some cases selectively, used in order to increase the contact force. These magnetic attraction forces result from the fact that a magnetic circuit strives to reduce its magnetic resistance by closing any air gaps in the magnetic circuit, such as gaps between the magnetic circuit device and the adjacent rail.

[0008] All these known systems, however, have the disadvantage that they increase the mass and construction effort due to the comparatively complex support structure necessary for placing the magnetic circuit device close to the rails. Moreover, some of them require additional actuators to actively move components of the system. Furthermore, the magnetic attraction forces are generated at a location situated (typically halfway) between the wheel to rail contact points of the adjacent wheel units, thereby generating considerable bending loads, both on the rail and the running gear unit.

[0009] Apart from proper transmission of traction and braking moments, a defined and sufficiently large contact force is also required in the context of derailment safety of the vehicle. For example, unfavorable load distributions over the vehicle (e.g. due internal static and dynamic factors but also due to external factors, such as wind loads) may lead to an undesired reduction of the contact force between individual wheels and the rail, which greatly increases the risk of derailment.

SUMMARY OF THE INVENTION

[0010] Thus, it is the object of the present invention to provide a rail running gear unit as described above, which does not show the disadvantages described above, or at least shows them to a lesser extent, and which, in particular, facilitates a simpler and lighter configuration with reduced bending loads on the running gear and the track.

[0011] The above objects are achieved starting from a running gear unit according to the preamble of claim 1 by the features of the characterizing part of claim 1. The above objects are also achieved starting from a method according to the preamble of claim 12 by the features of the characterizing part of claim 12.

[0012] The present invention is based on the technical teaching that a simpler and lighter configuration with reduced bending loads on the running gear and the track can be accomplished, if a part of the wheel contacting the track is integrated into the magnetic circuit such that the magnetic attraction forces enhancing the contact force between the wheel and the rail are produced at and in the vicinity of the wheel to rail contact area.

[0013] This has the great advantage that a simpler design of the magnetic circuit device and its support may be achieved since the magnetic circuit device does not have to be placed in close proximity to the rail. Hence, design freedom is greatly increased. Furthermore, additional bending loads (on the rail as well as on the running gear unit) due to a lever arm between the magnetic attraction force and the wheel to rail contact area are at least largely avoided.

[0014] Hence, according to one aspect, the present invention relates to a running gear unit for a rail vehicle, comprising at least one wheel unit and a magnetic circuit device for a magnetic circuit arrangement, the at least one wheel unit being configured to contact a part of a rail of a track to be travelled on with a contact force acting between the at least one wheel and the rail. The magnetic circuit arrangement has an activated state and a deactivated state, the magnetic circuit device being configured to participate in generating, in the activated state, a magnetic flux in a magnetic circuit of the magnetic circuit arrangement to increase the contact force compared to the deactivated state. The magnetic circuit device is configured such that at least a part of the at least one wheel unit and the part of the rail contacted by the at least one wheel unit, at least in the activated state, each form a part of the magnetic circuit.

[0015] The magnetic circuit device may be of any design suitable for generating the magnetic flux in the activated state. Preferably, the magnetic circuit device comprises a magnetic core device, the magnetic core device, in the activated state, forming a part of the magnetic circuit. With such a magnetic core device a magnetic interface for an inductor device (comprising e.g. one or more electrical windings or the like surrounding the magnetic core device) may be realized in a particularly simple manner.

[0016] The magnetic core device may be arranged at any suitable and readily accessible location within the magnetic circuit. Preferably, the magnetic core device is configured and, in particular, spatially associated to the at least one wheel unit, such that, at least in the activated state, the magnetic core device and the at least one wheel unit form adjacent parts of the magnetic circuit. Hence, a particularly simple and compact configuration may be achieved.

[0017] It will be appreciated that a certain gap may be present between the magnetic core device and the wheel unit in the activated state. The gap preferably is as small as possible in order to keep the magnetic losses to a minimum. Preferably, the magnetic core device comprises

a contact unit, the contact unit being configured to contact, at least in the activated state, a part of the wheel unit largely reduce or avoid an air gap at this contact location.

[0018] The contact unit may be spatially associated to and, in particular, contact any desired part of the wheel unit readily available for forming such a magnetic interface. Such locations or components of the wheel unit may be, for example, a shaft or a bearing unit of the wheel unit. Preferably, a wheel of the wheel unit is used for this magnetic interface to keep the magnetic circuit as short as possible (thereby reducing magnetic losses as far as possible).

[0019] It will be further appreciated that any part of the wheel may be used for this magnetic interface. Preferably a lateral surface (i.e. a surface facing in a transverse direction of the running gear unit) of the wheel is used, since such lateral surfaces are particularly suitable for forming such a magnetic interface even under eventually varying steering angles of the wheel.

[0020] With certain embodiments of the invention, the magnetic core device may be a stationary component (i.e. a component that is substantially rigidly mounted to a support structure of the running gear unit, such as e.g. a running gear frame) without any movable elements or the like. To achieve the close spatial association between the magnetic core device and the wheel unit at the location of their magnetic interface in the activated state it is also possible, in principle, to move the entire core device, if necessary. However, preferably, only the contact unit is movable.

[0021] Preferably, the contact unit is configured and, in addition or as an alternative, articulated to a magnetic core element of the magnetic core device in such a manner that, in the deactivated state, the contact unit does not contact the wheel unit. This configuration has the advantage that wear of the magnetic interface may be minimized.

[0022] With advantageous embodiments of the invention, the contact unit comprises a resetting means, in particular, a spring element. The resetting means, at least in the deactivated state, exerts a resetting force on the contact unit, the resetting force, if not compensated by a counterforce, bringing the contact unit out of contact with the wheel unit. Hence, a very simple, wear minimizing configuration may be achieved.

[0023] Furthermore, preferably, the contact unit is configured and/or articulated to a magnetic core element of the magnetic core device in such a manner that, in the activated state, an actuation force is exerted on the contact unit, the actuation force, if not compensated by a counterforce, bringing the contact unit into contact with the wheel unit. It will be appreciated that the contact unit may be locked in position by suitable locking means once contact is established, such that the actuation force may only be necessary for establishing this contact.

[0024] The actuation force for bringing the contact unit into contact with the wheel unit may be generated by any

suitable means. For example, a separate actuator device may be provided (and triggered in the activated state) to move the contact unit accordingly whenever needed. Preferably, however, the actuation force is generated as a result of the magnetic flux in the magnetic circuit (i.e. through the magnetic attraction force acting between the wheel unit and the contact unit and resulting from the magnetic flux in the magnetic circuit), such that no additional actuator is needed.

[0025] Immediate contact between the contact unit and the wheel unit may be of any contact type. Hence, for example, a sliding contact may be provided between the contact unit and the wheel unit. Preferably, to minimize wear, a contact type including rolling relative motion is selected. Thus, with preferred embodiments of the invention, the contact unit comprises at least one contact element and a contact element holder rotatably holding the at least one contact element, the contact element, in the activated state, being in substantially rolling contact with the wheel unit. Obviously, depending on the actual contact situation, a combined rolling and sliding motion may be present at the contact location.

[0026] Typically, the running gear unit defines a longitudinal direction, a transverse direction and a height direction, while the contact element holder defines at least one axis of rotation of the at least one contact element. This axis of rotation may have any desired and suitable orientation in space. Preferably, the axis of rotation is oriented to minimize sliding motion at the contact location between the contact element and the wheel unit.

[0027] Preferably, the at least one axis of rotation is substantially parallel to the longitudinal direction or substantially parallel to the height direction since these two orientations allow particularly simple configurations taking into account relative motion between the running gear structure (supported on the wheel unit) and the wheel unit under normal operating conditions due to steering/yawing and/or tilting and/or pitching motions.

[0028] Preferably, the at least one axis of rotation, when running on a straight level track, extends through a virtual cylinder defined by a maximum diameter and a rolling axis of a wheel unit rolling axis device, in particular, a wheel unit shaft or a wheel unit axle. As a consequence of such an alignment, the at least one axis of rotation is located in close proximity to the rolling axis of the wheel unit, thereby minimizing sliding motion. Preferably, the at least one axis of rotation, when running on a straight level track, substantially intersects the rolling axis of the wheel unit.

[0029] Particularly favorable contact conditions may be achieved if the at least one axis of rotation, when running on a straight level track, is substantially parallel to a radial direction of a wheel of the wheel unit defined at a contact point of the contact element with the wheel.

[0030] As mentioned above, the contact unit may contact any part of the wheel unit. Preferably, the contact unit contacts a lateral surface of a wheel of the wheel unit, in particular a lateral surface of a wheel flange of

the wheel, since this allows particularly simple and low wear implementation of the contact.

[0031] The contact unit may be connected to the magnetic core device by any suitable means. For example, the contact unit may be connected to the magnetic core device via elastic elements, such as spring devices, e.g. leaf spring devices. These may be configured to form part of the magnetic circuit and to integrate the function of a resetting device moving and/or keeping the contact unit out of contact with the wheel unit in the deactivated state of the magnetic circuit device. Preferably, the contact unit is hinged to a magnetic core element of the magnetic core device and/or the contact unit is slidably mounted to a magnetic core element of the magnetic core device, both allowing particularly simple and robust configurations.

[0032] With certain preferred embodiments of the invention, the magnetic core device is configured and, in particular, spatially associated to the part of the rail (forming part of the magnetic circuit) such that, in the activated state, the magnetic core device and said part of the rail form adjacent parts of the magnetic circuit. By this means it is possible to associate a magnetic circuit device to individual wheels allowing individual control of the contact force at each single wheel. Preferably, the magnetic core device, in the activated state, contacts said part of the rail to keep the magnetic losses to a minimum at this location.

[0033] With other embodiments of the invention the running gear unit comprises a further wheel unit contacting the rail, the magnetic core device being configured and, in particular, spatially associated to the further wheel unit, such that, at least in the activated state, the magnetic core device and the further wheel unit form adjacent parts of the magnetic circuit. Such a solution is particularly simple to implement and allows control of the contact force acting at both wheels of the two adjacent wheel units forming part of the magnetic circuit. It will be appreciated that, with certain embodiments of the invention, the part of the magnetic circuit arrangement associated to the further wheel unit may be of a design that is substantially symmetric to the part associated to the wheel unit as described above.

[0034] The magnetic circuit device may be of any suitable design to generate an appropriate magnetic flux in the magnetic circuit. Preferably, the magnetic circuit device comprises at least one (electrically operated) inductor device configured to generate the magnetic flux in the magnetic circuit under control of a control device. Preferably, the at least one inductor device is associated to a magnetic core device of the magnetic circuit device, the at least one inductor device, in particular, comprising at least one electrical winding surrounding a part the magnetic core device. ;

[0035] The control device may be adapted to adjust the magnetic flux as function of at least one operational parameter of the running gear calculated and/or detected via at least one detection unit. This operational parameter

of the running gear unit may, for example, be an operational parameter providing information about the actual running state of the vehicle but it may also be a parameter providing information on the actual external loads on the vehicle, such as e.g. wind loads (in particular so called side wind or crosswind loads), having an influence on the actual contact force situation. Preferably, the at least one operational parameter is representative of an actual amount of the contact force and/or an actual slip between the wheel unit and the rail and/or an actual traction power to be transmitted between the rail and the wheel unit and/or the actual rotational speed of the wheel unit and/or the actual translational speed of the wheel unit.

[0036] It will be appreciated that at least some of the components forming part of the magnetic circuit are made from a material having low magnetic resistance. Generally, it is preferred to use a material that allows high magnetic field strength (so called B field) strength at low magnetization field (so called H field) strengths. Preferably, a material is used for some components forming part of the magnetic circuit, preferably substantially all components forming part of the magnetic core device, comprising a soft magnetic or ferromagnetic material, such as iron and/or electrical steels (iron alloys with up to 6.5% silicon) and/or cobalt iron alloys (FeCo).

[0037] With further preferred embodiments of the invention, the running gear unit comprises a control device, a first wheel and a second wheel, both the wheels contacting a rail of the track. The magnetic circuit device forms a first magnetic circuit device associated to the first wheel, while the running gear unit comprises a second magnetic circuit device associated to the second wheel, such that it is possible to individually control the contact forces of the two wheels. To this end, the control device may be adapted to adjust a first magnetic flux in the first magnetic circuit device and a second magnetic flux in the second magnetic circuit device. The respective magnetic circuit device may have a split or branched design with at least two branches located on both sides (in the longitudinal direction) of the wheel and associated to the respective adjacent section of the rail contacted by the wheel. Such a configuration allows increasing the magnetic flux in the area of the respective contact location between the rail and the wheel and, hence, increasing the magnetic attraction forces enhancing the contact force.

[0038] In both cases, the control device may be adapted to adjust the first magnetic flux and/or the second magnetic flux as function of at least one operational parameter of the running gear unit, in particular calculated and/or detected via at least one detection unit. Again, the at least one operational parameter, may be representative of an actual amount of the contact force at the associated wheel and/or an actual slip between the associated wheel unit and the rail and/or an actual traction power to be transmitted between the rail and the associated wheel and/or the actual rotational speed of the wheel unit and/or the actual translational speed of the wheel unit and/or an

actual coefficient of friction (present at the contact location) between the respective wheel and the rail.

[0039] It will be appreciated that, with certain embodiments of the invention, the magnetic circuit device may also be used for generating braking forces itself. In these cases, for example, the magnetic circuit device may have a braking mode, the magnetic circuit device, in the braking mode, being used to generate a braking moment acting on the wheel unit in the manner of an eddy current braking device.

[0040] The present invention further relates to a rail vehicle comprising a running gear unit according to the invention.

[0041] The present invention further relates to a method of adjusting a contact force acting between a wheel of a wheel unit and a part of a rail of a track to be travelled on. The method comprises, in a activated state, generating a magnetic flux in a magnetic circuit to increase the contact force compared to a deactivated state, wherein the magnetic flux is generated in at least a part of the wheel and the part of the rail contacted by the wheel as parts of the magnetic circuit. With such a method the advantages and embodiments of the invention as outlined above in the context of the running gear device may be achieved to the same extent, such that reference is made to the statements given above.

[0042] Preferably, a magnetic core device is associated to the wheel unit, in particular to the wheel, such that, at least in the activated state, the magnetic core device and the at least one wheel unit form adjacent parts of the magnetic circuit. Preferably, in the activated state, contact is (preferably automatically, more preferably using the magnetic flux) generated between a contact unit of the magnetic core device and a part of the wheel unit, in particular, a wheel of the wheel unit, preferably a lateral surface of the wheel. In the deactivated state, contact between the contact unit and the wheel unit is preferably removed (preferably automatically).

[0043] The magnetic core device may be associated to the part of the rail (forming part of the magnetic circuit) such that, in the activated state, the magnetic core device and the part of the rail form adjacent parts of the magnetic circuit, wherein the magnetic core device, in the activated state, may contact this part of the rail. With other embodiments of the invention, the magnetic flux, in the activated state, is generated in a part of a further wheel unit contacting the rail such that the magnetic core device and the further wheel unit form adjacent parts of the magnetic circuit.

[0044] Further embodiments of the present invention will become apparent from the dependent claims and the following description of preferred embodiments which refers to the appended figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045]

- Figure 1 is a schematic side view of a preferred embodiment of a rail vehicle according to the present invention with a preferred embodiment of a running gear unit according to the present invention;
- Figure 2 is a schematic side view of the running gear unit of Figure 1;
- Figure 3 is a schematic sectional view of a part of the running gear unit of Figure 2 along line III-III of Figure 2.
- Figure 4 is a schematic side view of a further preferred embodiment of a running gear unit according to the present invention.
- Figure 5 is a schematic side view of a further preferred embodiment of a running gear unit according to the present invention.
- Figure 6 is a schematic side view of a further preferred embodiment of a running gear unit according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

First Embodiment

[0046] With reference to Figures 1 to 3 a preferred embodiment of a rail vehicle 101 according to the present invention comprising a preferred embodiment of a running gear unit in the form of a running gear 102 according to the invention will now be described in greater detail. In order to simplify the explanations given below, an xyz-coordinate system has been introduced into the Figures, wherein (on a straight, level track T) the x-axis designates the longitudinal direction of the rail vehicle 101, the y-axis designates the transverse direction of the rail vehicle 101 and the z-axis designates the height direction of the rail vehicle 101 (the same, of course, applies for the running gear 102). It will be appreciated that all statements made in the following with respect to the position and orientation of components of the rail vehicle, unless otherwise stated, refer to a static situation with the rail vehicle 101 standing on a straight level track under nominal loading.

[0047] The vehicle 101 may be any type of rail vehicle configured for passenger transport. It may, however, also be a locomotive or the like. The vehicle 101 comprises a wagon body 101.1 supported by a suspension system on two running gears 102. The respective running gear 102 comprises two wheel units in the form of wheel sets 103.1 and 103.2 supporting a running gear frame 104 via a primary spring unit 105. The running gear frame 104 supports the wagon body via a secondary spring unit 106.

[0048] The running gear frame 104 has a frame body

107 comprising two longitudinal beams 108 and a transverse beam unit 109 providing a structural connection between the longitudinal beams 108 in the transverse direction, such that a substantially H-shaped configuration is formed. Each longitudinal beam 108 has two free end sections forming a primary suspension interface for a primary suspension device of the primary suspension unit 105 connected to the associated wheel unit 103.1, 103.2.

[0049] As can be seen from Figure 2 (showing the running gear 102 with one of the longitudinal beams 108 cut away) and Figure 3, each wheel set 103.1, 103.2 comprises two wheels 103.3 and 103.4, respectively, each contacting one of the two rails 110.1 of a track 110 currently travelled with a contact force FC1 and FC2, respectively (the two wheels 103.3, 103.4 of the two wheel sets 103.1, 103.2 located on the same side of the vehicle 101 obviously contacting the same rail 110.1). It will be appreciated that the orientation of the contact force FC1 and FC2 depends of the actual wheel to rail contact geometry and, hence, will slightly vary continuously (under stable running conditions). On a straight level track, the contact force FC1, FC2 substantially lies in a plane parallel to the yz-plane.

[0050] The running gear 102, on each of the two vehicle sides, further comprises a magnetic circuit device 111 of a magnetic circuit arrangement 112 having an activated state and a deactivated state. The respective magnetic circuit device 111 is mounted to the running gear frame 104. The respective magnetic circuit device 111 is spatially closely associated to the two wheels 103.3, 103.4 of the two wheel sets 103.1, 103.2 located on the same side of the vehicle 101 and contacting the same rail 110.1.

[0051] As will be explained in greater detail in the following, the magnetic circuit device 111 is configured to participate in generating, in the activated state, a magnetic flux MF in a magnetic circuit 113 of the magnetic circuit arrangement 112 to increase the respective contact force FC1 and FC2 compared to the deactivated state. To this end, according to the present invention, the magnetic circuit device 111 is configured such that a part of each wheel 103.3, 103.4 and the part of the rail 110.1 contacted by these wheels 103.3, 103.4, in the activated state, each form a part of the magnetic circuit 113.

[0052] This integration of the wheels 103.3, 103.4 into the magnetic circuit 113 has the advantage that a simpler and lighter configuration with reduced bending loads on the running gear 102 and the rails 110.1 of the track 110 is achieved, since the magnetic attraction forces FM enhancing the contact force FC1, FC2 are produced at and in the vicinity of the wheel to rail contact area 114. As outlined above, these magnetic attraction forces FM result from the fact that the magnetic circuit 113 strives to reduce its magnetic resistance by closing any air gaps in the magnetic circuit 113. Hence, the magnetic flux MF present in the air gaps formed between the wheels 103.3, 103.4 and the rails 110.1 (both forming part of the magnetic circuit 113) in close proximity to the respective

wheel to rail contact area 114 generates these magnetic attraction forces FM.

[0053] Since the wheels 103.3, 103.4 form parts of the magnetic circuit 113, compared to conventional solutions, a simpler design of the magnetic circuit device 111 and its support may be achieved since the magnetic circuit device 111 does not have to be placed in close proximity to the rail 110.1. Furthermore, compared to conventional designs with the magnetic attraction force FM acting in the running gear frame substantially halfway between the wheel to rail contact areas, additional bending loads on the rail 110.1 as well as on the running gear frame 104 due to a lever arm between the magnetic attraction force FM and the wheel to rail contact area 114 are at least largely avoided.

[0054] In the present example, the magnetic circuit device 111 comprises a magnetic core device 115 mounted to the running gear frame 104 in the area of the transverse beam 109. The magnetic circuit device 111 further comprises an electrically operated inductor device 116 associated to a magnetic interface of the magnetic core device 115 and configured to generate the magnetic flux MF in the magnetic circuit 113.

[0055] The inductor device 116 comprises an electrical winding 116.1 surrounding a magnetic interface part of the magnetic core device 111 and electrically connected to a power source 117. The power source 117 is operated under control of a control device 118 to selectively generate the magnetic flux MF in the magnetic circuit 113.

[0056] In the present example, the control device 118, in the activated state, adjusts the magnetic flux MF in the magnetic circuit 113 as function of one or more operational parameters OP of the running gear 102 and/or the vehicle 101 calculated and/or detected via one or more detection units 119 connected to the control device 118.

[0057] Suitable operational parameters OP of the running gear 102 or the vehicle 101 may, for example, be an operational parameter OP providing information about the actual running state of the vehicle 101 and/or the running gear 102, but it may also be a parameter providing information on the actual external loads on the vehicle 101 and/or the running gear 102, such as e.g. wind loads (in particular so called side wind or crosswind loads), having an influence on the actual values of the contact forces FC1, FC2. Preferably, the operational parameter OP is representative of an actual amount of the contact force FC1, FC2 and/or an actual slip between the wheels 103.3, 103.4 and the rail 110.1 and/or an actual traction or braking power to be transmitted between the wheels 103.3, 103.4 and the rail 110.1 and/or the actual rotational speed of the wheel and/or the actual translational speed of the wheel and/or an actual coefficient of friction (present at the contact location) between the wheels 103.3, 103.4 and the rail 110.1.

[0058] In the present example, the magnetic core device 115 is at least largely made from a material having low magnetic resistance, such as, for example, a ferromagnetic material, such as iron and/or electrical steels

and/or cobalt iron alloys.

[0059] As can be seen from Figure 2 and 3, the magnetic core device 115 is configured and spatially associated to the wheels 103.3, 103.4, such that the magnetic core device 115 and the wheels 103.3, 103.4 form adjacent parts of the magnetic circuit 113.

[0060] In the present example, the magnetic core device 115 comprises a first contact unit 115.1 (located at one end of the magnetic core device 115 and associated to the first wheel 103.3), a second contact unit 115.2 (located at the other end of the magnetic core device 115 and associated to the second wheel 103.4) and magnetic core element 115.3 (located between the contact units 115.1, 115.2).

[0061] The contact units 115.1, 115.2, in the present example, are of identical design and functionality, which will be described in the following using the first contact unit 115.1. The contact unit 115.1 is slidably connected to the magnetic core element 115.3 and configured to contact, in the activated state, an inner lateral surface 103.5 (i.e. a surface facing in the transverse direction of the running gear unit) of the wheel flange 103.6 of the associated wheel 103.3 in order to largely reduce or avoid air gaps at the respective contact location (and, hence, to minimize magnetic losses). Using the inner lateral surface 103.5 in the uppermost area of the wheel flange 103.6 as the contact location is advantageous, since these surfaces are particularly suitable for forming a magnetic interface even under eventually varying steering angles of the wheel 103.3.

[0062] In the present example, each contact unit 115.1 is slidably connected to the magnetic core element 115.3 in such a manner that, in the deactivated state, the contact unit 115.1 does not contact the wheel 103.3 in order to minimize wear. To this end, the contact unit 115.1 comprises a resetting means in the form of a spring element 115.4 connected to the magnetic core element 115.3. The resetting spring element 115.4 exerts a resetting force FR on the contact unit 115.1, the resetting force FR, if not compensated by a counterforce, bringing the contact unit 115.1 out of contact with the associated wheel 103.3 and into a retracted state (as indicated by the double-dot-dashed contour 120 in Figure 3).

[0063] Furthermore, in the present example, the contact unit 115.1 is slidably mounted to the magnetic core element 115.3 in such a manner that, in the activated state, an actuation force FA is exerted on the contact unit 115.1. The actuation force FA, if not compensated by a counterforce, brings the contact unit 115.1 into contact with the wheel 103.3. It will be appreciated that the contact unit may be locked in position by suitable locking means (not shown) once contact is established, such that the actuation force FA may only be necessary for establishing this contact.

[0064] In the present example, the actuation force FA for bringing the contact unit 115.1 into contact with the wheel 103.3 is generated as a result of the magnetic flux MF in the magnetic circuit 113 (i.e. through the magnetic

attraction force acting between the wheel 103.3 and the contact unit 115.1 that results from the magnetic flux MF of the magnetic circuit 113), such that no additional actuator is needed.

[0065] In the present example, to minimize wear, a contact including rolling relative motion is provided between the contact unit 115.1 and the wheel 103.3. To this end, the contact unit 115.1 comprises one or more contact elements in the form of rollers 115.6 rotatably held in a contact element holder 115.7 of the contact unit 115.1. The contact element 115.6, in the activated state, is in substantially rolling contact with the wheel 103.3. Obviously, depending on the actual contact situation, a combined rolling and sliding motion may be present at the contact location.

[0066] The contact element holder 115.7 defines an axis of rotation 115.8 of the contact element 115.6 that is substantially parallel to the height direction (z-axis) since this orientation allows particularly simple configurations taking into account relative motion between the running gear frame 104 and the wheel set 103.1 under normal operating conditions due to steering/yawing and/or tilting and/or pitching motions.

[0067] In the present example, the axis of rotation 115.8, when running on a straight level track, extends through a virtual cylinder defined by a maximum diameter $D_{\max}$ and the rolling axis 103.7 of the wheel set 103.1. More precisely, in the present example and when running on a straight level track 110, the axis of rotation 115.8 is substantially parallel to a radial direction of the wheel 103.3 defined at the contact point of the contact element 115.6 with the wheel 103.3 and substantially intersects the rolling axis 103.7 of the wheel set 103.1, thereby minimizing sliding motion and, hence, wear.

[0068] It will be appreciated that, with the present embodiment, the contact forces FC1, FC2 present on one side of the running gear 102 (i.e. acting on one of the rails 110.1 of the track 110) are commonly influenced or controlled by the control unit 118. However, it is possible to individually influence the contact forces FC1, FC2 on different sides of the running gear 102. Hence, for example, the contact forces FC1, FC2 on the windward vehicle side hit by crosswind (of a considerable strength) may be increased, while the contact forces FC1, FC2 on the leeward vehicle side may be left uninfluenced or increased to a lower extent by the control unit 118.

[0069] In the present example, the control device may control the magnetic circuit device 111 to generate braking forces. In these cases, for example, the magnetic circuit device 111 may have a braking mode, the magnetic circuit device 111, in the braking mode, being used to generate a braking moment acting on the wheel sets 103.1, 103.2 in the manner of an eddy current braking device.

Second Embodiment

[0070] In the following, a second preferred embodi-

ment of a running gear unit 202 according to the present invention will be described with reference to Figure 4. The running gear 202 in its basic design and functionality largely corresponds to the running gear 102 of the first embodiment and may replace the running gear 102 in vehicle 101, such that it is here mainly referred to the differences. In particular, identical components have been given the identical reference, while like components are given the same reference numeral increased by the value 100. Unless explicitly deviating statements are given in the following, explicit reference is made to be explanations given above in the context of the first embodiment with respect to these components.

[0071] As can be seen from Figure 4, the only difference between the running gear 202 and the running gear 102 is within the deviating outlay of the magnetic circuit arrangement 212. More precisely, in the present embodiment, the magnetic circuit arrangement 212 comprises two identically designed magnetic circuit devices 211 (separately generating a magnetic flux MF in two separate magnetic circuits 213) each associated to one of the wheels 103.3, 103.4 and individually controlled by the control device 118.

[0072] The magnetic circuit arrangement 212 differs from the magnetic circuit arrangement 112 only insofar as the magnetic core element 215.3 of the magnetic core device 215 is configured and spatially associated to the part of the rail 110.1 contacted by the associated wheel 103.3, 103.4 such that, in the activated state, the magnetic core device 215 and said part of the rail 110.1 form adjacent parts of the respective magnetic circuit 213. Hence, it is possible to individually control of the contact force FC1, FC2 at each single wheel 103.3, 103.4 of the running gear 202

[0073] As indicated in Figure 4 by the dashed roller 215.9, preferably, the magnetic core device 215, in the activated state, contacts the associated part of the rail 110.1 to keep the magnetic losses to a minimum at this location. To this end, a modified core element 215.3 is used, while, in the area of the contact element 115.1 and for the inductor device 116, an identical design as in the first embodiment is used.

Third Embodiment

[0074] In the following, a third preferred embodiment of a running gear unit 302 according to the present invention will be described with reference to Figure 5. The running gear 302 in its basic design and functionality largely corresponds to the running gear 202 of the second embodiment and may also replace the running gear 102 in vehicle 101, such that it is here mainly referred to the differences. In particular, identical components have been given the identical reference, while like components are given the same reference numeral increased by the value 100 (compared to the second embodiment). Unless explicitly deviating statements are given in the following, explicit reference is made to be explanations given above

in the context of the first embodiment with respect to these components.

[0075] As can be seen from Figure 5, the only difference between the running gear 302 and the running gear 202 is within the deviating outlay of the magnetic circuit arrangement 312. More precisely, in the present embodiment, the magnetic circuit arrangement 312 again comprises two identically designed magnetic circuit devices 311 (separately generating a magnetic flux MF in two separate magnetic circuits 313) each associated to one of the wheels 103.3, 103.4 and individually controlled by the control device 118.

[0076] The magnetic circuit arrangement 312 differs from the magnetic circuit arrangement 212 only insofar as the magnetic core element 315.3 of the magnetic core device 315 is a split or dual branch core device. An inward branch 315.10 contacts an inward lying part of the rail 110.1 contacted by the associated wheel 103.3, 103.4 (i.e. a part of the rail 110.1 lying between the two contact points 114 of the wheels 103.3 and 103.4), while an outward branch 315.11 contacts an outward lying part of the rail 110.1 contacted by the associated wheel 103.3, 103.4 (i.e. a part of the rail 110.1 lying outside the space between the two contact points 114 of the wheels 103.3 and 103.4). The branching point of the magnetic core element 315.3 into the two branches 315.10 and 315.11 is located upstream or downstream (depending on the direction of the magnetic flux MF) of the inductor device 116. The two branches of the magnetic circuit 313 (formed due to the branched design of the magnetic core element 315.3) furthermore re-unite or split (depending on the direction of the magnetic flux MF) at the respective contact unit 115.1, 115.2.

[0077] Again, the two branches 315.10 and 315.11 are configured and spatially associated to the rail 110.1 such that, in the activated state, the respective branch 315.10, 315.11 of the magnetic core device 315 and the associated part of the rail 110.1 form adjacent parts of the respective branch of the magnetic circuit 313. By this means, it is not only possible to individually control of the contact force FC1, FC2 at each single wheel 103.3, 103.4 of the running gear 302. The branched design with an inward branch associated to an inward lying part of the rail 110.1 and an outward branch associated to an outward lying part of the rail 110.1 allows increasing the magnetic flux MF in the area of the respective contact location 114 and, hence, increasing the magnetic attraction forces FM enhancing the contact force FC1, FC2.

[0078] As indicated in Figure 5 by the dashed rollers 315.9, again preferably, the branches 315.10, 315.11 of the magnetic core device 315, in the activated state, contact the associated part of the rail 110.1 to keep the magnetic losses to a minimum at this location.

Fourth Embodiment

[0079] In the following, a fourth preferred embodiment of a running gear unit 402 according to the present in-

vention will be described with reference to Figure 6. The running gear 402 in its basic design and functionality largely corresponds to the running gear 202 of the second embodiment and may also replace the running gear 102 in vehicle 101, such that it is here mainly referred to the differences. In particular, identical components have been given the identical reference, while like components are given the same reference numeral increased by the value 200 (compared to the second embodiment). Unless explicitly deviating statements are given in the following, explicit reference is made to be explanations given above in the context of the first embodiment with respect to these components.

[0080] As can be seen from Figure 6, the only difference between the running gear 402 and the running gear 202 is within the deviating outlay of the magnetic circuit arrangement 412. More precisely, in the present embodiment, the magnetic circuit arrangement 412 again comprises two identically designed magnetic circuit devices 411 (separately generating a magnetic flux MF in two separate magnetic circuits 413) each associated to one of the wheels 103.3, 103.4 and individually controlled by the control device 118.

[0081] The magnetic circuit arrangement 412 differs from the magnetic circuit arrangement 212 only insofar as the magnetic core element 415.3 of the magnetic core device 415 is a split or dual branch core device. An inward branch 415.10 contacts an inward lying part of the rail 110.1 contacted by the associated wheel 103.3, 103.4 (i.e. a part of the rail 110.1 lying between the two contact points 114 of the wheels 103.3 and 103.4), while an outward branch 415.11 contacts an outward lying part of the rail 110.1 contacted by the associated wheel 103.3, 103.4 (i.e. a part of the rail 110.1 lying outside the space between the two contact points 114 of the wheels 103.3 and 103.4). The branching point of the magnetic core element 415.3 into the two branches 415.10 and 415.11 is located in the area of the respective contact unit 115.1, 115.2.

[0082] Hence, two branches of the magnetic circuit 413 are formed due to the branched design of the magnetic core element 415.3. Each branch has an associated inductor device 116 and 416, each being fed by the power source 117 under control of the control device 118 to selectively generate the magnetic flux MF in the respective magnetic circuit 413.

[0083] Again, the two branches 415.10 and 415.11 are configured and spatially associated to the rail 110.1 such that, in the activated state, the respective branch 415.10, 415.11 of the magnetic core device 415 and the associated part of the rail 110.1 form adjacent parts of the respective branch of the magnetic circuit 413. By this means, it is not only possible to individually control of the contact force FC1, FC2 at each single wheel 103.3, 103.4 of the running gear 402. The branched design with an inward branch associated to an inward lying part of the rail 110.1 and an outward branch associated to an outward lying part of the rail 110.1 allows increasing the

magnetic flux MF in the area of the respective contact location 114 and, hence, increasing the magnetic attraction forces FM enhancing the contact force FC1, FC2.

[0084] As indicated in Figure 6 by the dashed rollers 415.9, again preferably, the branches 415.10, 415.11 of the magnetic core device 415, in the activated state, contact the associated part of the rail 110.1 to keep the magnetic losses to a minimum at this location.

[0085] It will be appreciated that the rollers 415.9 as well as any other contact element 115.6, 215.9 and 315.9 described hereinbefore could be replaced by another contact element providing predominantly sliding contact. Particularly favorable solutions may be achieved using brush elements or the like, which cause only comparatively limited wear of the contacted components (wheel and/or rail). Moreover, they may serve to clean the contacted component.

[0086] Any of these contact elements (in a manner similar to contact element 115.6) may be configured to contact only in the activated state. In case of a brush element or the like stops (limiting approximation between the brush element and the contacted component) may be used to limit the contact pressure of the brush element and, hence, wear.

[0087] Although the present invention in the foregoing has only a described in the context of locomotives, it will be appreciated, however, that it may also be applied to any other type of rail vehicle in order to overcome similar problems with respect to a simple solution for influencing the wheel to rail contact forces.

Claims

1. A running gear unit for a rail vehicle, comprising

- at least one wheel unit (103.1, 103.2) and
 - a magnetic circuit device (111; 211; 311; 411) for a magnetic circuit arrangement (112; 212; 312; 412);
 - said at least one wheel unit (103.1, 103.2) being configured to contact a part of a rail (110.1) of a track to be travelled on with a contact force acting between said at least one wheel unit (103.1, 103.2) and said rail (110.1);
 - said magnetic circuit arrangement (112; 212; 312; 412) having an activated state and a deactivated state;
 - said magnetic circuit device (111; 211; 311; 411) being configured to participate in generating, in said activated state, a magnetic flux in a magnetic circuit (113; 213; 313; 413) of said magnetic circuit arrangement (112; 212; 312; 412) to increase said contact force compared to said deactivated state;
- characterized in that**
- said magnetic circuit device (111; 211; 311; 411) is configured such that at least a part of

said at least one wheel unit (103.1, 103.2) and said part of said rail (110.1) contacted by said at least one wheel unit (103.1, 103.2), at least in said activated state, forms a part of said magnetic circuit (113; 213; 313; 413).

2. The running gear unit according to claim 1, wherein

- said magnetic circuit device (111; 211; 311; 411) comprises a magnetic core device (115; 215; 315; 415);
- said magnetic core device (115; 215; 315; 415), in said activated state, forms a part of said magnetic circuit (113; 213; 313; 413),
- said magnetic core device (115; 215; 315; 415) being configured and, in particular, spatially associated to said at least one wheel unit (103.1, 103.2), such that, at least in said activated state, said magnetic core device (115; 215; 315; 415) and said at least one wheel unit (103.1, 103.2) form adjacent parts of said magnetic circuit (113; 213; 313; 413).

3. The running gear unit according to claim 2, wherein

- said magnetic core device (115; 215; 315; 415) comprises a contact unit (115.1; 115.2), said contact unit (115.1; 115.2) being configured to contact, at least in said activated state, a part of said wheel unit (103.1, 103.2), in particular, a wheel of said wheel unit (103.1, 103.2), preferably a lateral surface of said wheel;
- said contact unit (115.1; 115.2), in particular, being configured and/or articulated to a magnetic core element of said magnetic core device (115; 215; 315; 415) in such a manner that, in said deactivated state, said contact unit (115.1; 115.2) does not contact said wheel unit (103.1, 103.2),
- said contact unit (115.1; 115.2), in particular, comprising a resetting means (115.8), in particular, a spring element, said resetting means (115.8), at least in said deactivated state, exerting a resetting force on said contact unit (115.1; 115.2), said resetting force, if not compensated by a counterforce, bringing said contact unit (115.1; 115.2) out of contact with said wheel unit (103.1, 103.2);

4. The running gear unit according to claim 3, wherein

- said contact unit (115.1; 115.2) is configured and/or articulated to a magnetic core element (115.3; 215.3; 315.3; 415.3) of said magnetic core device (115; 215; 315; 415) in such a manner that, in said activated state, an actuation force is exerted on said contact unit (115.1; 115.2), said actuation force, if not compensated

by a counterforce, bringing said contact unit (115.1; 115.2) into contact with said wheel unit (103.1, 103.2);

- said actuation force, in particular, being generated as a result of said magnetic flux in said magnetic circuit (113; 213; 313; 413).

5. The running gear unit according to claim 4, wherein

- said contact unit (115.1; 115.2) comprises at least one contact element (115.6) and a contact element holder (115.7) rotatably holding said at least one contact element (115.6), said contact element (115.6), in said activated state, being in substantially rolling contact with said wheel unit (103.1, 103.2);

- said running gear unit defining a longitudinal direction, a transverse direction and a height direction and said contact element holder (115.7) defining at least one axis of rotation (115.8) of said at least one contact element (115.6);

- said at least one axis of rotation (115.8), in particular, being substantially parallel to said longitudinal direction or substantially parallel to said height direction;

- said at least one axis of rotation (115.8), when running on a straight level track, in particular, extending through a virtual cylinder defined by a maximum diameter and a rolling axis of a wheel unit rolling axis device, in particular, a wheel unit shaft or a wheel unit axle, said at least one axis of rotation (115.8), when running on a straight level track, preferably substantially intersecting said rolling axis;

- said at least one axis of rotation (115.8), when running on a straight level track, in particular, being substantially parallel to a radial direction of a wheel of said wheel unit (103.1, 103.2) defined at a contact point of said contact element (115.6) with said wheel unit (103.1, 103.2).

6. The running gear unit according to any one of claims 3 to 5, wherein

- said contact unit (115.1; 115.2) contacts a lateral surface (103.5) of a wheel (103.3, 103.4) of said wheel unit (103.1, 103.2), in particular a lateral surface of a wheel flange (103.6) of said wheel (103.3, 103.4),

and/or

- said contact unit is hinged to a magnetic core element (115.3; 215.3; 315.3; 415.3) of said magnetic core device (115; 215; 315; 415) and/or

- said contact unit (115.1; 115.2) is slidably mounted to a magnetic core element (115.3; 215.3; 315.3; 415.3) of said magnetic core device (115; 215; 315; 415).

7. The running gear unit according to any one of claims 2 to 6, wherein

- said magnetic core device (215; 315; 415) is configured and, in particular, spatially associated to said part of said rail (110.1) such that, in said activated state, said magnetic core device (215; 315; 415) and said part of said rail (110.1) form adjacent parts of said magnetic circuit (213; 313; 413); said magnetic core device (215; 315; 415), in particular, in said activated state, contacting said part of said rail (110.1);

or

- said running gear unit comprises a further wheel unit (103.1, 103.2) contacting said rail (110.1), said magnetic core device (115) being configured and, in particular, spatially associated to said further wheel unit (103.1, 103.2), such that, at least in said activated state, said magnetic core device (115) and said further wheel unit (103.1, 103.2) form adjacent parts of said magnetic circuit (113).

8. The running gear unit according to any one of claims 1 to 7, wherein

- said magnetic circuit device (111; 211; 311; 411) comprises at least one inductor device (116) configured to generate said magnetic flux in said magnetic circuit (113; 213; 313; 413) under control of a control device (118);

- said at least one inductor device (116), in particular, being associated to a magnetic core device (115; 215; 315; 415) of said magnetic circuit device (111; 211; 311; 411);

- said at least one inductor device (116), in particular, comprising at least one electrical winding (116.1) surrounding a part of a magnetic core device (115; 215; 315; 415) of said magnetic circuit device (111; 211; 311; 411);

- said control device (118), in particular, being adapted to adjust said magnetic flux as function of at least one operational parameter of said running gear unit, in particular calculated and/or detected via at least one detection unit (119), said at least one operational parameter, in particular, being representative of an actual amount of said contact force and/or an actual slip between said wheel unit (103.1, 103.2) and said rail (110.1) and/or an actual traction or braking power to be transmitted between said rail (110.1) and said wheel unit (103.1, 103.2) and/or an actual rotational speed of said wheel unit and/or an actual translational speed of said wheel unit and/or an actual coefficient of friction between said wheel unit (103.1, 103.2) and said rail (110.1).

9. The running gear unit according to any one of claims

1 to 8, wherein

- said running gear unit comprises a control device (118), a first wheel (103.3) and a second wheel (103.4), both said wheels (103.3, 103.4) contacting a rail (110.1) of said track;
- said magnetic circuit device (211; 311; 411) forming a first magnetic circuit device (211; 311; 411) associated to said first wheel;
- said running gear unit comprising a second magnetic circuit device (211; 311; 411) associated to said second wheel (103.4);
- said control device (118), in particular, being adapted to adjust a first magnetic flux in said first magnetic circuit device (211; 311; 411) and a second magnetic flux in said second magnetic circuit device (211; 311; 411),
- said control device (118), in particular, being adapted to adjust said first magnetic flux and/or said second magnetic flux as function of at least one operational parameter of said running gear unit, in particular calculated and/or detected via at least one detection unit (119), said at least one operational parameter, in particular, being representative of an actual amount of said contact force at said associated wheel and/or an actual slip between said associated wheel unit (103.1, 103.2) and said rail (110.1) and/or an actual traction or braking power to be transmitted between said rail (110.1) and said associated wheel and/or an actual rotational speed of said wheel unit and/or an actual translational speed of said wheel unit and/or an actual coefficient of friction between said wheel unit (103.1, 103.2) and said rail (110.1).

10. The running gear unit according to any one of claims 1 to 9, wherein

- said magnetic circuit device (111; 211; 311; 411) has a braking mode,
- said magnetic circuit device (111; 211; 311; 411), in said braking mode, being used to generate a braking moment acting on said wheel unit (103.1, 103.2) in the manner of an eddy current braking device.

11. A rail vehicle comprising a running gear unit (102; 202; 302; 402) according to any one of claims 1 to 10.

12. A method of adjusting a contact force acting between a wheel (103.3, 103.4) of a wheel unit (103.1, 103.2) and a part of a rail (110.1) of a track to be travelled on, comprising,

- in a activated state, generating a magnetic flux in a magnetic circuit (113; 213; 313; 413) to increase said contact force compared to a deac-

tivated state;

characterized in that

- said magnetic flux is generated in at least a part of said wheel (103.3, 103.4) and said part of said rail (110.1) contacted by said wheel (103.3, 103.4) as parts of said magnetic circuit (113; 213; 313; 413).

13. The method according to claim 12, wherein

- associating a magnetic core device (115; 215; 315; 415) to said wheel unit (103.1, 103.2), in particular to said wheel (103.3, 103.4), such that, at least in said activated state, said magnetic core device (115; 215; 315; 415) and said at least one wheel unit (103.1, 103.2) form adjacent parts of said magnetic circuit (113; 213; 313; 413);
- in said activated state, in particular, generating contact, preferably automatically generating contact, more preferably automatically generating contact using said magnetic flux, between a contact unit (115.1; 115.2) of said magnetic core device (115; 215; 315; 415) and a part of said wheel unit (103.1, 103.2), in particular, a wheel (103.3, 103.4) of said wheel unit (103.1, 103.2), preferably a lateral surface (103.5) of said wheel (103.3, 103.4);
- in said deactivated state, in particular removing, in particular automatically removing, contact between said contact unit (115.1; 115.2) and said wheel unit (103.1, 103.2);

14. The method according to claim 12, wherein

- said magnetic core device (215; 315; 415) is associated to said part of said rail (110.1) such that, in said activated state, said magnetic core device (215; 315; 415) and said part of said rail (110.1) form adjacent parts of said magnetic circuit (213; 313; 413); said magnetic core device (215; 315; 415), in particular, in said activated state, contacting said part of said rail (110.1); or
- said magnetic flux, in said activated state, is generated in a part of a further wheel unit (103.1, 103.2) contacting said rail (110.1) such that said magnetic core device (115) and said further wheel unit (103.1, 103.2) form adjacent parts of said magnetic circuit (113).

15. The method according to any one of claims 12 to 14, wherein

- said magnetic flux is adjusted as function of at least one operational parameter of a running gear unit comprising said wheel unit (103.1, 103.2), in particular calculated and/or detected

via at least one detection unit (119), said at least one operational parameter, in particular, being representative of an actual amount of said contact force and/or an actual slip between said wheel unit (103.1, 103.2) and said rail (110.1) and/or an actual traction or braking power to be transmitted between said wheel unit (103.1, 103.2) and said rail (110.1) and/or an actual rotational speed of said wheel unit and/or an actual translational speed of said wheel unit (103.1, 103.2) and/or an actual coefficient of friction between said wheel unit (103.1, 103.2) and said rail (110.1);

- a first magnetic flux in a first magnetic circuit (213; 313; 413) associated to a first wheel (103.3) of said running gear unit and/or a second magnetic flux in a second magnetic circuit (213; 313; 413) associated to a second wheel (103.4) of said running gear unit, in particular, being adjusted as function of at least one operational parameter of said running gear unit, in particular calculated and/or detected via at least one detection unit (119), said at least one operational parameter, in particular, being representative of an actual amount of said contact force at said associated wheel and/or an actual slip between said associated wheel unit (103.1, 103.2) and said rail (110.1) and/or an actual traction or braking power to be transmitted between said rail (110.1) and said associated wheel and/or an actual rotational speed of said wheel and/or an actual translational speed of the wheel and/or an actual coefficient of friction between said wheel unit (103.1, 103.2) and said rail (110.1);

- said magnetic flux, in a braking mode, being used to generate a braking moment acting between said wheel unit (103.1, 103.2) and said rail (110.1) in the manner of an eddy current braking device.

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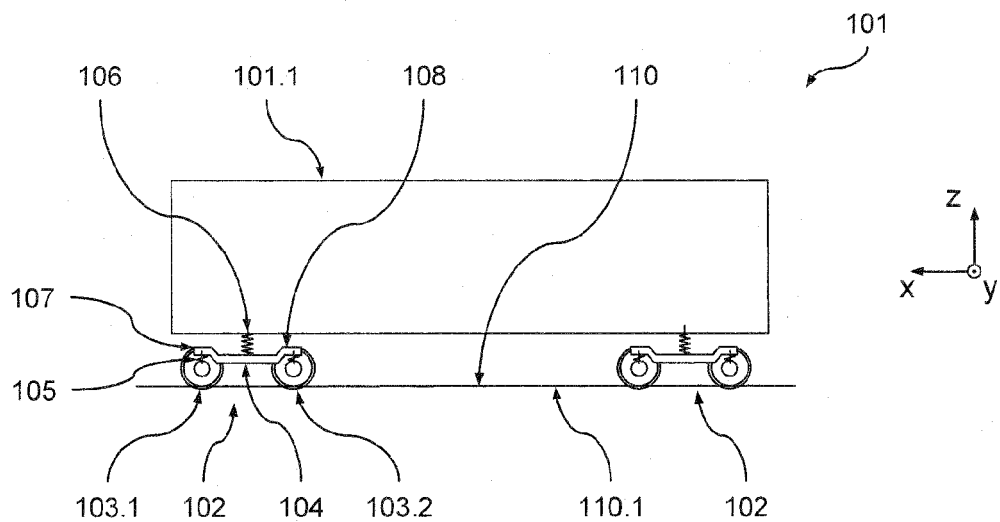


Fig. 1

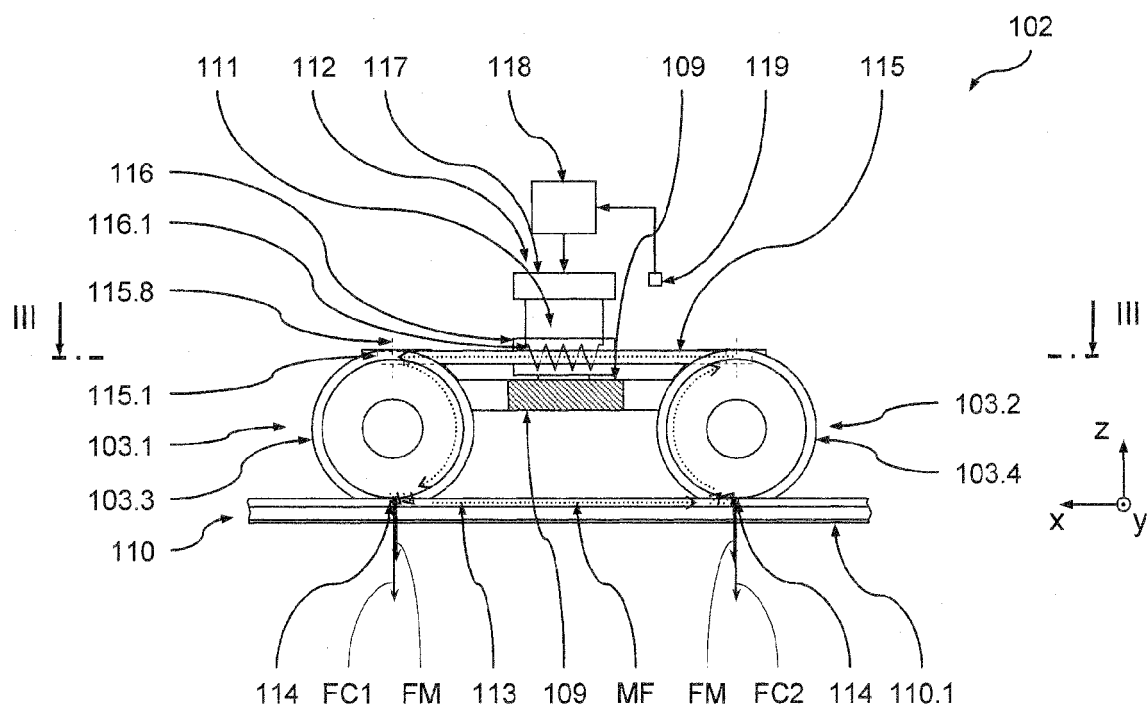


Fig. 2

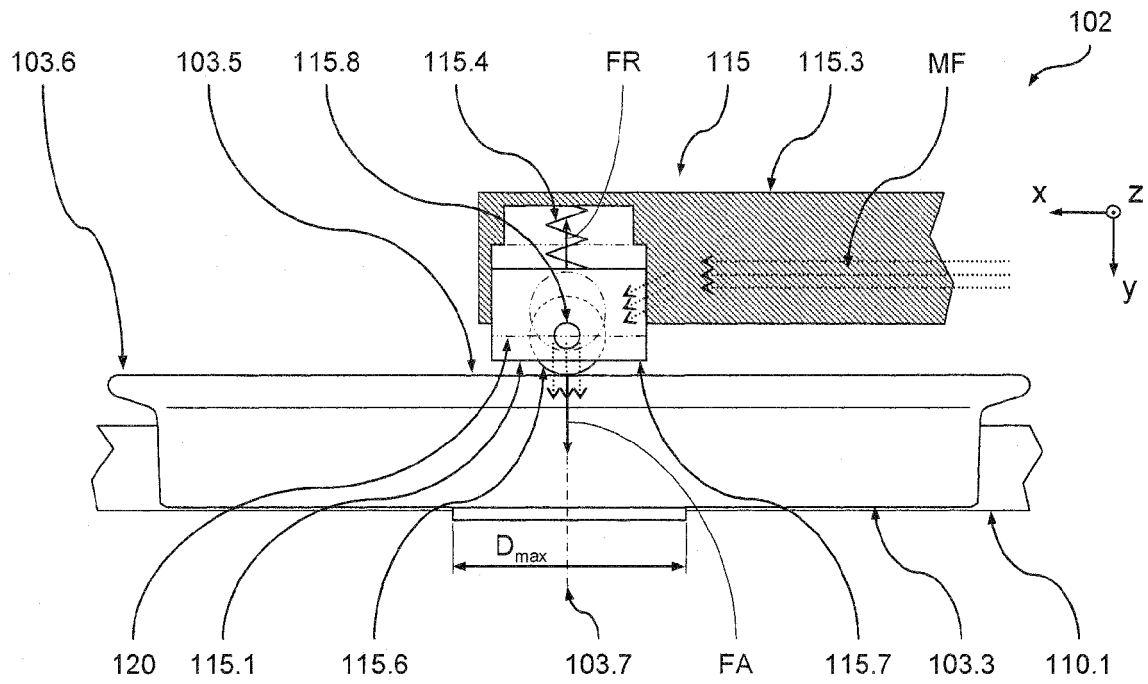


Fig. 3

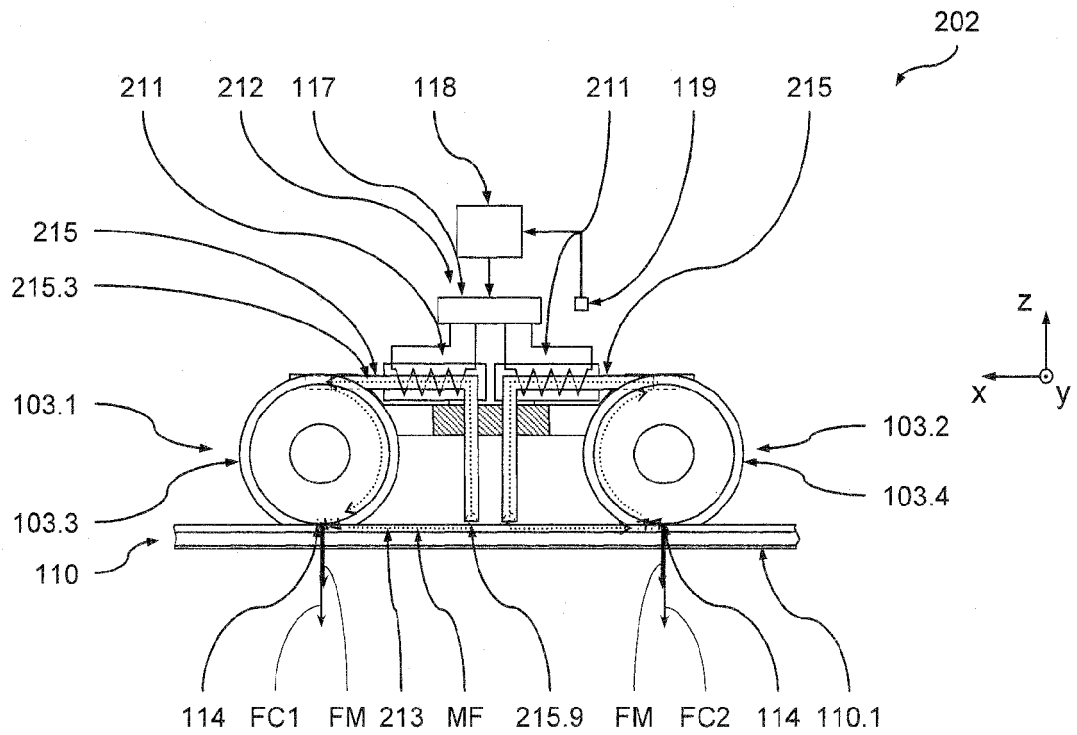


Fig. 4

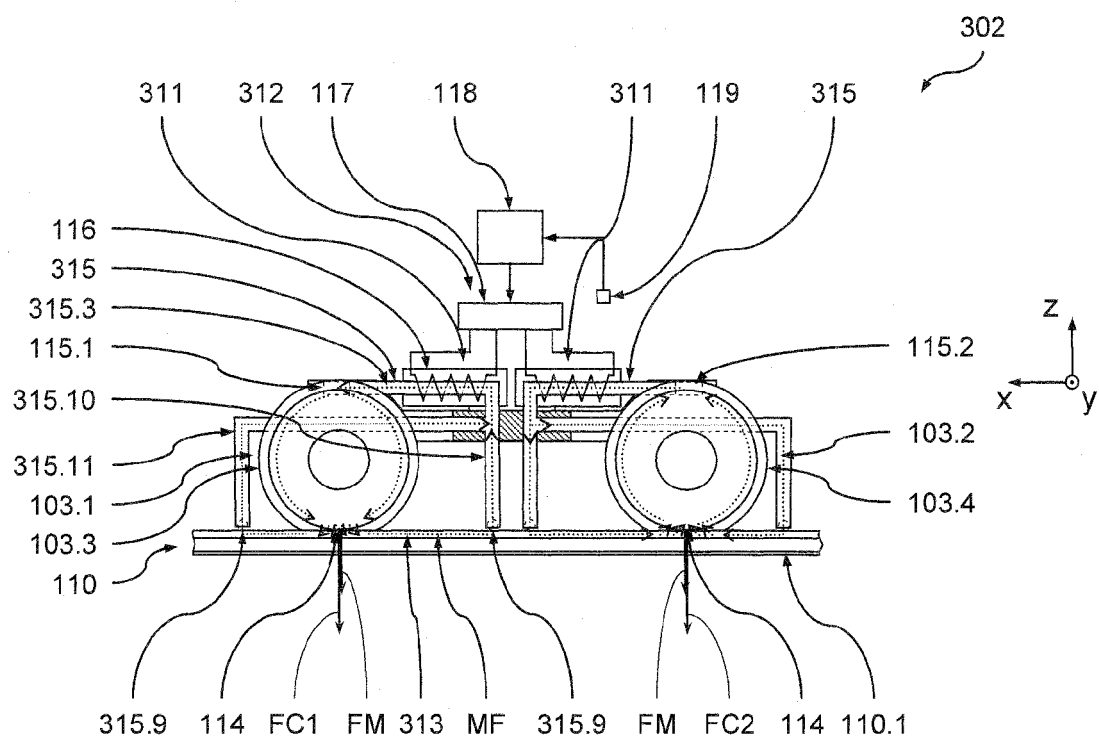


Fig. 5

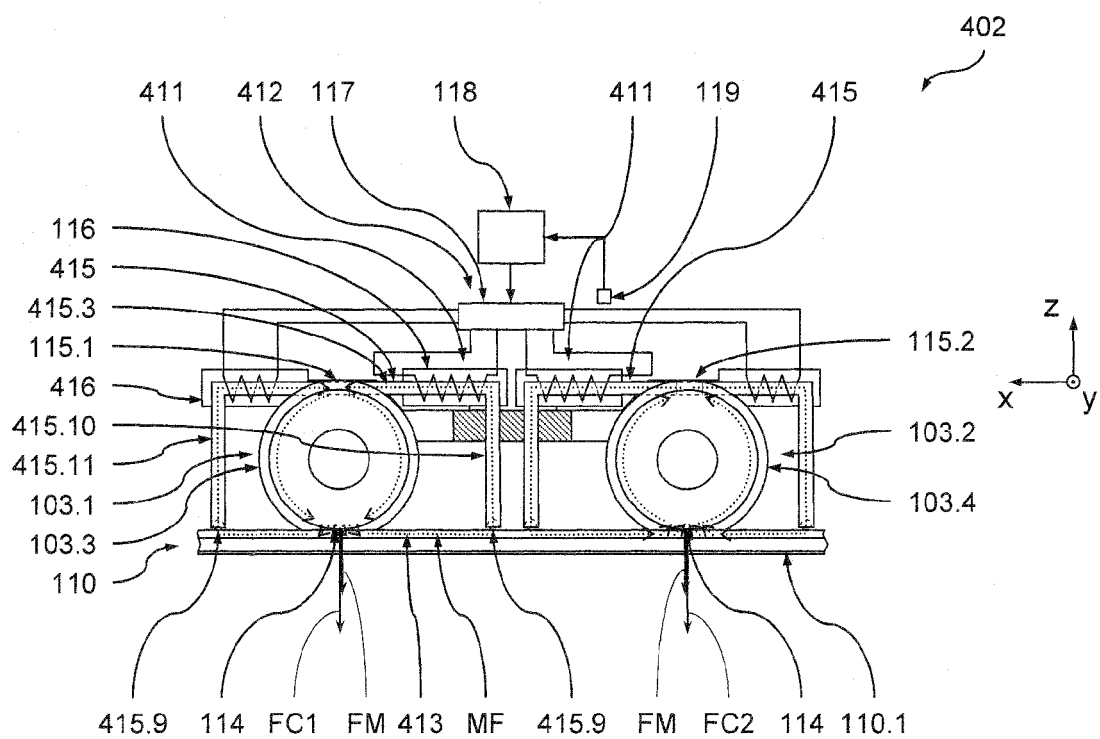


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 12 19 0663

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	US 3 881 578 A (DUBREUCQ YVON) 6 May 1975 (1975-05-06) * column 5, line 62 - column 6, line 20 * * column 6, line 60 - column 7, line 32 * * column 8, line 45 - line 58; figures 1,3-5,7 *	1,2, 8-12,14, 15	INV. B61C15/04
X	DE 103 59 821 A1 (STAEGE RUEDIGER [DE]) 8 September 2005 (2005-09-08) * paragraph [0005] - paragraph [0006]; claim 1; figures 1,2 * -----	1,11,12	
			TECHNICAL FIELDS SEARCHED (IPC)
			B61C B61H B60L H01F H02K
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 28 February 2013	Examiner Chlosta, Peter
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.92 (P04C01)

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

EP 12 19 0663

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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28-02-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3881578	A	06-05-1975	BE 824561 A1 22-07-1975
			CA 1014080 A1 19-07-1977
			DE 2356112 A1 22-05-1974
			GB 1410865 A 22-10-1975
			IT 1008597 B 30-11-1976
			JP 50024916 A 17-03-1975
			JP 51020086 B 22-06-1976
			US 3881578 A 06-05-1975

DE 10359821	A1	08-09-2005	NONE

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 2012388 A1 [0007]
- DE 19940046 A1 [0007]
- EP 1048542 A2 [0007]