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DESCRIPTION

Technical Field

[0001] The present invention refers to an axle suspension and a wheel axle preferably for track bounded tools or vehicles, which axle suspension allows the tool to have track contact also at uncorrected track areas and even when the tool has a heavy side displaced load tending to tilting of the tool.

Background Art

[0002] Increasing demands on safety with respect to tilting and derailment of track bounded tools requires that all the wheels of the vehicle are in contact with the track even in the worse thinkable conditions. Often a construction track has an unfavourable geometry which involves that the risk for derailment is higher than for a completed track.

[0003] Historically wheel axles for track bounded tools have been a stiff construction. The only mobility earlier being allowed was the deflection of the structure of the construction in alteration of the wheel load. This allowed certain flexibility to the irregularities of the track.

[0004] However the safety demands that the flexibility to a bed, such as tracks having unfavourable geometries, are improved and if possible that a tilting limit is indicated as well.

[0005] The technique known per se in this area includes a tool to be driven on a track section where the tool is connected to a wheel axle having track contact and up to a certain limit is able to follow a track section with unfavourable geometry, i.e. the two parallel going rails are not adjusted to each other in the horizontal level. Thereby the wheel axle is suspended at the framing thereof and is pivotally arranged with respect to the framing around a longitudinal centre axis, whereby hydraulic cylinders are used to lock the angle position of the wheel axle when in work and which support the rest of the vehicle onto this wheel axle though the wheel axle of the tool vehicle itself is not able to maintain a track/ground contact.

[0006] Technique known per se includes some type of hydraulics to obtain stability when working with the tool. Thus the existing devices require hydraulic pipes, pressure means, hydraulic steering mechanisms etc. All those devices add further components to the system complicating and increasing the price of the construction.

[0007] WO91/13786 discloses an axle assembly for rail vehicles comprising a support member pivotally connected to a railway vehicle body for rotation about a vertical steering axis. An axle beam is pivotally connected to a chassis for movement about the steering axis and has a wheel at opposite ends. Elastomeric suspension elements are located between the ends of the

beam and the ends of the support member to maintain the tube and support member in a vertically spaced relationship.

[0008] US2798735 discloses an undercarriage for road vehicles comprising a pair of spaced wheel and axle assemblies, a pair of spaced beams spanning the distance between the axles of said assemblies. U-shaped frames are connected to the beams, each frame comprising a pair of down-turned laterals having a pair of spaced plates. Innermost upright plates embracing the corresponding axle are being arranged in parallel with the spaced plates. Elastic bodies are arranged between the spaced plates and the innermost plates. The axles are vertically movable at either end with respect to the beams.

Purpose of the Invention

[0009] The purpose with the present invention is to obtain an axle device allowing a vertical mobility of the wheels such that the contact with the rail always is maintained.

[0010] Furthermore the purpose is to obtain such a device which means that the mobility does not act on the tool in a negative way with respect to reduced stability at the working.

[0011] Furthermore the purpose is to obtain such a device which offers a higher degree of safety from tilting.

[0012] The purpose is also to obtain such a device without additional hydraulic or electrical support functions in the system.

[0013] Furthermore the purpose is to obtain a simple and cost effective device being easy to maintain and easy to adapt for different load occasions as well.

Summary of the Invention

[0014] By the present invention such as it is evident from the independent claims the purposes mentioned above are satisfied and the drawbacks mentioned are eliminated. Suitable embodiments of the invention are given by the dependent claims.

[0015] The invention refers to a railway vehicle equipped with a rigid wheel axle, where a wheel is rotatably mounted at each one of the two ends thereof. The wheel axle is connected to and is held by a suspension means directly or indirectly fixed to the frame of the vehicle in such a manner that at least one end of the wheel axle is movable in a vertical direction with respect to the suspension means. The suspension means surrounds at least a part of the wheel axle, wherein the suspension means, alone or in combination with further means, allows a restricted free translatory motion of the wheel axle with respect to the suspension means.

The restricted free translatory motion is restricted to a defined distance within the suspension means.

[0016] With "translatory" one aims at that all the points at the wheel axle move the same distance by a motion of the wheel axle. This translatory motion may be combined with an angle motion of the wheel axle as well. With "free" motion one aims at a motion being independent of further parts of the construction. The suspension as such or with further means define a restricted motion area of the wheel axle.

[0017] In one embodiment of the invention the suspension means includes a beam above and partly surrounding the wheel axle and having end openings, inside said beam the wheel axle is movable without load between two end positions in a vertical way. In such a way one or the other end of the wheel axle can be moved a defined distance under load. That the wheel axle can move without load means that there is some space where the wheel axle can move with respect to the suspension means if one imagines that all forces counteracting such a movement are eliminated. For instance, such a movement can be the fact if the whole wheel axle system was lifted such that the wheels "floated" in the air and displacement forces were allowed to act on the wheel axle in this situation. That the wheel axle can be moved a defined distance under load means that this movement can be the fact at the same time as forces are transferred from the suspension means to a base on which the wheels are running through the wheel axle. This movement under load is an angle motion of the wheel axle with respect to the suspension means having the centre of rotation situated at the one or other position of the force transmission between the suspension means and the wheel axle. Thus the wheel axle has a free motion within the suspension means and with respect to the beam if no loads exist. The advantages with such a "free movable" wheel axle are that the wheel axle is not connected with another suspension component at all. Furthermore such a wheel axle will be quite self-regulated for different types of load cases.

[0018] In one embodiment of the vehicle said distance is restricted on one hand by the suspension means and on the other hand by caps connected to the suspension means. According to the embodiments shown the suspension means restricts the movement of the wheel axle in the upward as well as in the forward and backward direction. Thus the suspension means and the cap determine the boundaries for the maximum movement of the wheel axle.

[0019] In one embodiment of the vehicle spacing means are arranged between the wheel axle and the suspension means to transfer force therebetween. Such spacing means can be assembled on suspensions or on the wheel axle and are adapted to transfer forces as a result of the mass of the tool.

[0020] In one embodiment of the vehicle the spacing means are arranged at the top side of the wheel axle within the beam close to the two ends thereof.

[0021] In one embodiment of the vehicle the spacing means are assembled on and around

guiding means assembled to a part of the wheel axle at least, said guiding means are equipped with assembling surfaces for assembling of the spacing means. In the embodiments shown these guiding means are designed as rectangular blocks with upper, front and rear cooperation surfaces. These surfaces cooperate with the suspension means and especially in one embodiment they are cooperating with the inside of the beam.

[0022] In one embodiment of the device said guiding means are equipped with a front length spacing mean and a rear length spacing mean. These length spacing means are an adaption of the position of the wheel axle with respect to the beam.

[0023] In one embodiment of the vehicle at least one of the length spacing means is equipped with one or more shims, that is thin inserts, for a more exact adjustment of the length position of the wheel axle with respect to the power beam. Shims may also be used to minimize the vertical move possibilities of the wheel axle.

[0024] In one embodiment of the vehicle all the suspension surfaces are planar. This embodiment is preferable as the planar surfaces are simple to assemble and are a regulated distribution of the forces transferred.

Brief Description of the Drawings

[0025] Now the invention will be described in more detail with references to the drawing figures included hereto. The drawing figures show only principle sketches to facilitate the understanding of the invention.

Fig. 1 shows an exploded view in perspective of a first embodiment of the invention.

Fig. 2 shows a perspective of the first embodiment of the invention assembled.

Fig. 3 shows a top view of the embodiment according to Fig. 2.

Fig. 4 shows a front view of the embodiment according to Fig. 2.

Fig. 5 shows an axial section view A-A according to Fig. 3.

Fig. 6 shows a cross section view B-B according to Fig. 4.

Fig. 7 shows an axial section view of a second embodiment according to the invention at a first load case.

Fig. 8 shows the section view according to Fig. 7 at a second load case.

Fig. 9 shows the section view according to Fig. 7 at a third load case.

Description of the Invention

[0026] Fig. 1 shows an exploded view of a wheel axle system 10 including a device according to an embodiment within the scope of the present invention at a wheel axle, which device includes a fixed wheel axle 11, at which a respective wheel 12, 13 is rotatable carried on the two axle ends. The wheel axle 11 is connected to a suspension means 14 directly or indirectly fixed to the frame of a tool in such a manner that the wheel axle 11 at one end at least is movable in a vertical direction with respect to the suspension means 14. The suspension means is designed to surround at least a part of the wheel axle 11 as a U-formed beam 15 equipped with end openings 16. Within the beam 15 the one end 17 and the other end 18 respectively of the wheel axle can be vertically moved a defined distance. The distance is restricted in the vertical direction upwards by spacing means 19 at the top side of the wheel axle 11. The spacing means 19 are assembled to top surfaces 20 of rectangular guiding means 21 in turn assembled around the wheel axle 11. Furthermore the guiding means are equipped with length spacing means 221, 222 being assembled to the front and rear surfaces of the guiding means for adjusting of the length position of the wheel axle in the suspension means 14. To obtain a further fine adjustment of the position one or more shims 223 being added to the length spacing means. The distance mentioned is also restricted in the vertical direction downwards by caps 23 connected to the end openings of the beam 15, said caps being connected to the ends of the beam by screw joints. The guiding means 21 are assembled around the wheel axle 11 at the two ends thereof. Thus also spacing means and length spacing means are assembled at said two ends. The two wheels 12, 13 are carried on the wheel axle through respective axle taps 24.

[0027] Fig. 2 shows the wheel axle system 10 as assembled. The wheels 12, 13 are assembled on their axle taps 24 and the wheel axle is assembled on the suspension means 14 by the caps 23, connected to the suspension means 14 by screw joints 25. As obvious from the figure the whole upper part of the wheel axle is surrounded by the suspension means 14. The suspension means is equipped with load reinforcements 26 shaped as disk beams being connected to a first assembling device 27 and a second assembling device 28 for the suspension means 14 attachment to a tool vehicle, not shown.

[0028] Fig. 3 shows a top view of the embodiment according to Fig. 2 having the two wheels 12, 13 connected with the axle taps 24 of the wheel axle and the suspension means 14 of the device.

[0029] Fig. 4 shows a front view of the embodiment according to Fig. 2 having the two wheels 12, 13 connected with the axle taps 24 of the wheel axle and the suspension means 14 of the device. The figure also shows an adjustment element 41 to stabilize the movements of the wheel axle 11 in the suspension means 14.

[0030] Fig. 5 shows an axial section view A-A according to Fig. 3 having the wheels 12, 13

carried by respective axle taps 24 at the ends of the wheel axle 11, in turn situated inside the suspension means 14. The wheel axle 11 bears against the inside of the suspension means 14 through the spacing means 19 at the top side of the wheel axle 11. At vertically downwards loaded suspension means 14 the wheel axle 11 and the spacing means 19 will be forced against the inside and the suspension means 14 as shown by the figure. If the downward directed force F is symmetrically positioned against the suspension means the forces will be distributed onto the wheel axle 11 with $F/2$ through each one of the spacing means 19 according to the vertically directed arrows in the figure. Furthermore the figure shows that in each one of the caps 23 there is a vertical play 51, 52 allowing the respective end of the wheel axle 11 to be displaced in a vertical direction within the suspension means 14 if there is any uneven load of the suspension means 14.

[0031] Fig. 6 shows a cross section view B-B according to Fig. 4 through the guiding means 21 being assembled around the wheel axle 11. The wheel 13 is connected to the wheel axle 11 as described above. The spacing means 19 situated on one side and being planar and horizontally assembled on the guiding means 21, bears against the inside of the top side of the suspension means 14. The figure shows also the play between the wheel axle 11 and the inside of the cap 23. The length spacing means 221, 222 are assembled in the length direction on the guiding means 21. These length spacing means are planar and assembled against vertically directed planar sides of the guiding means 21. An adaption of the length spacing means is made to adjust the position of the wheel axle in the length direction in the suspension means 14. Thereby the length spacing means 221, 222 bear against the vertical inner sides 61, 62 of the suspension means 14 according to the figure.

[0032] In connection with Figs. 7 through 9 some load cases are described illustrating the present invention.

[0033] Fig. 7 shows a first load case at a second embodiment of the invention with numeric references corresponding to those used in Fig. 5. Thus the figure shows a corresponding axial section view having the wheels 12, 13 carried by respective axle taps 24 at the ends of the wheel axle 11, in turn situated inside the suspension means 14. The wheel axle 11 bears against the inside of the suspension means 14 through the spacing means 19 at the top side of the wheel axle 11. If the downwards directed force F is symmetrically positioned against the suspension means the forces will be distributed onto the wheel axle 11 with $F/2$ through each one of the spacing means 19 according to the vertically directed arrows in the figure in the same manner as shown by Fig. 5. Furthermore the figure shows that in each one of the caps 23 there is a vertical play 51, 52 allowing the respective end of the wheel axle 11 to be displaced in a vertical direction within the suspension means 14 if there is any uneven load of the suspension means 14. In the figure the base 71, being quite planar, is shown with a dash dotted line. The base in the figure represents a rail section where the two rails are quite horizontal with respect to each other, i.e. the load case is quite symmetric. Equal large force is transferred to the contact with the respective base for each one of the wheels 12, 13. A tool vehicle is equipped with a front wheel axle 11 and a rear wheel axle, said two wheel axles are in the load case shown situated at a quite horizontal rail section and all the four wheels are in

contact with respective rail and the power is symmetrically transferred in dependence of the position of the centre of gravity of the tool vehicle.

[0034] Fig. 8 shows the same wheel axle 11 as in Fig. 7 but in this second load case one rail below the left hand wheel 12 is lower than below the right hand wheel 13 and therefore the wheel axle 11 at the left side is displaced inside the suspension means 14 a distance d , which corresponds to the corresponding distance d of the unfavourable geometry 81 of the rail section. Since the force F is proportional to the mass m according to the equation $F = ma$, a mass distribution to each rail may be as follows: 10 ton centre load is distributed only to the wheel axle 11 through the right hand spacing means 19. The transferred mass is distributed according to the moment law as $m_1x_1 = m_2x_2$, where the levers x_1 and x_2 are respective moment axle distance from the rail contact to the normal force line through the spacing means 19, which for a certain axle construction would give the distribution of the mentioned 10 t to be $m_1 = 1.13$ t and $m_2 = 8.87$ t. As also the left hand wheel 12 in the figure is in contact with the rail a certain part of the mass m_1 will be accumulated also by this wheel. The result will be that both sides are in contact with the base and the mass will be distributed to the two sides. In such a way one obtains a flexibility to the base though the unfavourable geometry at the same time as power is transferred through all the wheels being in contact with the base.

[0035] Fig. 9 shows a third load case where a tool, e.g. a bucket, is working with a load far away from the position of the centre of gravity of the tool, i.e. at the right hand side in the figure, with a downward directed force, which may correspond to the upward directed force F_2 acting on the suspension means 14 left side. From the position shown in Fig. 7 with a favourable load the load of Fig. 8 has been transferred in the right direction in the figure, whereby the suspension means 14 will be angled with respect to the wheel axle 11 around the support point at the position P1. The moment M_1 at this point will be $M_1 = F_2 \times Y_1$ around the position P1. However the wheel axle 11 will hit the cap 23 at the left hand wheel 23 when the twisting of the suspension means 14 obtained its largest twist, which is a hard warning to the operator that the limit for tilting is near. When the cap 23 hit the wheel axle 11 the suspension point for continued side load will be transferred from the position P1 to the position P2 whereby $M_2 = F_2 \times (Y_1 + Y_2)$. This implies that the moment arm for the tilting force has increased with the distance Y_2 , which implies a temporary reduction of the tilt moment. Thus on one hand a tilting warning is obtained before a real tilting is the fact by a loud impact in the construction with a device according to the present invention and on the other hand one obtains a safety margin against tilting of about 20% by this transfer of the suspension point.

[0036] In all the embodiments shown the wheel axle 11 is movable within the area defined upwards by the suspension means 14 and downwards by the cap 23. If all the suspension means 14 was raised such that the two wheels 12, 13 missed the rail contact the wheel axle 11 would be hanging free in the two sides of the cap 23. In such a hypothetical raised position the wheel axle 11 would have a vertically free movement within said area and would be moved upwards in a translatory way until the two sides of the wheel axle are in contact with the suspension means 14. Of course within the scope of such a translatory motion the wheel axle 11 can carry out also angle movements within this area as is shown by Figs. 8 and 9. Though

the figures show a suspension mean 14 combined with a cap 23 to define the restricted area for the movement of the wheel axle the invention also comprises other constructions of suspension means which as a whole defines the restricted area for the movements of the wheel axle. E.g. the suspension means can be designed as a tube with a cylindrical or rectangular cross section having an inside measure exceeding the outside measure of the wheel axle in such a way to define the restricted movement area for the wheel axle. In such constructions the wheel axle is inserted from one end of the suspension means. Other constructions of the suspension means may be such that it is designed in an upper part and a lower part being put together around the wheel axle and thereby define the restricted movement area of the wheel axle.

[0037] Though only a few embodiments within the scope of the invention have been described there are many more embodiments conceivable within the scope of the claims enclosed.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- [WO9113786A \[0007\]](#)
- [US2798735A \[0008\]](#)

INDRETNING TIL EN HJULAKSEL OG SPORBUNDET KØRETØJ MED EN SÅDAN HJULAKSEL

Patentkrav

1. Jernbanekøretøj, der er forsynet med en stiv hjulaksel (11), på hvilken der roterbart er monteret et hjul (12, 13) i hver af de to ender deraf, hvor hjulakslen (11) er forbundet med og er fastholdt med et ophængningsmiddel (14), som direkte eller indirekte er fikseret til køretøjets ramme på en sådan måde, at mindst én ende af hjulakslen (11) kan bevæges i en vertikal retning i forhold til ophængningsmidlet (14), **kendetegnet ved, at** ophængningsmidlet (14) omgiver mindst en del af hjulakslen (11), hvor ophængningsmidlet (14), alene eller i kombination med yderligere midler, er anbragt med henblik på at tillade en begrænset fri translatorisk bevægelse af hjulakslen (11) i forhold til ophængningsmidlet (14), idet den begrænsede frie translatoriske bevægelse er begrænset til en defineret afstand inden i ophængningsmidlet.

2. Jernbanekøretøj ifølge krav 1, **kendetegnet ved, at** ophængningsmidlet (14) indbefatter en bjælke (15) oven over og delvist omgivende hjulakslen (11) og med endeåbninger (16), inde i hvilken bjælke hjulakslen (11) uden last kan bevæges translatorisk mellem to endepositioner på en vertikal måde, således at den ene eller den anden ende (17, 18) af hjulakslen (11) ved last kan bevæges en defineret afstand.

3. Jernbanekøretøj ifølge et hvilket som helst af kravene 1-2, **kendetegnet ved, at** afstanden på den ene side er begrænset af ophængningsmidlet (14) og på anden side af kapper (23), der er forbundet med ophængningsmidlet (14).

4. Jernbanekøretøj ifølge et hvilket som helst af kravene 1-3, **kendetegnet ved, at** der er anbragt afstandsmidler (19, 221, 222) mellem hjulakslen (11) og ophængningsmidlet (14) til overførsel af kraft derimellem.

5. Jernbanekøretøj ifølge krav 4, **kendetegnet ved, at** afstandsmidlerne (19) er anbragt på oversiden af hjulakslen (11) inden i bjælken (15) tæt på de to ender deraf.

6. Jernbanekøretøj ifølge et hvilket som helst af kravene 4-5, **kendetegnet ved, at** afstandsmidlerne (19, 221, 222) er monteret på og omkring styremidler (21), der mindst er monteret på en del af hjulakslen (11), idet styremidlerne er forsynet med montageoverflader (20) til montering af afstandsmidlerne (19, 221, 222).

7. Jernbanekøretøj ifølge krav 6, **kendetegnet ved, at** styremidlerne (21) er forsynet med et forreste længdeafstandsmiddel (221) og et bageste længdeafstandsmiddel (222).

8. Jernbanekøretøj ifølge krav 7, **kendetegnet ved, at** mindst ét af længdeafstandsmidlerne (221, 222) er forsynet med én eller flere underlagsskiver (223) til indstilling af hjulakslens (11) position.

9. Jernbanekøretøj ifølge et hvilket som helst af kravene 6-8, **kendetegnet ved, at** alle ophængningsfladerne (20) er plane.

DRAWINGS





