March 14, 1961 W. GRUBE 2,974,608

SUSPENSION RAILWAY

Filed March 19, 1957 3 Sheets-Sheet 1

Fig. 1

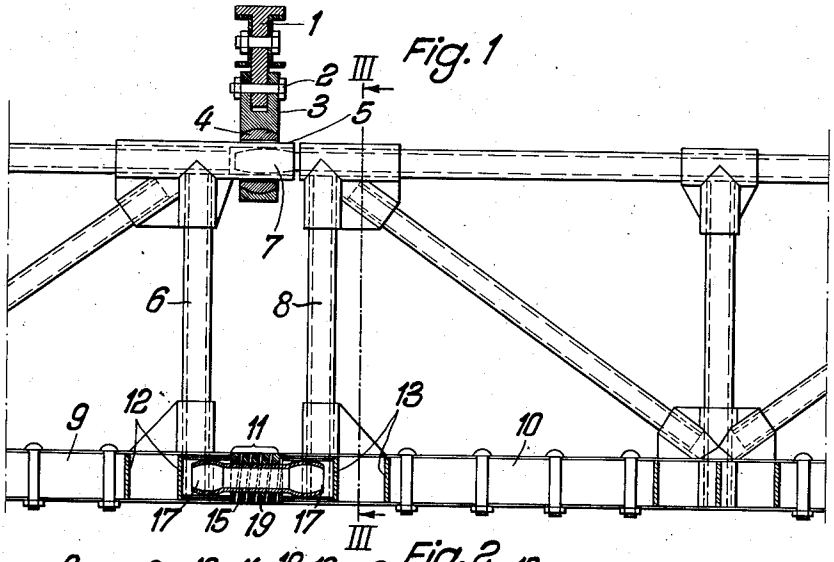


Fig. 2

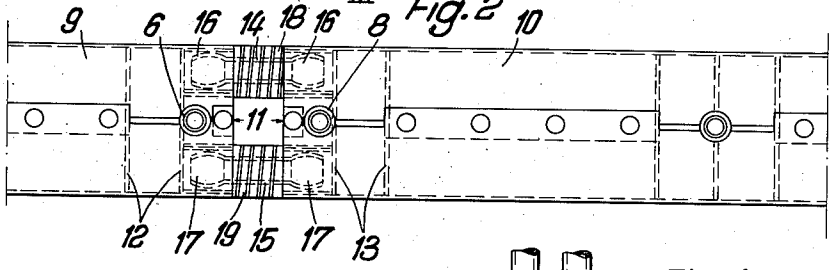


Fig. 4

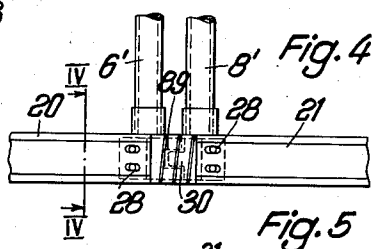


Fig. 5

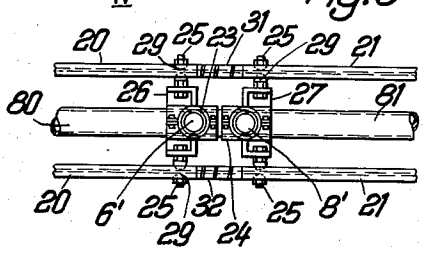
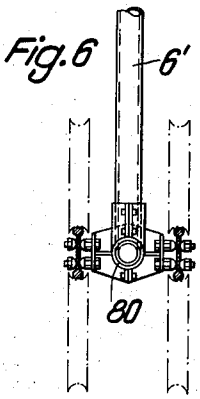


Fig. 6



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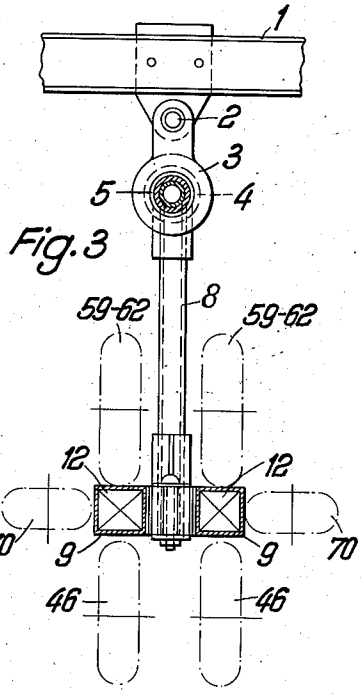


Fig. 3

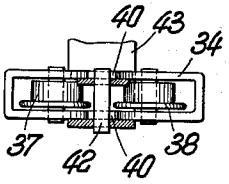


Fig. 9

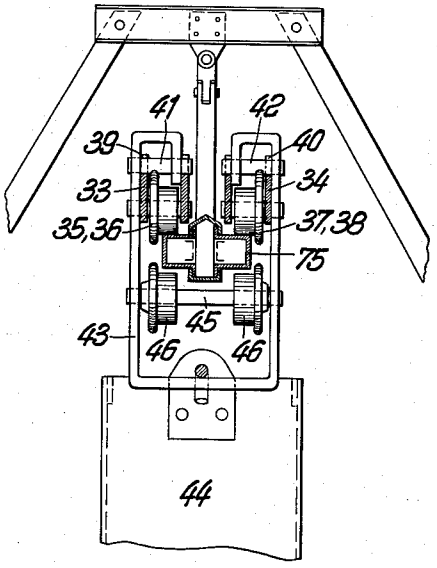


Fig. 8

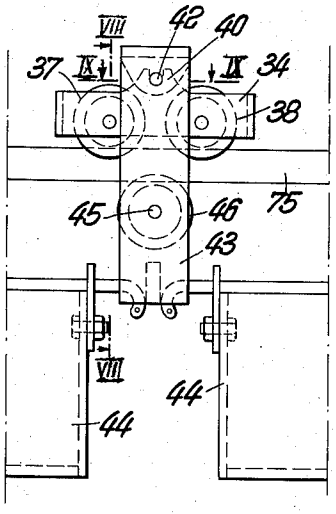


Fig. 7

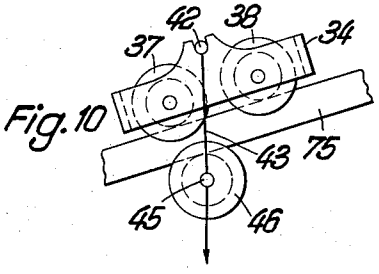


Fig. 10

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SUSPENSION RAILWAY

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Fig. 11

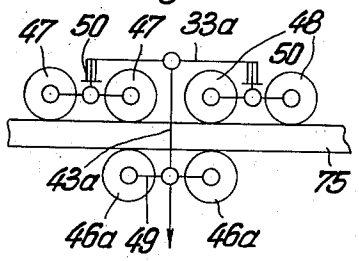


Fig. 12

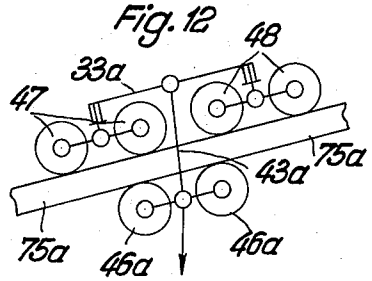


Fig. 13

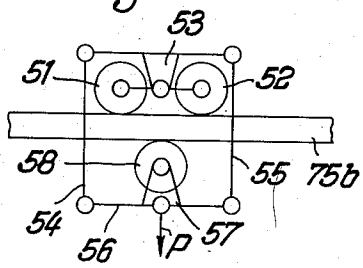


Fig. 14

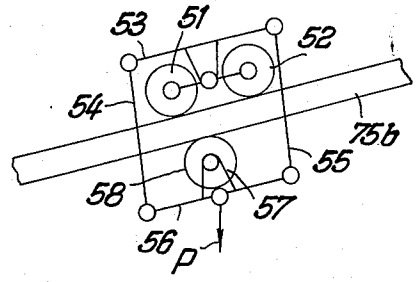


Fig. 15

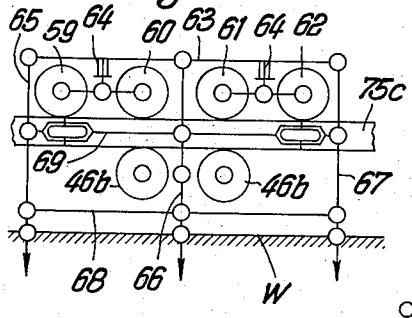


Fig. 16

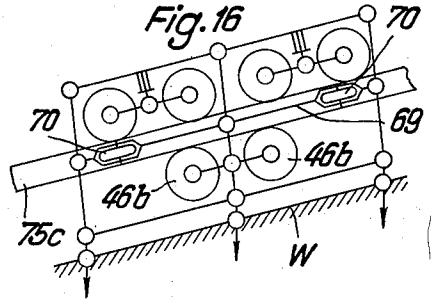
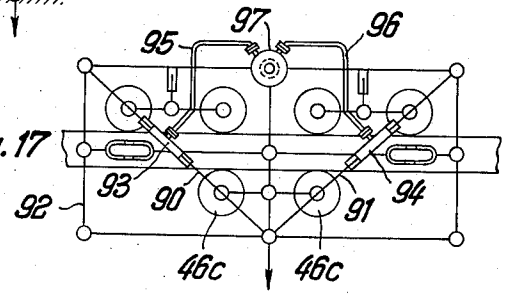


Fig. 17



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SUSPENSION RAILWAY

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2 Claims. (Cl. 104—95)

The present invention relates to a suspension railway consisting of at least one overhead-rail track composed of a plurality of rail sections which are suspended on suitable supporting elements which, in turn, are mounted on cables or a latticed framework connecting the supporting pillars of such railway with each other, and on which persons or goods may be transported by means of traveling gears, each of which is provided with at least one check wheel which may be pressed upwardly against the lower surface of the rail track.

The overhead-rail tracks as are presently known have the disadvantage that the connections between the adjacent ends of the rail sections are flexible only within a vertical plane and that such connections are rigid within any other plane.

Furthermore, the check wheels of the traveling gears of these known suspension railways always engage with the rail track under pressure from below not only when the track is inclined but even when it extends horizontally. Therefore, such check wheels always exert a considerable friction which then has to be overcome by an increase of driving force.

It is an object of the present invention to provide a suspension railway consisting of at least one overhead-rail track which is composed of a plurality of rail sections which are suspended on suitable supporting elements in such a manner that the connections between these rail sections will be flexible both within a vertical and a horizontal plane.

Another object of the present invention is to provide an overhead-rail track, wherein the adjacent rail sections are connected with each other so as to be capable of shifting relative to each other in a longitudinal direction, for example, to compensate for temperature influences upon the individual rails.

A further object of the invention is to provide an overhead railway, the rail sections of which are flexibly connected with each other so as to be pivotable relative to each other in any direction, and thus to be able to take up transverse stresses to which the track and its supporting framework might be subjected, for example, by strong lateral winds, without any danger that any parts thereof might bend or break under such stresses. Consequently, according to the invention, the supporting pillars or posts, between which the rail track is suspended in a manner known as such on suitable supporting elements and by means of cable or latticed frame structures connecting the pillars with each other, may be mounted at much greater distances from each other than was possible with the known suspension railways as above described, in which the connection of the adjacent rail sections was rigid within a horizontal plane. This, in turn, means that an overhead track according to the invention may be supported by a smaller number of pillars than previously required, and that areas can thus be more easily bridged by such overhead track where supporting columns or pillars can only be erected with great difficulty and at great expense.

Another object of the present invention is to provide a traveling gear for an overhead-rail track which is provided with at least one check wheel which is adapted to be entirely disengaged from the lower surface of the rail track at a horizontal stretch thereof, or, at any rate, to engage therewith at such time only loosely and without considerable friction, and which is adapted to engage with the lower side of the rail track when the latter is upwardly or downwardly inclined, and at a pressure depending upon the degree of inclination of the track and the weight of the load which is perpendicularly suspended on the traveling gear.

One object of such a traveling gear is to prevent any detrimental effect upon the universal flexibility of the connections between the adjacent rail sections as may be caused by the continuous pressure and friction of the check wheels of the traveling gear upon the lower surface of the rails, and further to attain a considerable saving in the energy required to drive the suspension railway by avoiding the usual friction of the check wheels on the rail track when the traveling gear runs along a horizontal level.

Another object of such a traveling gear is to increase the pressure and friction of both the running and check wheels thereof upon the upper and lower surfaces of the wheel track when the traveling gear runs along an upwardly or downwardly inclined track. Thus, when the traveling gear runs downwardly, such wheel pressure upon both sides of the rail or rails exerts a braking action upon the downward movement, while when it runs upwardly, the pressure of the check wheels upon the lower rail surface increases the pressure of the running wheels on the rail track so as to overcome the gradiant more easily.

These objects and advantages of the present invention may be attained according to the invention by supporting the adjacent rail sections of the track so as to be substantially freely movable relative to its bearing supports which, in turn, are mounted on the supporting elements which connect the supporting pillars by means of a latticed framework or cable structure, and further by connecting the ends of the adjacent rail sections of each track with each other by a ball-and-socket joint. These objects and advantages of the invention are further attained by the provision of a traveling gear which is adapted to roll on wheels or rollers along the mentioned rail track and forms a flexible frame on which a load of any kind, either consisting of persons or material, may be suspended perpendicularly thereto, and which is provided with at least one check wheel or check roller which is adapted to engage from below against the rail track or rail tracks. While on a horizontal track, such flexible frame retains its normal shape, and the check wheels will not or only loosely engage with the lower side of the track, the weight of such a load which always acts upon the flexible frame in a perpendicular direction thereto will, when the traveling gear moves along an upwardly or downwardly inclined track, deform the shape of the frame and thereby reduce the distance between the running wheels and check wheels so that the latter will then engage with the lower side of the track and both sets of wheels will run on the track under an increased friction, pressing against the track from opposite sides.

A further object of the present invention is to provide a traveling gear of the type as described above with an additional mechanism which permits a positive engagement of the check wheels upon the rail track regardless of any inclination thereof so as to control the braking action of such check wheels when the traveling gear runs along an inclined track, and to permit such braking action also to be applied when the traveling gear runs along a horizontal track.

These and still further objects, features, and advantages of the present invention will be apparent from the following detailed description thereof, particularly when read with reference to the accompanying drawings, in which—

Fig. 1 shows a side view of the place of connection of two adjacent double-track rail sections of a suspension railway according to the invention with their supporting structure;

Fig. 2 shows a plan view of Fig. 1;

Fig. 3 shows a cross section taken along line III—III of Fig. 1;

Fig. 4 shows on a slightly reduced scale as compared to Fig. 1, a side view of a modification of the invention;

Fig. 5 shows a plan view of the embodiment according to Fig. 4;

Fig. 6 shows a cross section taken along line VI—VI of Fig. 4;

Fig. 7 shows a side view of a simple traveling gear according to the invention;

Fig. 8 shows a cross section taken along line VIII—VIII of Fig. 7;

Fig. 9 shows a cross section taken along line IX—IX of Fig. 7;

Fig. 10 shows a simplified side view of the traveling gear according to Fig. 7 on an inclined rail track;

Fig. 11 shows a diagrammatic illustration of a modification of the traveling gear according to the invention on a horizontal track;

Fig. 12 shows the traveling gear according to Fig. 11 on an inclined track;

Fig. 13 shows a diagrammatic illustration of another modification of the traveling gear according to the invention on a horizontal track;

Fig. 14 shows the traveling gear according to Fig. 13 on an inclined track;

Fig. 15 shows a diagrammatic illustration of a further modification of the traveling gear according to the invention on a horizontal track;

Fig. 16 shows the traveling gear according to Fig. 15 on an inclined track; while

Fig. 17 shows a diagrammatic illustration of still another modification of the traveling gear according to the invention provided with a hydraulic control mechanism for operating the check wheels.

Referring to the drawings, and first particularly to Figs. 1 to 3, a beam 1 forms a part of the latticed framework of the overhead-railway 1 which is mounted on suitable pillars or posts, not shown, which are disposed at suitable intervals. A bearing member 3 is pivotally suspended on beams 1 by means of a bolt 2 and supports a bushing 4 with spherical outer surfaces which is rotatably mounted in a corresponding aperture in bearing member 3. A tubular extension 5 of a supporting frame 6 extends through and is supported by bushing 4, and a pear-shaped member 7 which is secured to a second supporting frame 8 engages into this tubular member 5 and is slidable as well as pivotable therein to some extent. Thus, it will be seen that supporting frames 6 and 8 can shift relative to each other in their longitudinal direction, and that they are also pivotable with respect to each other as well as with respect to bearing member 3. Frames 6 and 8 form the supporting structure of a double-rail track which is composed of rail sections 9 and 10. In the embodiment of the invention as shown in Figs. 1 to 3, this double-track consists of hollow members of rectangular cross section made of sheet metal. The adjacent ends of rail sections 9 and 10 are separated from each other by a distance 11. The ends of rail sections 9 are suspended on supporting frame 6, while the ends of the adjacent rail sections 10 are suspended on supporting frame 8. For this purpose, cross members 12 and 13 are centrally secured to frames 6 and 8, respectively, and extend toward both sides thereof. These cross members 12 and 13 have a shape, as shown in Fig. 3, corresponding to the

rectangular cross section of the hollow rail sections 9 and 10, and the adjacent outer ends of rail sections 9 and 10 are freely slidable in the longitudinal direction on these cross members 12 and 13. The adjacent ends of rail sections 9 and 10 of each track are connected with each other by means of connecting members 14 and 15 having spherical ends 16 and 17, respectively, which engage into the hollow ends of rail sections 9 and 10 and have an outer diameter substantially corresponding to the maximum inner diameter of these hollow ends. Thus, rail sections 9 and 10 of each track are connected by ball-and-socket joints and are freely movable relative to each other within a vertical plane and are also capable of pivoting in all directions with respect to each other.

In order to provide a support for the running wheels and check wheels or check rollers of a traveling gear even within the space 11 between the adjacent ends of rail sections 9 and 10, these ends are connected by coil springs 18 and 19 of a rectangular cross section which surround the free central part of connecting members 14 and 15 and abut under spring pressure against the adjacent ends of rail sections 9 and 10. These springs 18 and 19 are disposed so that at least their upper surface coincides with the plane of the upper surface of rail sections 9 and 10. If the traveling gear is also provided with check wheels which are adapted to engage with the lower surface of rail sections 9 and 10, as indicated in dotted lines in Fig. 3, the lower surface of coil springs 18 and 19 should, of course, also coincide with the lower surface of rail sections 9 and 10, as shown in Fig. 1.

Instead of making the track of hollow rectangular rail sections 9 and 10 of sheet metal, the sections may also be made of any other suitable cross-sectional shape since the latter is of no particular importance insofar as the present invention is concerned.

Thus, for example, the track may also be made of steel rails 20 and 21, as shown in Figs. 4 to 6, in which the upper parts and the bearing structure of the supporting frames are not shown as they may be similar to those shown in Fig. 1, in that the two supporting members 6' and 8' are capable of shifting relative to each other in the longitudinal direction of the track and are also pivotable in all directions relative to each other.

The lower ends of supporting members 6' and 8' which may be, for example, of tubular cross section are provided with connecting members 26 and 27 which may, for example, be clamped thereto and have tubular extensions 23 and 24, respectively, within which the outer ends of lower chord sections 80 and 81 of the supporting structure of a length corresponding to that of rail sections 20 and 21 are mounted so as to permit members 23 and 24 and supporting members 6' and 8' thereon to slide longitudinally relative to each other.

For securing the ends of rail sections 20 and 21 to connecting members 26 and 27, respectively, the rail ends are provided with longitudinally extending slots 28 in which bolts 25 are mounted. These bolts are provided with spherical washers or the like 29, the spherical surfaces of which engage with rail sections 20 and 21 so as to insure that bolts 25 will not interfere with the universally pivotable connection of rails 20 and 21. Each of rails 20 has a cutout 89, and the adjacent end of the corresponding rail 21 is provided with a ball-shaped head 30 which engages in cutout 89 so that the two end portions of rails 20 and 21 are capable of sliding relative to each other in the longitudinal direction and also of pivoting with respect to each other in all directions. Similarly as shown in the embodiment according to Figs. 1 to 3, the adjacent ends of rails 20 and 21 are also provided with coil springs 31 and 32, respectively, of rectangular cross section, the upper and lower surfaces of which lie within the same plane as the upper and lower surfaces of rails 20 and 21.

The traveling gear to be used on an overhead-rail track as above described for carrying any kind of load, either

persons or materials, may be of different types, as illustrated, for example, in Figs. 7 to 17. According to Figs. 7 to 10, such traveling gear if designed for a double-rail track as shown in Figs. 1 to 3 or 4 to 6, respectively, may consist, for example, of two rectangular frames 33 and 34 in each of which a pair of rimmed wheels 35 and 36 and 37, 38, respectively, is rotatably mounted. Each frame 33 and 34 is further provided at a central point above the wheels with a bearing 39 and 40, respectively, in each of which a pivot pin 41 or 42, respectively, is rotatably mounted. These pivot pins together carry a bracket 43 which is suspended on frames 33 and 34 like a pendulum. The lower end of bracket 43 supports the load which may likewise be pivotally suspended thereon and which, in the particular example illustrated in Figs. 7 and 8, consists of containers 44 in which any kind of material may be transported. In place of such containers, suitable cabs or carriages may also be suspended on these brackets 43 for the transportation of persons. Underneath the double-rail 75, a shaft 45 with wheels 46 thereon is rotatably mounted within bracket 43 which serve as check wheels and may at certain times engage with considerable friction against the lower surface of rails 75 to exert a braking action upon the movement of the traveling gear. If the traveling gear runs along a substantially horizontal stretch of track 75, check wheels 46 will not, or only loosely, engage with the lower surface of track 75, so that in such case only the friction of the running wheels 35 to 38 has to be overcome to drive the traveling gear. If, however, track 75 is upwardly or downwardly inclined, as shown in Fig. 10, bracket 43, which on a horizontal stretch of the track is suspended perpendicularly thereto, will pivot from such perpendicular position under the weight of its load 44 like a pendulum and thereby pivot check wheels 46 toward running wheels 35 and 37 or toward running wheels 36 and 38, respectively, thereby reducing the distance between check wheels 46 and these respective running wheels, so that both sets of wheels will then engage the upper and lower surfaces of track 75 with considerable friction, the strength of which depends upon the degree of angularity of track 75 and the weight of the load suspended on bracket 43. Thus, in a downward movement, check wheels 46 produce a braking action, while in an upward movement, their action upon the lower side of track 75 produces a firmer adherence of the running wheels 35 to 38 upon the track.

The modification of the traveling gear as shown in Figs. 11 and 12 differs from that shown in Figs. 7 to 10 by the provision of two double-sets of running wheels 47 and 48 for supporting frame 33*a* on track 75*a*, and by the provision of vertical pivots 50 for balancing the traveling gear or adapting the same to a curved track. A bracket 43*a* is suspended on frame 33*a* and carries a flexible frame 49 which, in turn, carries a pair of check wheels 46*a*. The effect and operation of this traveling gear is otherwise similar to that as shown in Figs. 7 to 10 and therefore does not need to be again described.

According to the modification of the traveling gear as shown in Figs. 13 and 14, an upper frame 53 supporting the running wheels 51, 52 carries a normally rectangular but adjustable frame which is composed of a pair of parallel arms 54 and 55, the mentioned upper frame 53, and parallel to such upper frame a lower frame 56 on which the load P is suspended. The check rollers 58 are mounted vertically above load P in bearings 57 on the lower frame 56 so that, when the traveling gear moves along a horizontal stretch of track 75*b*, check rollers 58 will not or only loosely engage with the lower side of track 75*b*. If track 75*b* is upwardly or downwardly inclined, as shown in Fig. 14, the weight of load P will change the angularity of the parallelogram 53 to 56 so that check roller 58 will press with considerable friction against the lower surface of track 75*b*.

The embodiment of the invention as shown in Figs. 15 and 16 is similar to that shown in Figs. 11 and 12 insofar as the number and arrangement of the carrying wheels and check wheels is concerned. However, the frame of the traveling gear also forms a flexible parallelogram. For this purpose, the two double sets of carrying wheels 59 to 62 carry a frame 63 by means of vertical pivots 64, and this frame is connected by three parallel arms 65, 66, and 67 to a lower frame 68 which extends parallel to frame 63 and on which a load W is suspended which is only indicated diagrammatically and may, for example, be a carriage or cab for transporting people. This load W is suspended on frame 68 at three different points and in such a manner that it is disposed perpendicularly below track 75*c* when such track extends horizontally, so that at such time the check wheels 46*b* which are mounted on the central arm 66 will be disengaged from the lower side of track 75*c*. If, however, track 75*c* is upwardly or downwardly inclined, as shown in Fig. 16, the angularity of the parallelogramlike frame will change under the action of load W, so that check wheels 46*b* will be applied with a considerable frictional pressure against the lower surface of track 75*c*.

In order to maintain the traveling gears, such as shown, for example, in Figs. 15 and 16, in proper engagement with track 75*c* also in a lateral direction thereof, intermediate frame members 69 may be provided which flexibly connect arms 65, 66, and 67 with each other laterally of track 75*c* and rotatably support guide wheels 70 which are adapted to engage with the side walls of track 75*c*.

The running wheels and check wheels of each traveling gear may be provided with wheel flanges, as shown in Figs. 7 to 10 so as to guide the wheels along the rails. They may, however, also be provided with elastic or pneumatic tires, as indicated, for example, in Fig. 3, in which case the lateral guide wheels may also carry such tires.

In the event that it should be advisable or necessary to utilize the check wheels for braking purposes, regardless of whether the rail track extends horizontally or is either upwardly or downwardly inclined, a special mechanism may be provided to move these wheels positively toward or away from the lower side of the rails. A mechanism of this type is shown, for example, in Fig. 17 and may consist of diagonal frame members 90 and 91 which connect the outer upper ends of frame 92 with the central lower point thereof, and of cylinders 93 and 94, respectively, which are interposed in these diagonal frame members and are connected by flexible tubing 95 and 96 to a pump 97 for supplying a hydraulic pressure fluid, either liquid or gaseous, to cylinders 93 and 94. Depending upon the direction of operation of pump 97, the hydraulic fluid will either be passed from cylinder 93 into cylinder 94 or vice versa, and the pistons slidable in these cylinders will thus either be placed under pressure or be released. Frame 92 will then by such hydraulic operation be either contracted or expanded, and check wheels 46*c* will thus be moved positively either toward or away from the rail track. In the normal operation of the traveling gear, pump 97 will be disconnected so that the pistons in cylinders 93 and 94 will slide therein freely and without being resisted by the hydraulic fluid.

The frame structure supporting the traveling gear according to Fig. 17 may be designed so that the angularity of the parallelogram forming the frame will change automatically as previously described in accordance with the inclination of the rail tracks and the weight of the load carried by the frame. However, if the check wheels are to exert an additional braking action when the traveling gear is running downwardly, or are to increase the friction of the running wheels on the rail tracks when running upwardly, the hydraulic control mechanism may be operated. This mechanism may, of course, also be operated on a horizontal track to reduce the speed of the traveling gear and even to serve as a brake to stop the movement.

Although my invention has been illustrated and de-

scribed with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments but is capable of numerous modifications within the scope of the appended claims. Thus, for example, the control mechanism may be of a different design than that described above and illustrated in Fig. 17, and such control mechanism may also be of a type other than hydraulic, and may even be purely mechanical and adapted to be operated by hand.

Having thus fully described my invention, what I claim as new is:

1. A suspension railway comprising in combination, at least two rail tracks consisting of a plurality of rail sections which are mounted in pairs parallel to each other in a horizontal and spaced relation, means for supporting said rail sections freely pivotable against each other above the ground, said means comprising a plurality of supporting members extending substantially in a vertical direction, each of which supports at its lower end one end of one of said pairs of rail sections; joints for securing said supporting members, said joints comprising horizontal extensions secured to the upper ends of adjacent supporting members, one of said horizontal extensions having a substantially pear-shaped end, the other of said horizontal extensions having a tubular end portion for receiving slidably and pivotably the substantially pear-shaped end of the one horizontal extensions, to allow for flexibility about a vertical axis passing through the joint; means for allowing rotation of said horizontal extension about a longitudinal axis, comprising, a bearing member having an inner spherical aperture, a bushing slidably mounted on said tubular end of said other horizontal extension and having a substantially spherical outer surface received in the spherical aperture of said bearing member; the adjacent ends of each of said rail sections being formed with hollow portions and spaced in longitudinal direction, means for joining the ends of said rail sections, said joining means comprising connecting members having spherical end portions received in said hollow portions of the adjacent rail ends, to allow flexibility about a vertical axis passing through the joint, and spring means enclosing said connecting members, said spring means having ends abutting against the respective end of the adjacent rail sections.

2. The suspension railway according to claim 1, wherein said spring means comprise coil springs of rectangular shape.

References Cited in the file of this patent

UNITED STATES PATENTS

403,443	Patric	May 14, 1889
544,677	Maag	Aug. 20, 1895
589,714	Glenn	Sept. 7, 1897
596,015	Cook	Dec. 21, 1897
916,390	Cuno	Mar. 23, 1909
1,811,270	Henderson	June 23, 1931
2,425,739	Henderson	Aug. 19, 1947
2,771,309	Clark	Nov. 20, 1956
2,781,001	Davino	Feb. 12, 1957
2,884,655	Maddox	May 5, 1959

FOREIGN PATENTS

504,571	Belguim	July 31, 1951
453,350	Germany	Dec. 8, 1927
608,641	Great Britain	Sept. 17, 1948