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<th><strong>54</strong></th>
<th><strong>Title</strong></th>
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<td>Inclination control for a rail-mounted vehicle</td>
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<th><strong>51</strong></th>
<th><strong>International Patent Classification(s)</strong></th>
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<td>B61F 005/00</td>
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<th><strong>21</strong></th>
<th><strong>Application No:</strong> 200020693</th>
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<td><strong>Application Date:</strong> 2000.03.07</td>
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<th><strong>33</strong></th>
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<th><strong>43</strong></th>
<th><strong>Publication Date:</strong> 2000.09.21</th>
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<th><strong>71</strong></th>
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<tr>
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The invention proposes an inclination control system for a rail-mounted vehicle which is negotiating a curve in the track, and in which there is a memory (3) in which the section data (S) from the track system such as for example straight sections, curves of constant radius, points and elevated sections are stored as a function of distance and/or geodetically. As a function of the constantly acquired current location of the vehicle (1), so inclination signals (N) for positioning elements (9) which serve to control inclination can be derived from these section data (S).

Advantageously, the inclination technology of the rail-mounted vehicle may so enjoy optimum and in particular precise use that always the maximum speed of the vehicle can be attained while utilising and maintaining maximum transverse acceleration. The positioning elements for controlling the inclination are always operated without delay and with the optimum inclination signals.

Significant drawing: Fig. 1
Invention Title:

Inclination control for a rail-mounted vehicle

The following statement is a full description of this invention including the best method of performing it known to us:
Description

The invention refers to an inclination control for a rail-mounted vehicle, in accordance with the preamble to claim 1.

The trend towards ever greater speeds in conjunction with existing sections of track which generally feature many bends, is leading to the use of rail-mounted vehicles boasting inclination technology and thus to the negotiation of curves in the track with high and uncompensated transverse accelerations.

An unavoidable prerequisite of inclination technology is the knowledge of the current parameters of the bend such as the curve radius camber, start and finish or length of the bend in the track and data concerning the respective transition curves for travelling at the maximum possible speed while at the same time maintaining a maximum possible transverse acceleration. These parameters can only be ascertained approximately with sensors and other acquisition systems on the rail-mounted vehicle.

A further important requisite for the optimum use of inclination technology is the differentiation between travelling over points (in which case there must be no inclination control) and a curve in the track which, upon acquisition of the curve data, generally results in a disadvantageous delay before the inclination control commences in the curve.

The invention is based on the problem of proposing an inclination control for a rail-mounted vehicle and which makes optimum and in particular undelayed use of the inclination technology possible.

According to the invention, this problem is resolved by measures indicated in the characterising part of claim 1, in conjunction with the features set out in the preamble.
In particular, the advantages which are attainable by the invention reside in that the inclination technology of the vehicle can be so optimally and in particular precisely used that always the maximum speed of the vehicle is attained while maximum transverse acceleration is utilised and respected. The final control elements for inclination control are always actuated with no delay and with the optimum inclination signals. Inclination control commences already when the individual vehicles of a train enter a curve in the track. At the end of the curve, the inclination control is automatically withdrawn, likewise without any delay, since the length of the curve is known. Inclination control when passing over points is out of the question.

Advantageous further developments of the invention are disclosed in the sub-claims.

Further advantages of the proposed inclination control will emerge from the following description.

The invention is explained in greater detail hereinafter with reference to the example of embodiment shown in the accompanying drawings, in which:

Fig. 1 shows a basic embodiment of inclination control for a rail-mounted vehicle;
Fig. 2 shows a first alternative form of inclination control;
Fig. 3 shows a second alternative form of inclination control.

Fig. 1 shows a basic embodiment of inclination control for a rail-mounted vehicle. It shows, framed in dash-dotted lines, a rail mounted vehicle 1 with a control/regulating unit 2 for controlling the inclination of the vehicle. The control/regulating unit 2 for controlling inclination and which is framed by broken lines comprises particularly a memory 3 and a computer unit 8. The memory 3 receives on the input side signals G from a sensor 4 which is arranged to receive GPS signals (GPS = Global Positioning System, a satellite-supported navigation system) and/or distance signals W from a sensor 5 which serves to determine distance over ground.
Stored in the memory 3 are all the essential line data regarding the track system over which the vehicle is running, such as in particular the straight sections, curves with a precise radius of curvature, transition curves, points and any super-elevated portions, as a function of the distance (for example by a "mileage rating" of the journey) and/or geodetically (for example via precise land/field survey), the said data being stored for instance in the form of a CD (compact disc). From the signals G received on the input side and which serve to determine location and/or distance signals W, the memory 3 constantly ascertains the associated stored data S relating to the section of the journey, for example the length of the straight portions currently being negotiated and the radius of curvature of the next curve in succession, and delivers these data S to the computer unit 8.

Acquisition of the distance signals W is particularly important if the track system also includes tunnels in which there is no possibility of receiving signals G. In the event of both signals G and also distance signals W being used, there is preferably a synchronisation of both signals after predeterminable periods of time.

As a function of the track data S received on the input side, the computer unit 8 delivers on its output side inclination signals N to control elements 9 for controlling inclination, i.e. the necessary distances for inclination control for the respective curve in the track are or will be precisely computed. Commencement of inclination control upon reaching the curve and resetting of the inclination control to its starting position at the end of the curve are precisely predetermined by the track data S. In this respect, memory 3 and computer unit 8 can naturally also be combined into one single unit which, on its input side, receives signals G and/or distance signals W and, on its output side, delivers the appropriate inclinations signals N.

Fig. 2 shows a first alternative form of inclination control. The alternative corresponds to the basic embodiment but the computer unit 8 additionally receives on its input side current train data Z such as in particular the speed at which the rail-mounted vehicle is travelling at that particular point in time, the total length of the train and the length of one
carriage of the train. On the output side, the computer unit 8 delivers inclination signals N which are optimally adapted to the drain data Z to positioning members 9 for controlling the inclination. Since the individual lengths of the individual vehicles in a composite train are known, the inclination control of each individual vehicle advantageously takes place according to its actual location before the curve in the track, in the curve and after the curve, all at the respective points in time.

Fig. 3 shows a second alternative embodiment of inclination control. The alternative corresponds to the basic embodiment but on its input side the computer unit 8 receives both the train data Z as well as additional position signals P from a sensor 6 mounted on the vehicle and arranged to determine position (and which receives signals from position sensors mounted along the track) and/or direction signals R from a direction sensor 7 mounted on the vehicle.

The advantage of this developed embodiment of the invention resides in that the precise point in time at which inclination control commences and/or is withdrawn can be additionally influenced via the position signals P and/or direction signals R. As a function of the current train data Z, the computer unit 8 converts the section data S fed to it into inclination signals N for the positioning elements 9 as soon as the sensor 6 and/or the direction sensor 7 indicates the commencement of the curve (see position signals P and/or direction signals R).

In accordance with further alternative embodiments which are not shown, it is possible to feed the position signals P and/or direction signals R likewise or exclusively to the memory 3 in order to effect a constant balancing or adaptation of the signals, which further enhances the accuracy of the inclination control. A further alternative embodiment is possible in which the positions signals P are used instead of the distance signals W.
List of reference numerals

1 Rail-mounted vehicle
2 Control/regulating unit for inclination control
3 Memory
4 Sensor for receiving GPS signals
5 Sensor for determining distance over ground
6 Sensor for determining position
7 Direction sensor
8 Computer unit
9 Positioning elements for inclination control

G Signals
N Inclination signals
P Position signals
R Direction signals
S Section data
W Distance signals
Z Current train data
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. An inclination control for a rail-mounted vehicle in a curve, characterised in that a memory (3) is provided in which the section data (S) concerning the track system such as in particular the straight sections, curves of constant radius, switches and elevated sections are stored according to distance and/or geodetically and in that from these section data (S) and as a function of the constantly ascertained present location of the vehicle (1), so inclination signals (N) can be derived for positioning elements (9) which serve to control inclination.

2. An inclination control according to claim 1, characterised in that signals (G) from a sensor (4) arranged to receive GPS signals are used for determining location.

3. An inclination control according to claim 1 and/or 2, characterised in that distance signals (W) from a sensor (5) which serves to determine distance over ground are used for determining position.

4. An inclination control according to one of the preceding claims, characterised in that position signals (P) from a sensor (6) arranged for determining position are used for determining location.

5. An inclination control according to one of the preceding claims, characterised in that direction signals (R) from a direction sensor (7) are used for determining location.

6. An inclination control according to one of the preceding claims, characterised in that inclination signals (N) are given in conjunction with the current train data (Z) such as in particular the speed of the vehicle at that moment, the total length of the train, the length and position of the vehicle within the train.
7. An inclination control according to one of the preceding claims, characterised
in that in transition curves between straight sections and curves with constant parameters,
the time gradient and the timing of inclination control in the transition curves are all so
taken into account as a function of speed, the length of the transition curve and the
parameters or function of the transition curve that at the start of the constant curve (or
of the straight section when driving out of a curve), the inclination is always adjusted to
whatever is the optimum.

DATED THIS 7 DAY OF MARCH 2000

DaimlerChrysler AG

Patent Attorneys for the Applicant:-

F B RICE & CO