April 12, 1960 E. G. MARQUARD 2,932,258

RAILWAY SYSTEMS

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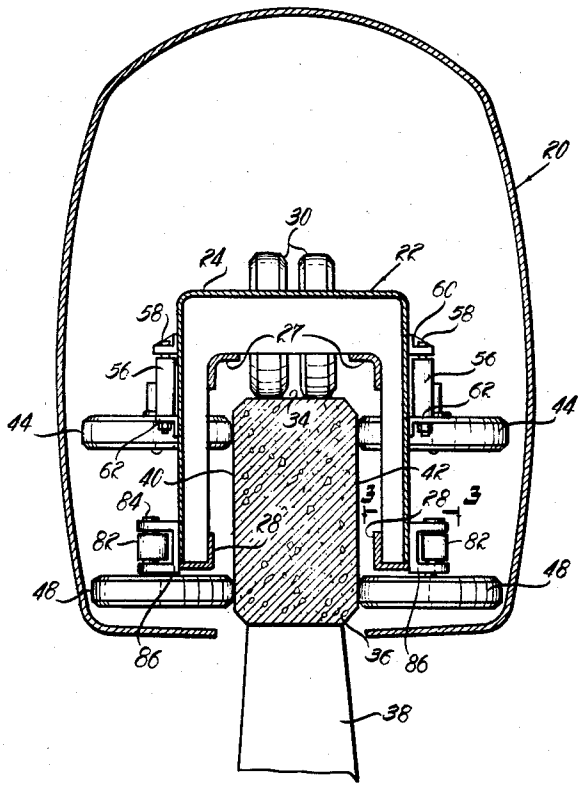

Fig. 1

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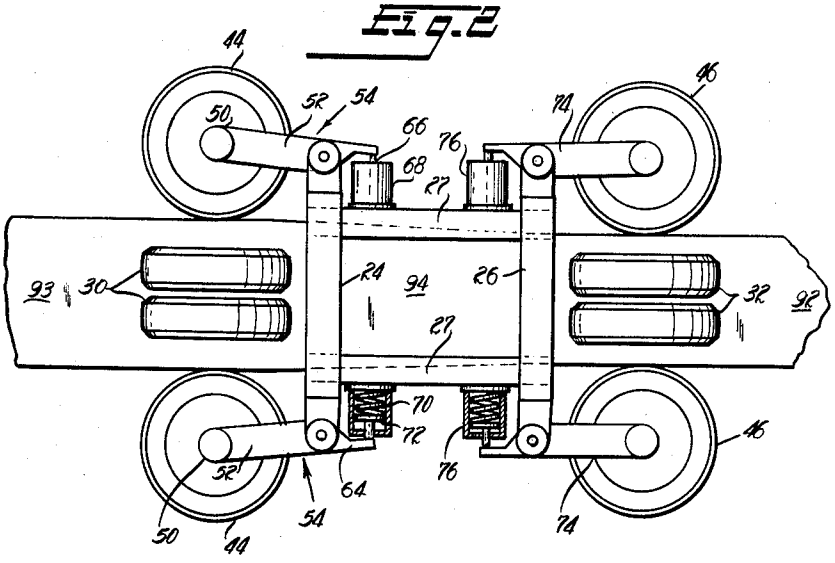
Fig. 2



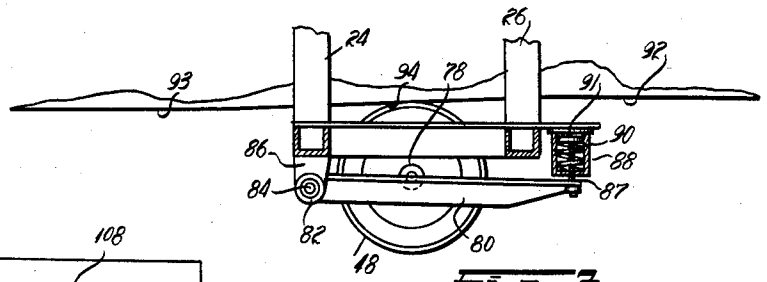


Fig. 3

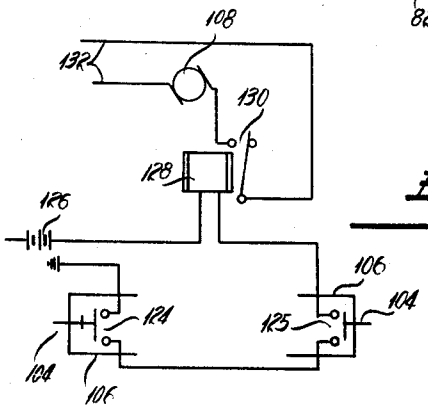


Fig. 6

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RAILWAY SYSTEMS

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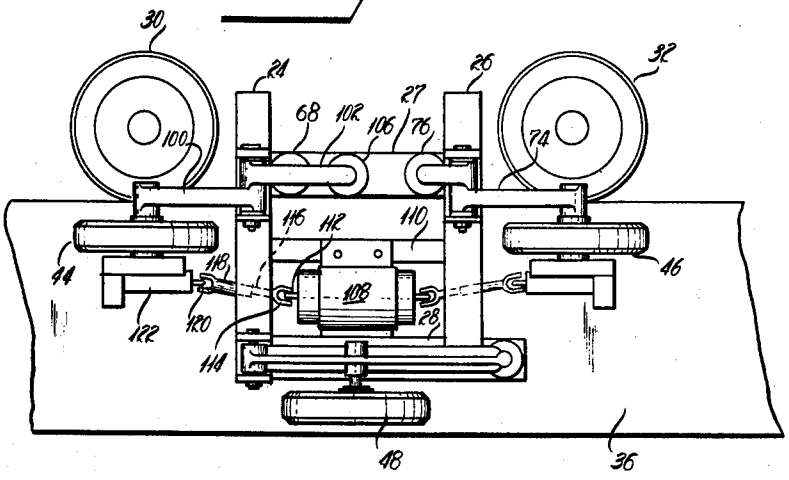
Fig. 4



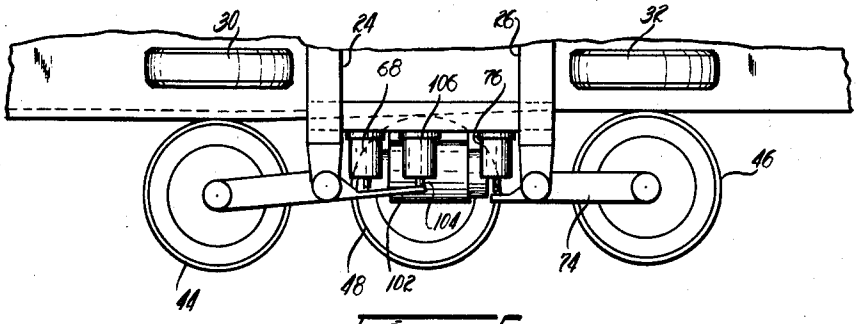


Fig. 5

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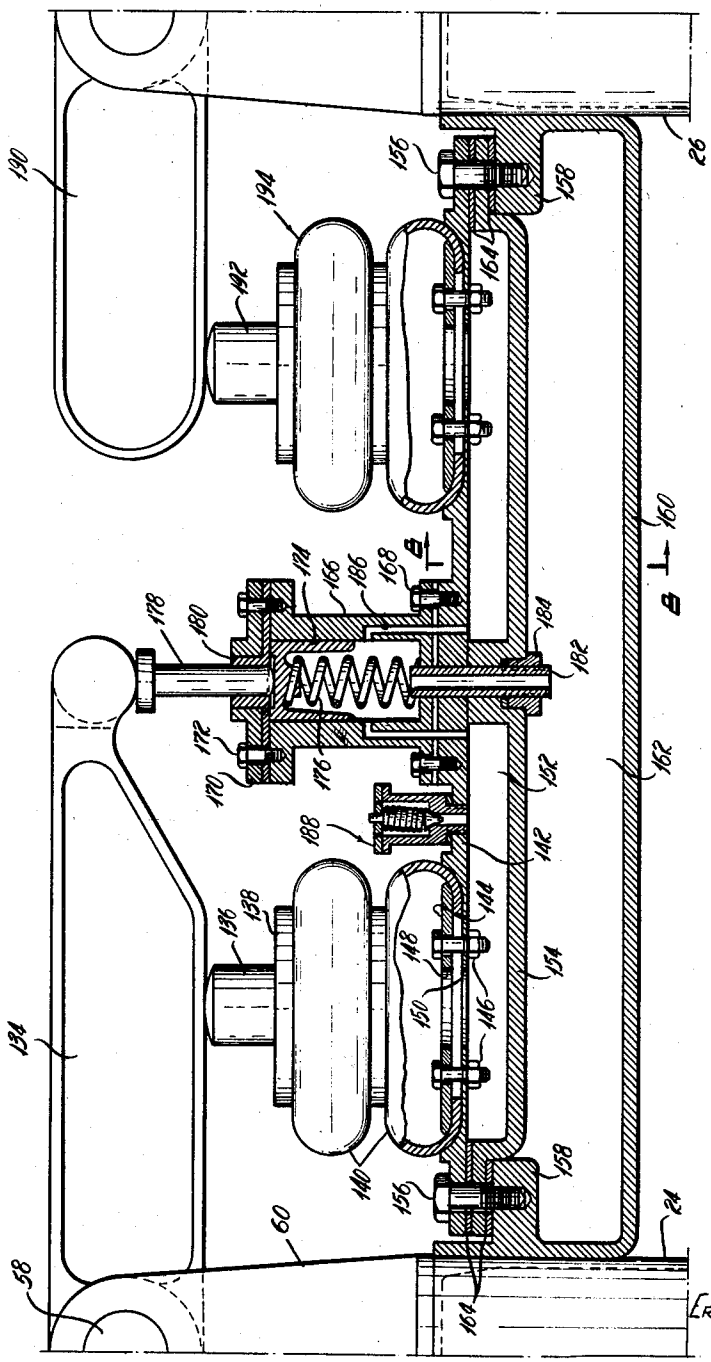

Fig. 7

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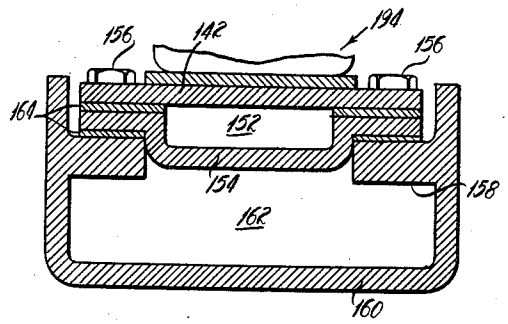
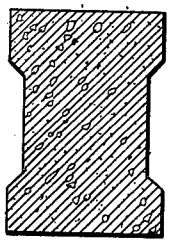


Fig. 8

Fig. 9



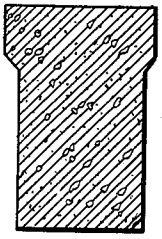


Fig. 11

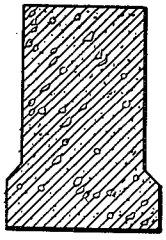


Fig. 10

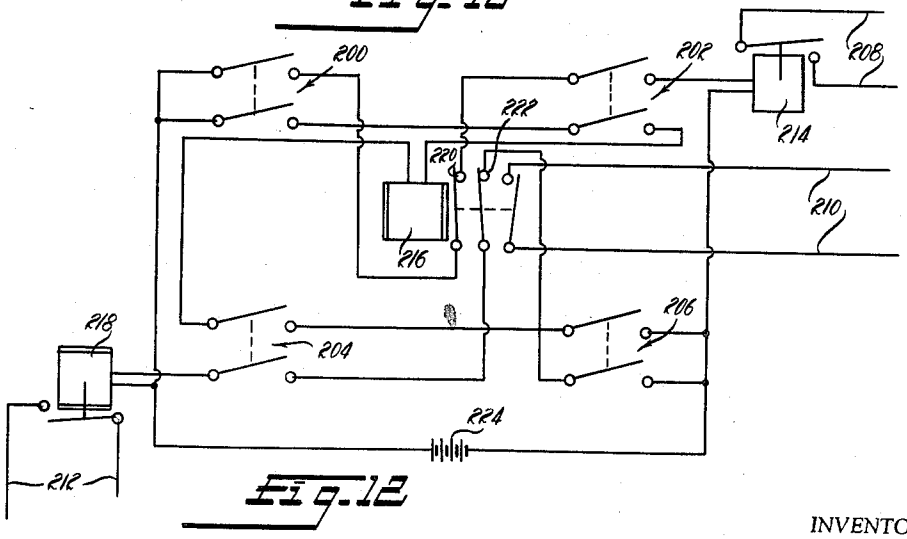


Fig. 12

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United States Patent Office 2,932,258 Patented Apr. 12, 1960

2,932,258

RAILWAY SYSTEMS

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Application August 15, 1956, Serial No. 604,093

Claims priority, application Germany August 16, 1955

6 Claims. (Cl. 104—120)

This invention relates to railways and more particularly to railways of the monobeam or monorail type. While certain aspects of the present invention are of broad utility and wide application, for illustrative purposes the invention will be disclosed in an application in which the vehicle is supported by one or more chassis having load carrying wheels and guiding wheels adapted to engage the upper surface and side surfaces, respectively, of a track beam of generally rectangular section.

Systems of this general type in connection with which the present invention has found primary utility are disclosed and claimed in co-pending applications Serial Nos. 534,106, filed September 13, 1955, now abandoned; 558,376, filed January 10, 1956, now abandoned, and 603,389, filed August 10, 1956.

It is the principal purpose and object of the present invention to provide improved railway apparatus and systems which operate automatically in response to passage of the vehicle over the beam way to actuate control devices or driving devices within the vehicle.

It is also an important object of the present invention to provide improved railway systems and apparatus which are actuated in response to passage of the vehicles over the tracks to automatically alter the relationship between the vehicle and the trackway, for example, to change the character or quality of the vehicle suspension.

In prior systems of this general type in which the top and side surfaces of a substantially rectangular beam provide running surfaces for the load carrying and guiding wheels of a vehicle-supporting chassis the dimensions of the beam and particularly the width of the beam is maintained at a constant value along the entire length of the track. While such systems have proved satisfactory for many purposes, nevertheless it has been discovered that they do not provide the necessary flexibility of operation necessary to properly accommodate widely varying conditions along differing stretches of the trackway. For example, for high speed travel along a straight section of track it is of primary importance that the rolling friction between the vehicle wheels and the trackway be minimized. On the other hand, in sections where the track runs over relatively steep grades it is necessary to provide for additional traction or additional braking forces and the degree of rolling friction is of secondary importance. Also, it is necessary in stations that the vehicle be supported in a relatively rigid manner against lateral displacements to permit positioning of the loading platforms as close as possible to the sides of the vehicle.

In accordance with the present invention it has been found that these varying and often contradictory requirements can be satisfied by the provision of a beam of varying width which cooperates in a unique manner with a novel chassis construction and which in some instances actuates a control system which regulates the operation of auxiliary drive motors, brakes, or governors.

It is accordingly a further and more specific object of

the present invention to provide monobeam trackways of varying width and improved vehicle suspension systems which cooperate with the trackway in a unique manner to change the spring characteristics of the suspension system or to actuate control devices within the vehicle.

Additional objects and advantages will become apparent as the description proceeds in connection with the accompanying drawings in which:

Figure 1 is a partly diagrammatic transverse sectional view of a railway system constructed in accordance with the present invention;

Figure 2 is a partly diagrammatic top plan view of the track beam and a portion of the chassis, the details of the mounting of the drive wheels being omitted for clarity;

Figure 3 is a fragmentary section taken along line 3—3 of Figure 1 showing details of the mounting of the lower side wheels;

Figure 4 is a side elevation of a modified form of the invention showing the chassis removed from the vehicle and omitting the structure for mounting the upper load carrying wheels;

Figure 5 is a fragmentary top plan view of the apparatus of Figure 4;

Figure 6 illustrates a motor control circuit suitable for use in connection with the embodiment of Figures 4 and 5;

Figure 7 is a fragmentary top plan view of a further embodiment of the present invention;

Figure 8 is a transverse section taken along line 8—8 of Figure 7 showing details of construction;

Figures 9, 10 and 11 are transverse sections of modified forms of the track beam; and

Figure 12 is a wiring diagram of a system for controlling auxiliary apparatus within the vehicle.

Referring now more particularly to the drawings and especially to Figures 1, 2 and 3, the body of a railway vehicle indicated generally at **20** is suitably supported by means not shown on one or more chassis constructions indicated generally at **22**. The chassis is preferably of welded construction and includes front and rear straps, **24** and **26** which are preferably sheet metal stampings and are generally U-formed in plan and U-shaped in section. The straps **24** and **26** are rigidly secured together by upper and lower connecting beams **27** and **28**. The chassis **22** supports by means not shown upper front and rear sets of driven load carrying wheels **30** and **32**. Conveniently the suspension and drive mechanism for these wheels may take the form shown in co-pending applications Serial Nos. 558,376 or 603,389. The load carrying wheel sets **30** and **32** ride along the upper surface **34** of a generally rectangular beam **36** which is preferably of cast concrete or similar material and is supported at a suitable elevation above the ground on a series of pylons **38**. The beam **36** is also provided with substantially vertical side surfaces **40** and **42** which form running surfaces for the upper and lower sets of side guide wheels **44**, **46** and **48**, the upper wheels **44** and **46** being disposed at opposite ends of the chassis **22** and the lower wheels being disposed substantially centrally thereof.

The upper lateral wheels **44** are rotatably journalled by a conventional bearing means in bosses **50** formed integrally in the outer end of the arm **52** of levers **54**. The levers **54** are provided with hubs **56** journalled on pivot pins **58**, the projecting opposite ends of which are mounted in upper and lower brackets **60** and **62**, respectively, rigidly secured as by welding to the strap **24** of the chassis.

The levers **54** each also include a second lever arm **64**, the free end of each of the lever arms contacting

plungers 66 which extend into spring cups 68 suitably secured to the cross members 27 of the chassis frame. Coil springs 70 are compressed between the surfaces of the cross members 27 and pressure plates 72 secured to the inner ends of the plungers 66. The springs 70 are thus effective to bias the wheels 44 resiliently into contact with the respective side surfaces 40 and 42 of the track beam 36.

The upper guide wheels 46 are mounted by substantially identical constructions including the levers 74 and the spring assemblies 76.

As best shown in Figures 1 and 3 the lower side wheels 48 are rotatably journalled by conventional bearing means 78 mounted substantially centrally of lever arms 80, one end of which carries a hub 82 journalled on a pin 84 mounted on spaced brackets 86 secured to the strap member 24. At its opposite end each of the levers 80 carries a plunger 87 which extends into a spring cup 88 rigidly secured to the projecting end of the lower brace member 28. The wheels 48 are resiliently urged into contact with the respective side surfaces 40 and 42 of the beam by coil springs 90 compressed between the outer end of the spring cups 88 and pressure plates 91 rigid with the inner end of the plunger 87. The side wheel mounting constructions just described effectively resiliently urge the side wheels into contact with the side surfaces of the beam 36 with a force which is a function of the beam width.

In Figure 2 the chassis is shown passing over a section of the beam 36 which is of varying width, the upper lateral wheels 46 running on a section 92 of the beam having normal width and the wheels 44 running on a section 93 of the beam which is of increased width. The two beam sections are connected by a transition section indicated generally at 94 of such length that no undue stresses are imposed upon the lateral wheels as they pass between the relatively narrow and broad beam sections. In practice, the length of the transition section will depend on the normal speed of the vehicle as it passes over the transition and on the variation in width between the beam sections 92 and 93. Normally the beam section 93 is from one to six inches wider than the beam section 92 with the increase in width being effected symmetrically. The transition may be linear as shown in the figures or curved according to a mathematical law to obtain a shock and jerk free ride of the wheels when passing it.

As suggested above, under normal circumstances, that is, when the vehicle is passing over straight sections of track at relatively high speed it is desirable to minimize the rolling friction between the side guide wheels 44, 46 and 48 and the adjacent side surfaces of the beam. In practice the several springs associated with the side guide wheels are selected to be of the minimum size necessary to prevent the wheels from leaving the sides of the beam during unavoidable tilting or lateral movement of the vehicle. The contact pressure between the side guide wheels and the adjacent surfaces of the beam is not sufficient when the vehicle is passing over the beam section 92 to permit the wheels 44 to be utilized either as braking or driving means and under these conditions it is neither feasible or desirable to load the supporting spring sufficiently to assure absolute lateral stability of the vehicle. As the vehicle passes from the beam section 92 to the broader beam section 93 an additional load is imposed on the springs which increases the contact pressure between the side guide wheels 44, 46 and 48 and the adjacent side surfaces of the beam, thus increasing the rolling friction between the side wheels and the beam surfaces. The effect is particularly advantageous in cases where it is desirable to stabilize the vehicle in curves or when approaching a station to decrease the lateral movements of the vehicle to permit placement of the platform as close as possible to the vehicle.

The increased contact pressure produced by cooperation of the relatively broadened track section and the chassis construction also substantially increases the effectiveness of the brakes of the lateral wheels to substantially increase the safety and flexibility of operation of the vehicle in mountainous regions or where rapid deceleration is desirable such as in an approach to a station. Similarly the increased beam width substantially increases the total tractive force available if the side wheels are driven to permit rapid acceleration when leaving a station or in mountainous regions where the track is steeply inclined. Accordingly, the present invention contemplates the utilization of a relatively narrow track beam to carry the vehicle over straight relatively level sections of track and a beam of increased width in regions where the track is steeply inclined at the approaches and exits from stations and in some cases at curves.

It will be noted that this construction readily accommodates passage of a vehicle in either direction over the track with maximum efficiency being effected in both directions. For example, on a given inclined track section the increased beam width permits increased braking effort if the vehicle is proceeding in one direction over the track and increased tractive force if the vehicle is proceeding in the opposite direction over the tracks. Similarly the relative widening of the track beam at opposite ends of the station permits rapid deceleration and acceleration of the vehicle regardless of the direction from which the station is approached. It is to be particularly noted that these unique advantages are obtained from a novel cooperation of the beam and the chassis construction.

In the embodiment of Figures 4 and 5 to which detailed reference will now be made, provision is made for supplementing the advantages of the construction of Figures 1 through 3 by incorporating an automatic control system actuated in response to variations in the beam width.

In the particular embodiment shown, the passage of the vehicle onto the track section of increased width automatically energizes auxiliary driving motors for the side wheels to thereby automatically provide for increased tractive effort as the vehicle passes upward over the beam sections of increased width which, in accordance with the invention, are provided in steeply inclined track sections. Thus the side wheels are positively driven only when the rolling friction between the side wheels and the adjacent surfaces of the beam is increased to the point where slippage between the wheels and the beam is avoided.

Normally only the load carrying wheels 30 and 32 are driven. Since they do not per se form part of the present invention the driving mechanisms for these wheels have been omitted.

The chassis of the embodiment of Figures 4 and 5 is substantially the same as that discussed above in connection with Figures 1 through 3. The support structure for the upper wheels 46 is the same as that shown in Figure 2. However, the lever assemblies 100 carrying the upper wheels 44 are provided with extensions 102 which extend beyond the associated spring cups 68 to a point opposite plungers 104 which when depressed, close normally open switches positioned in housings 106 rigidly secured to the brace member 27. When closed the switches either directly, or indirectly by means of a relay, energize driving motors 108 secured by any suitable means to the strap members 28 and auxiliary supporting straps 110. The output shafts 112 of the motors 108 are connected by universal joints 114 to drive shafts 116 splined to drive shafts 118 connected by universal joints 120 to gear boxes 122 drivingly connected to the respective wheels 44. The splined connection between the shafts 116 and 118 is provided to accommodate changes in the effective length of the drive shaft caused by the spring movements of the upper wheels. Overrunning clutches may be incorporated in the drive sys-

tem preferably in the gear boxes 122 to avoid a reverse drive from the wheels 44 to the motors 108 when the latter are not energized. A similar construction is provided to drive the wheels 46.

To avoid actuation of the drive motor 108 when only one of the wheels 44 swings laterally, for example, because of inaccuracies in the lateral surface of the beam or during unusual tilting or lateral movements of the vehicle, the motor operating switches actuated by lateral movements of the respective wheels 44 are placed in series in the motor control circuit so that the motor is actuated only when both switches are closed.

A suitable circuit of this type is shown diagrammatically in Figure 6. The switches 124 and 125 in the respective housings 106 are in series relation with a suitable power source, such as a battery 126, and with a relay 128. The relay 128, when energized, closes a normally open switch 130 in series with a suitable main power source 132 and the motor 108. Accordingly the relay 128 will be energized to close switch 130 and energize motor 108 only when both of the switches 124 and 125 are closed. This action in turn can be effected only when the vehicle passes on to a relatively broadened section of the track such as that shown at 93 in Figure 2.

A further embodiment of the invention is shown in Figures 7 and 8 which is generally similar to the previous embodiments except that a bellows type air suspension system is used instead of the coil springs discussed above.

The chassis incorporates identical wheel suspensions on its opposite sides only one of which will be described in detail. The wheels 44 are supported on a lever assembly 134 corresponding to the lever assembly 54 of Figure 2. The lever assembly 134 contacts a plunger 136 which is rigidly secured to a pressure plate 138 secured to or resting on a flexible bellows assembly 140. The opposite end of the bellows is secured to a mounting plate 142 by a clamping plate 144 and nut and bolt assemblies 146. The interior of the bellows is in communication through apertures 148 and 150 in the clamp plate 144 and the mounting plate 142 with a chamber 152 formed between the mounting plate 142 and a cover plate 154. The marginal flanges of the mounting plate 142 and the cover 154 are secured by screws 156 to the flange 158 of a dish-shaped member 160 which is suitably secured as by welding to the straps 24 and 26 and which replaces the upper straps 27.

A second chamber 162 is formed between the dish-shaped member 160 and the cover 154, both of the chambers being sealed by suitable annular gaskets 164. The mounting plate 142 also carries a cylinder 166 held in place by screws 168 and having an outer cover 170 held in place by screws 172. A piston 174 is slidably received in cylinder 166 and is normally biased into contact with cover 170 by a coil spring 176. The end surface of the piston 174 also contacts the inner end of a plunger 178 which extends through a stuffing box 180 and is normally in contact with the free end of the lever assembly 134. The interior of the cylinder 166 is connected by a tube 182 to the chamber 162, and tube 182 being held in place by a nut 184. The interior of cylinder 166 is also in communication with the chamber 152 through a plurality of registering passages 186 formed in the wall of the cylinder 166 and in the mounting plate 142. A safety valve 188 of any suitable construction is supported on the mounting plate 142 to protect the air suspension system against excessive pressures. The free end of the lever assembly 190 supporting the wheel 46 contacts a plunger 192 which is associated with a bellows assembly 194 preferably identical to the bellows assembly 140. Air under pressure is supplied to the suspension system by any convenient compressor system of conventional construction which is not shown and which per se forms no part of the present invention.

The components of the suspension system of Figures 7 and 8 are shown in the position they occupy when the vehicle is running along a beam of normal width such as the beam section 92 of Figure 2. Under these conditions the air volume effective for the air suspension is that of the two bellows assemblies 140 and 194 plus the chambers 152 and 162. This volume is sufficient to provide a relatively soft spring action. However, when the vehicle passes on to a track section of increased width such as the section 93 of Figure 2, the plunger 178 and the piston 174 are moved downwardly as viewed in Figure 7 closing the channels 186 and effectively isolating the chamber 162 thereby decreasing the air volume effective for the air suspension system. Accordingly when this action takes place, a stiffer spring characteristic is immediately established which offers increased resistance against lateral displacement or tilting movements of the vehicle which is particularly desirable in curved track sections or in the approaches to or exits from stations. It will be noted that sufficient distance is provided between the bottom of the skirt of piston 174 and the adjacent end of the channels 186 so that normal oscillations of the wheels 44 as they ride along a beam section of normal width do not close the channels 186.

Normally the entire cross section of the beam is broadened as indicated in Figure 2. However, the invention contemplates the broadening of the beam only in the sections which support the upper and lower lateral wheels as shown in Figure 9 or the broadening of the portion of the beam which supports only the upper wheels as shown in Figure 10 or the broadening of only that portion of the beam which supports the lower wheels as shown in Figure 11.

The invention also contemplates asymmetrical broadening of the beam. For example, it may be desirable in some cases to broaden the beam only at the tracks of the upper lateral side wheels inside a curve section and at the tracks for the lower lateral wheels outside of the curve. This construction results in an inclination of the vehicle as it passes over the curved section of the track without the necessity of inclining the entire beam.

Also the beam may be broadened between the upper and lower lateral wheel tracks either on one or both sides. In this case, a special wheel or roll adapted to run on the broadened portion of the beam will be provided and may be mounted in essentially the same manner as any of the side guide wheels 44, 46 or 48. Since the only function of such a roll is to control the actuation of switches, it is not necessary that the roll contact the lateral surface of the beam on stretches of normal width. It is necessary only that the displacement of the roll as the vehicle passes on to the relatively broadened beam section be sufficient to actuate a control switch.

In addition to the control of an auxiliary motor as described in connection with Figures 4, 5 and 6 the present invention also contemplates the control of emergency brakes or speed governors in response to the passage of the vehicle onto track sections of varying width.

Because of the provision in accordance with the present invention, of beams which are broadened only at the top or the bottom or in both regions, considerable flexibility of operation of the control system is possible.

A typical circuit for performing additional control functions is shown in Figure 12. In this circuit the switches 124 and 125 operated by the respective upper wheels 44 are replaced by double pole switches 200 and 202, respectively. Similar switches operated by lateral displacement of the lower wheels 48 are indicated at 204 and 206. Leads 208 are in series with a drive motor not shown. Leads 210 are in series with an emergency brake system and leads 212 are in series with a governor. The circuits 208, 210 and 212 are normally open and are closed by respective relays 214, 216 and 218. The relay 216 is provided with additional contacts 220 and 222 which are normally closed and are opened when the relay 216 is energized. A battery 224 is connected in se-

ries with the several switches and relays by conventional circuitry which does not require detailed description.

When the switches **200**, **202**, **204** and **206** are open all of the auxiliary circuits are deenergized. When both of the switches **200** and **202** are closed and only under these conditions, the relay **214** is energized thus energizing the circuit **208** for the auxiliary drive motor. It will be noted that the circuit for relay **214** includes the contacts **220**. When both of the switches **204** and **206** are closed and only under these conditions, the relay **218** is closed thus energizing the governor circuit **212**. Again it will be noted that the circuit for the relay **218** includes the normally closed contacts **222**. When all of the switches **200**, **202**, **204** and **206** are closed the relay **216** will energize opening contacts **220** and **222** and closing the circuit **210** to operate the emergency brake. Opening of the contacts **220** and **222** deenergizes the relays **214** and **218** thus deenergizing the governor and the auxiliary drive motor to permit effective emergency braking.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is to be claimed and desired to be secured by United States Letters Patent is:

1. A monobeam railway comprising a beam-like member forming a trackway having a top running surface and separate upper and lower side running surfaces, the lateral spacing of certain of said side running surfaces being increased at predetermined sections along the length of said trackway, a vehicle having wheels adapted to ride along said running surfaces, springs mounted on said vehicle resiliently urging certain of said wheels into contact with said side running surfaces to establish a predetermined contact pressure along said predetermined sections of said trackway and a lower contact pressure along other sections of said trackway.

2. A monobeam railway comprising a beam-like member forming a trackway and having a substantially horizontal top running surface and substantially vertical side running surfaces, the lateral spacing of said side running surfaces being increased at predetermined sections along the length of said trackway, a vehicle having wheels adapted to ride along said side running surfaces, levers supported on said vehicle for pivotal movement about substantially vertical axes and mounting said wheels for movement toward and away from said side running surfaces, springs operatively connected to said vehicle and said levers urging said levers in one direction to move said wheels into contact with said side running surfaces along the entire length thereof whereby when said vehicle passes onto said predetermined sections of said trackway, said levers are rotated in the opposite direction to load said springs and thereby increase said contact pressure.

3. A monobeam railway comprising a beam-like member forming a trackway having top and side running surfaces, the lateral spacing of said side running surfaces being increased at predetermined sections along the length of said trackway, a vehicle having top and side wheels adapted to ride along the respective running surfaces, a motor drivingly connected to certain of said wheels, and means responsive to passage of said vehicle onto said predetermined sections of said trackway for energizing said motor.

4. A monobeam railway comprising a beam-like member forming a trackway having top and side running surfaces, the lateral spacing between said side running surfaces being increased at predetermined sections along the length of said trackway, a vehicle having top and side wheels adapted, respectively, to ride along the top and side running surfaces of said beam, levers pivotally supported on said vehicle and mounting said side wheels for movement toward and away from said side running surfaces, springs operatively connected to said levers and said vehicle for urging said levers in one direction to move said side wheels into contact with said side running surfaces, a normally deenergized electric motor mounted on said vehicle and drivingly connected to certain of said side wheels, a normally open switch mounted on said vehicle and adapted when closed to energize said electric motor, and means responsive to movement of said lever in the opposite direction when said vehicle passes onto said predetermined sections of said trackway for closing said switch to thereby energize said electric motor.

5. A monobeam railway comprising a beam-like member forming a trackway having top and side running surfaces, the lateral spacing of said side running surfaces being increased at predetermined sections along the length of said trackway, a vehicle having wheels adapted to ride along said running surfaces, springs operatively connected to said vehicle and said wheels for resiliently urging certain of said wheels into contact with said side running surfaces, a control circuit for an auxiliary device such as a brake, governor, or motor carried by said vehicle, and means responsive to passage of said vehicle onto said predetermined sections of trackway to energize said control circuit.

6. A monobeam railway comprising a beam-like member forming a trackway having top and side running surfaces, the lateral spacing of said side running surfaces being increased at predetermined sections along the length of said trackway, a vehicle having wheels adapted to ride along said running surfaces, flexible air bellows operatively connected to said wheels and said vehicle for resiliently urging certain of said wheels into contact with said side running surfaces to establish a predetermined contact pressure along said predetermined sections of said trackway, said bellows having a predetermined normal effective air volume, and means responsive to movement of said vehicle onto said predetermined trackway sections to decrease said effective air volume.

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