

Oct. 12, 1937.

T. H. SCHOEPF ET AL.

2,095,677

RAILWAY CAR

Filed April 8, 1935

2 Sheets-Sheet 1

Fig. 2

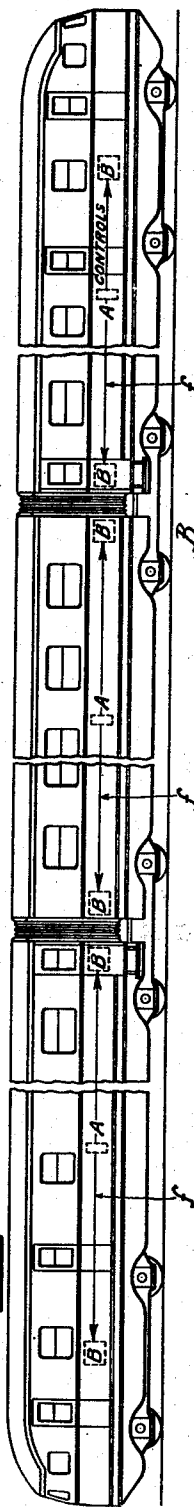
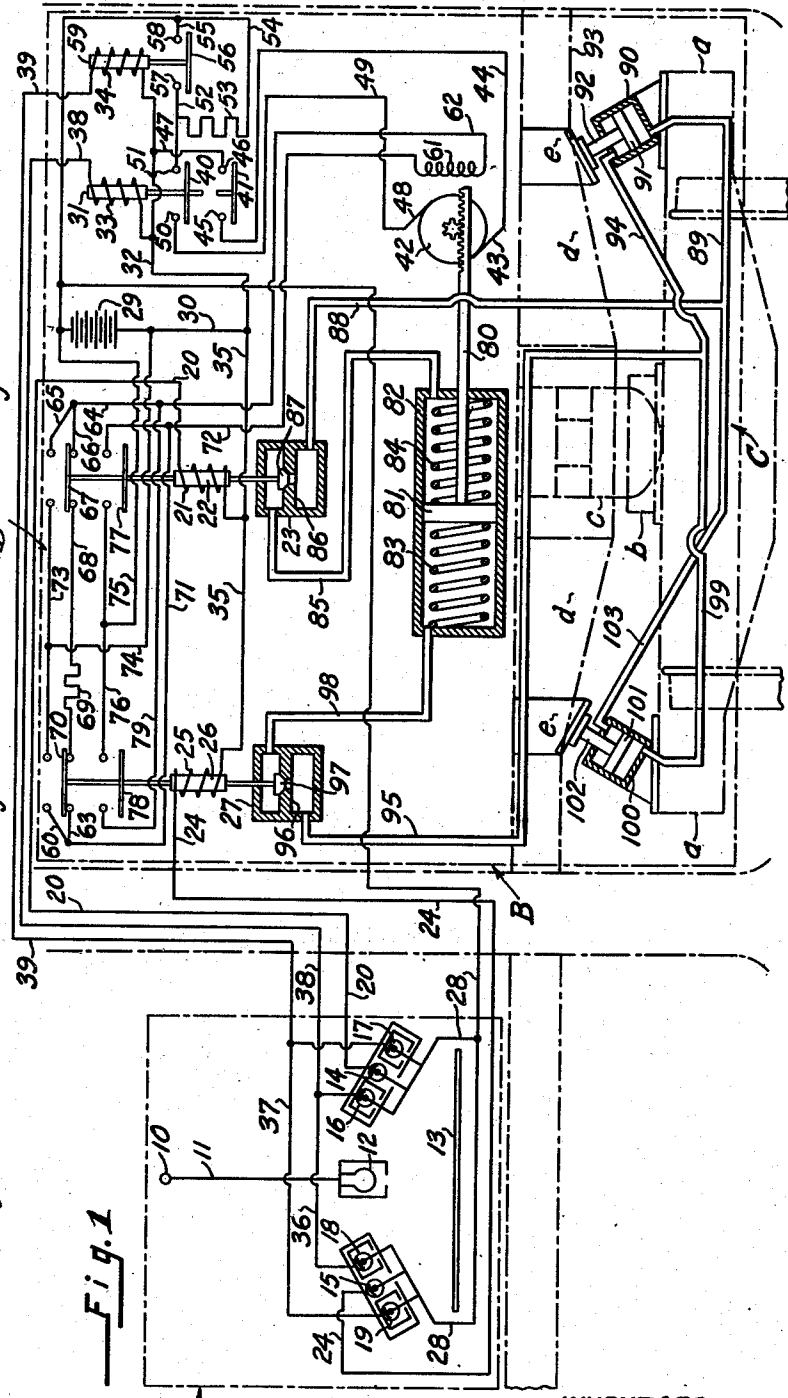


Fig. 1



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Fig. 3.

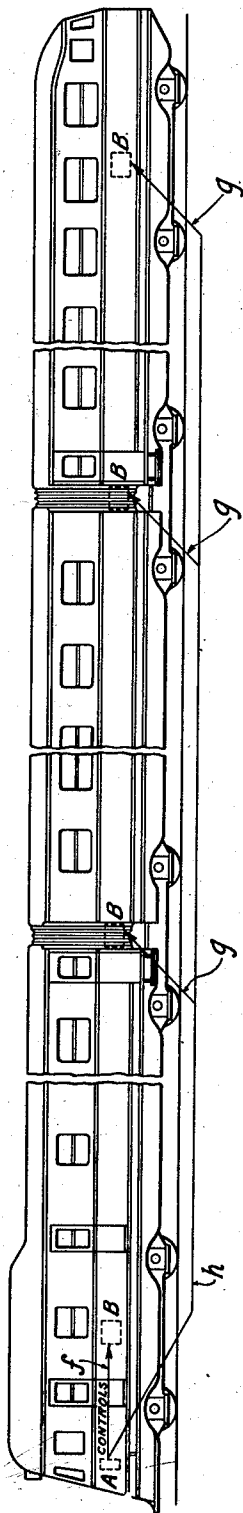
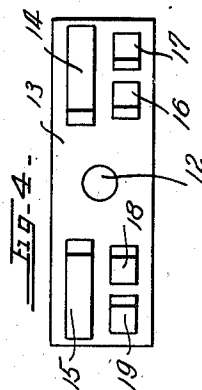
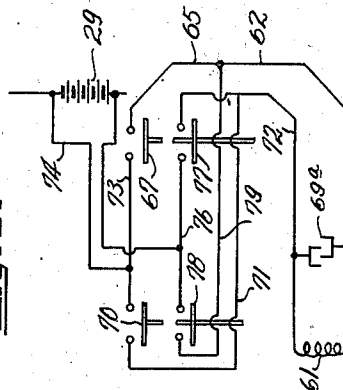


Fig. 5.



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RAILWAY CAR

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Application April 8, 1935, Serial No. 15,278

22 Claims. (Cl. 105-164)

This invention relates to vehicle controls, and in particular, to the automatic control of the movements of vehicle bodies, especially articulated railway cars.

One object of our invention is to provide a control mechanism actuated by photo-electric cells and adapted to set in motion devices for counteracting the tilting and twisting of vehicle car bodies.

Another object is to provide such a control wherein the photo-electric cell control unit is mounted at a remote distance from the controlled mechanism for resisting the twisting and tilting of the vehicle body.

Another object is to provide such a control mechanism wherein the photo-electric cell unit is placed at the forward end of the foremost car in such a position as to be the device first subjected to the tilt or twist brought about by the car entering a curve, the action for resisting this force being set in motion by the controlled devices before the vehicle bodies, upon which they are mounted, begin to twist or tilt. In other words, the control device anticipates the corrective movements necessary to be made by the controlled devices.

Another object is to provide a photo-electric cell control unit and a plurality of electro-hydraulically controlled units, the latter being responsive to the signals sent by the former, and adapted to set in motion forces which will counteract the forces brought about by irregularities in the track, such as curves and banks.

In the drawings:

Figure 1 is a drawing of the control unit A, the electrically controlled unit B, which units are to be mounted in the cars of the train as indicated by the letters A and B, and the hydraulic corrective arrangement C, which latter is mounted on the truck.

Figure 2 is a view of a train of cars in which the control units A, and the electrically controlled units B, are, in practice, mounted.

Figure 3 is a view of another train of cars in which are mounted the control unit at the point indicated by A in the forward part of the front end of the first car, and the electrically controlled unit at the station indicated by B; while the second and third cars, which follow the motorman's front car, have mounted in them the electrically controlled units at the point B in the second car, and likewise at the points B, B in the third car.

Figure 4 is a top plan view of the photo-electric

cell control unit shown at the upper part of Figure 1.

Figure 5 is a fragmentary wiring diagram of a modified portion of the control arrangement shown in Figure 1.

Referring to the drawings in detail, Figure 1 shows the general arrangement, both electrical and hydraulic, of the control arrangement of our invention. It will be understood that the device consists generally of three parts:

1. A photo-electric cell control unit A, shown in the upper part of Figure 1, and preferably arranged in the forward part of the foremost car of the train as seen in Figure 3;

2. A controlled unit B, shown in the central part of Figure 1, and consisting of electrical mechanism responsive to the signals sent out by the control unit shown in the upper portion of Figure 1; and

3. Hydraulic mechanism C for applying resisting forces in response to the action of the electro-hydraulic mechanism in order to resist the action of the undesirable forces set up by irregularities or curves in the track.

It will be understood that while a single photo-electric cell control unit A is used, a plurality of controlled units B may be provided, one preferably for each circuit of the car or for each end of each car.

This invention is applicable to ordinary trains, with a plurality of trucks on each car, but it is especially valuable in its application to articulated trains. The latter are used increasingly for extremely high-speed travel, where the irregularities and curves of the track aggravate the twisting, torsion or tilting of the car floor, resulting in great discomfort to the passengers.

For example, when the foremost car of a train enters a curve, the combination of centrifugal force, banking of the curve, and other factors will tend to rock and twist the bodies around their horizontal axes, a reverse twist being given as the car leaves the curve. This twist is experienced in succession by each car, and results in a repetition of the twisting movements given to the foremost car. Accordingly, the photo-electric cell control unit A, hereinafter described, is preferably mounted in the forward end of the foremost car (see Fig. 3) so that its orders will be transmitted to the regulatory mechanism B in the following cars so that the regulatory forces will be set in motion slightly before the car reaches the curve or track irregularity. In this manner any time lag of the apparatus is compensated for, such a time lag being otherwise

liable to bring the mechanism into operation after the twist has taken place and too late for the corrective measures.

Referring particularly to Figure 1, there is shown at the left side a photo-electric cell control unit, generally designated A; in the upper middle portion of Figure 1, there is shown an electrically-controlled unit, generally designated B; and in the lower portion of Figure 1 there is shown a hydraulic corrective arrangement, generally designated C.

Referring to Figure 1, the photo-electric control unit A consists of a pendulum 11, mounted to oscillate around a pivot point 10, and carrying on its lower end a light source 12, provided with a suitable shield. Arranged beneath this light source 12 is a mirror 13. On the right-hand and left-hand sides of the light source 12 are arranged suitably shielded photo-electric cell units 14 and 15, respectively. On each side of the photo-electric cell unit 14 are mounted photo-electric cell units 16 and 17. Similarly, on either side of the photo-electric cell unit 15 are mounted photo-electric cell units 18 and 19.

The photo-electric cell units 16, 17, 18 and 19 are shielded to admit rays of light in a narrower bundle and over a narrower angle than the photo-electric cell units 14 and 15. The purpose of this feature is to cause the light source 12 to send illumination by reflection from the mirror 13 to the photo-electric cell units 14 or 15, while the pendulum is tilted generally in their direction, to restrict the entrance of rays to the photo-electric cell units 14 and 16 or 15 and 18, respectively, when the pendulum tilts through but a small angle; and to the photo-electric cell units 14, 16 and 17 or 15, 18 and 19, respectively, when the pendulum tilts through a large angle.

The tilting of the pendulum is brought about by the tilting of the car containing the photo-electric cell unit A, the pendulum 11 remaining vertical while the other apparatus tilts relatively thereto. The photo-electric cell unit 14 is connected by the line 20 to a solenoid winding 21, having an armature 22. This solenoid is arranged in the controlled unit B. The solenoid armature 22 is connected in a manner hereinafter described to a hydraulic valve 23, which serves to actuate a portion of the hydraulic corrective mechanism C. In a similar manner the photo-electric cell unit 15 is connected by the line 24 to the solenoid winding 25, having the armature 26 arranged to operate the hydraulic valve 27.

The energization of the solenoid windings 21 and 25, together with the remainder of the electrical circuit, is brought about by the battery 29. The line 28 from one pole of the battery 29 connects the latter to one set of the terminals of the photo-electric cells 14, 15, 16, 17, 18 and 19. The opposite terminals of the photo-electric cells 14 and 15 are connected, as previously described, to the lines 20 and 24. The connections of the opposite terminals of the remaining photo-electric cells 16, 17, 18 and 19 will be subsequently described.

From the pole of the battery 29, opposite that to which the line 28 is connected, the line 30 runs, branching in one direction to continue in the line 32, serving to energize the solenoid winding 33 having an armature 31. The line 32 also serves to energize another solenoid winding 34. The branch 35 of the battery line 30 serves to energize the opposite terminals of the solenoid windings 21 and 25, previously described. The other terminals of the inner photo-electric cells

16 and 18 are connected by the line 36 to the line 38, the latter running to the solenoid winding 33, previously described, and completing the energizing circuit to the battery 29 when the photo-electric cells 16 or 18 are energized by light falling upon them. Similarly, the other terminals of the outer photo cells 17 and 19 are connected by the line 37 to the line 39, running to the solenoid winding 34 and completing the energization circuit thereof when the photo-electric cells 17 and 19 are energized by light falling upon them.

The armature 31 of the solenoid winding 33 is mechanically connected to the switch blades 40 and 41, these switch blades controlling the energization of the armature 42 of a motor employed for creating the hydraulic pressure used for applying the corrective forces to the car. The armature 42 is provided with a brush 43, from which the line 44 runs to the terminal 45 engageable by the switch blade 41, and from the opposite terminal 46 thereof, the line 47 runs to the line 32, previously mentioned. Similarly, the opposite brush 48 of the motor armature 42 is connected by the line 49 to the switch terminal 50 engageable by the switch blade 40, and from the opposite terminal 51 thereof the line 52 runs to the armature series resistance 53. The opposite end of the latter is connected by the line 54 to the same pole of the battery 29 as the line 28, previously described.

From the line 54 the branch line 55 runs to the terminal 58, engageable by the switch blade 56 operated by the solenoid armature 59. The opposite terminal 57 thereof is connected to the line 52. In this manner the energization of the solenoid windings 33 and 34 is controlled, respectively, by the energization of the inner or inner and outer photo-electric cells 16 or 18 or 16 and 17 or 18 and 19, according to the amount of tilt of the pendulum; and the armature series resistance 53 is inserted or withdrawn from the circuit as a consequence by the energization or deenergization of the solenoid 34.

The motor field 61 is likewise electrically controlled by the solenoid windings 21 and 25, previously described. The motor field 61 is connected on one side by the line 62 and its branches 65 and 66 to the upper switch blade 67, operated by the solenoid armature 22. From the opposite lower terminal thereof the line 68 runs to the field discharge resistance 69, the opposite side of which is connected to one terminal engageable by the upper switch blade 70, operated by the solenoid armature 26. Similarly, the upper inner terminals engageable by the upper switch blades 67 and 70 are interconnected by the line 73, from which the line 74 runs to the battery 29.

The remaining upper terminals engageable by the upper switch blade 70 are joined by the branch lines 60 and 63 to the line 71, joining the line 72, which runs to the remaining pole of the motor field winding 61. The line 72 also runs to one of the switch terminals engageable by the lower switch blades 77, operated by the solenoid armature 22. The opposite terminal thereof is connected by the line 76 to the nearest terminal engageable by the switch blade 78, operated by the solenoid armature 26. The line 76 is connected by the line 75 to the battery 29. The remaining terminal engageable by the switch blade 78 is connected by the line 79 to the line 62 running to the motor field winding 61, as previously described.

The hydraulic corrective mechanism C is supplied with pressure fluid by the piston rod 80, 75

operating the piston 81 in the hydraulic cylinder 82, these being mechanically operated by the motor armature 42. The piston head 81, on its opposite sides, bears against the coil springs 83 and 84. One end of the hydraulic cylinder 82 is connected by the pipe line 85 to the hydraulic valve 23, above the ported partition 86 thereof. The valve member 87 connected to the solenoid armature 22 is arranged to open and close the port in the partition 86, according to the action of the solenoid winding 21.

The opposite chamber of the hydraulic valve 23 is connected by the pipe line 88 to a branch line 89, leading to the bottom of the hydraulic corrective cylinder 90. The latter is provided with a piston 91, having a piston rod 92 mechanically connected to the body of the vehicle, as indicated diagrammatically by the reference numeral 93, as shown in Fig. 1. The opposite side of the cylinder 90 is connected by the pipe line 94 to the pipe line 95, running to the lower chamber of the hydraulic valve 27. The latter contains the ported partition 96, having the valve member 97 operating therein and controlled by the solenoid armature 26. From the upper chamber of the hydraulic valve 27 the line 98 runs to the left-hand end of the hydraulic cylinder 82. From the line 95 the branch line 99 runs to the bottom of the hydraulic corrective cylinder 100. The latter has a piston 101 with a piston rod 102 connected to the opposite side of the vehicle body 93. From the opposite side of the cylinder 100 the pipe line 103 runs to join the pipe line 88, leading to the lower chamber of the hydraulic valve 23.

It will be observed by those skilled in the art that the wiring diagram of Figure 1 shows the photo-electric cells connected directly to the various solenoid windings. This connection is shown for the purpose of clarity and simplification. It will be understood, however, that ordinarily amplifying and/or relay means are usually placed between the photo-electric cell and the devices controlled by it. Such amplifiers and relays for use with photo-electric cells are conventional and well known to those skilled in the art, hence, require no detailed description. The necessity for such amplifiers and relays depends upon the particular type of photo-electric cell employed, and also upon other conditions of the installation. Ordinarily, a photo-electric cell alone does not deliver enough current to operate the solenoids intended to be controlled thereby, resulting in the employment of amplifiers and/or relays to accomplish this purpose.

Referring again to Figs. 1 and 3, in the operation of the mechanism of our invention, as the forward car of the train enters a curve the bank of the latter causes the car to tilt and the pendulum 11 assumes an angular position with reference to the car floor. If the car tilts slightly to the left (Figure 1) the pendulum 11 appears to tilt to the left to an observer in the car. The light rays from the light source 12 on the end of the pendulum are then reflected from the mirror 13 into the interior of the photo-electric cell unit 14, energizing the latter and consequently the solenoid winding 25 is energized by the completion of its circuit with the battery 29. The consequent lifting of its armature 26 connects the switch blades 78 and 79 to the switch terminals immediately above these blades, resulting in the cutting of the field discharge resistance 69 out of the motor circuit and the energization of the field coil 61 with current of one polarity. Similarly,

when the pendulum 11, in effect, tilts to the right by the tilting of the car, the photo-electric cell unit 14 is energized, as a consequence energizing the solenoid winding 21 from the battery 29, and similarly, throwing the field discharge resistance 69 out of the motor circuit and energizing the field coil 61 with current of opposite polarity.

In the modification shown in Figure 5 the construction is identical with that shown in Figure 1 as concerns the electrical connections just described, with the exception of the fact that a capacitor 69a is used in place of the field discharge resistance 69. The action, however, as well as the electrical connections, are otherwise substantially the same and no further description is necessary.

Continuing with reference to Figure 1 the armature field resistance 53 meanwhile is thrown into or out of the circuit of the motor armature 42 by the energization of the solenoid windings 33 or 34 as controlled by the inner or outer groups of photo-electric cells 16 and 18 or 17 and 19, respectively. When the car tilts through but a small angle the pendulum light source 12 reflects rays into the inner photo-electric cells 16 or 18, energizing the latter and consequently energizing the solenoid winding 33 from the battery 29. The armature 31 of the latter moves upward, closing its switch blades 40 and 41 across the lines connected thereto. This action places the motor armature series resistance 53 in the armature circuit and causes the motor armature 42 to revolve with a predetermined torque, with a consequent effect upon the hydraulic pressure cylinder 82 and its piston 81 operated by the motor armature 42. On the other hand, when the car rounds a steep curve the light rays from the light source 12 of the tilting pendulum are also reflected by the mirror 13 into the outer photo-electric cells 17 or 19, energizing these and maintaining energization of the inner photo-electric cells 16 or 18. The middle photo-electric cells 14 or 15, also, remain energized throughout the tilting of the pendulum because their shielding is not as selective as that of the other photocells.

The energization of the outer photocells 17 or 19 results in the consequent energization of the solenoid winding 34 and the deenergization of the solenoid winding 33. This results in the connection of the lines 52, 54 and 55 through the switch blade 56, operated by the solenoid armature 59 and engaging the switch terminals 57 and 58. This short-circuits the opposite terminals of the motor armature series resistance 53, causing the motor armature 42 to revolve with increased torque, with an increased effect, upon the production of hydraulic pressure fluid within the hydraulic cylinder 82. At the same time the energization of the solenoid winding 33 causes its armature 31 and its switch blades 40 and 41 to remain up, thus maintaining the circuit in the lines 44 and 49 leading to the motor series armature resistance 53.

Still continuing as to Figure 1, the hydraulic corrective mechanism is set in motion by the valve members 87 or 97 connected mechanically to the solenoid armatures 22 or 26, respectively. When the solenoid 25 is energized the valve member 87 rises so as to pass pressure fluid from the cylinder 82 by way of the line 98, through the valve 27, thence by way of the lines 95, 94 and 99 to the upper side of the right-hand hydraulic cylinder 90 and to the lower end of the left-hand hydraulic cylinder 100. This causes the piston 91 to move downward and the piston 101 to move up-

ward, creating a resisting force upon the car body 93 in opposite directions.

Similarly, if the solenoid winding 21 is energized in a manner previously described, the valve member 87 rises from its port in the partition 86. This permits pressure fluid to pass from the right-hand side of the hydraulic cylinder 82 by way of the pipe line 89 to and through the valve 23, thence by way of the pipe lines 88, 89 and 103 to the bottom of the hydraulic cylinder 90 and the top of the hydraulic cylinder 100. The upward motion thus given to the hydraulic piston 91 and the downward motion given to the piston 101 cause a reverse effect to be given to the vehicle body 93 from that just described.

In Figure 2 we have shown in side elevation a train of three cars and we have indicated by the letters A and B the stations or places in the respective cars where the control unit A will, or may be, placed in each car, and where the electrically controlled unit B will, or may be, placed in each car. In this illustration each car has mounted therein one control unit A and a plurality of controlled units B.

And finally, referring to Figure 3, it will be seen that in the forward part of the forward car, which is at the extreme left in the drawings, there is located the control unit A, and at any suitable place there is also located in each car one of the electrically controlled units B.

In these connections we have not mentioned, as yet, the location of the hydraulically corrective arrangement C, which is comprised of the cylinders 90 and 100, the pistons 91 and 101 and the piston rods 92 and 102 and their connecting hydraulic pipe lines 88 and 103, and 94 and 99, all of which devices of unit C are carried by the trucks.

In Figure 1 we have also shown the truck members comprising the bolster *a* supporting the socket plate *b*, and the articulation trunnion *c*, the trunnions being carried by the car body or underframe.

There is also shown in dotted lines a transverse car body member or bolster *d* having contact parts *e* with which the hydraulic piston rods 92 and 102 make connection so as to control or oppose the side tipping of the car bodies, which is the primary object or result sought by this invention.

In Figure 2 the arrows *f* indicate the connection between the control unit A and the several controlled units B, each car being complete in having one unit A and two units B which are controlled thereby. In Fig. 3, it is similarly shown how the arrow lines *g* and the extended connecting line *h* are used to transmit the control from the control unit A to the controlled units B in the several cars. In this Figure 3 we also have one controlled unit B in each of two of the cars and two controlled units B in one of the cars. This is to illustrate such an installation if it be desirable or required.

We desire to comprehend within our invention such modifications as may be embraced within the claims and the scope of the invention.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. In a method of controlling the tilting movements of a plurality of railway cars in a train, receiving the tilting movements of the foremost car at a position near the forward end thereof, signalling these changes to the succeeding cars ahead of the reception of such changes by said

cars, and causing the thus anticipated action to be resisted by setting up opposing forces before the expected changes occur.

2. In a method of controlling the tilting movements of a plurality of railway cars in a train, receiving the tilting movements of the foremost car at a position near the forward end thereof, signalling these changes to the succeeding cars, and causing the signals to release resisting forces opposed to the forces which will tilt the car as soon as the anticipated changes occur but in advance of the occurrence thereof.

3. In combination, a car, means for resisting the tilting movements of the car, and means for initiating the operation of said resisting means at a point remote therefrom, said initiating means comprising a photo-electric cell and a light source adapted to be moved relatively to one another during the tilting of the car.

4. In combination, a plurality of cars arranged in a train, means on each car for resisting the tilting movements thereof, and means in the foremost car for initiating the operation of said resisting means prior to the tilting thereof by the causes which tilt the foremost car, said initiating means comprising a photo-electric cell and a light source adapted to be moved relatively to one another during the tilting of the car.

5. In combination, a car, means for resisting the tilting motion of said car brought about by changes in the relative elevation of the rails of the track, a light source and a photo-electric cell movable relatively to one another and located near the forward end of said car, and electrical means for transmitting the signals of said photo-electric cell to said resisting means to operate the same in anticipation of the changes in the tilt of the car brought about by the changes in the track.

6. In combination, a car, means for resisting the tilting motion of said car brought about by changes in the relative elevation of the rails of the track, a light source and a photo-electric cell movable relatively to one another and located near the forward end of said car, and electrical means for transmitting the signals of said photo-electric cell to said resisting means to operate the same in anticipation of the changes in the tilt of the car brought about by the changes in the track, said resisting means comprising hydraulic cylinder and piston assemblies connected to tilt said car, a source of pressure fluid and valve means controlled by said photo-electric cells to regulate the admission of fluid to said assemblies.

7. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit.

8. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell control unit comprising a light source and a photo-electric cell movable relatively to one another by the tilting of said car, said photo-electric cell being shielded to receive illumination from said light source only during the tilting of said car.

9. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell control unit

comprising a light source and a pair of photo-electric cells movable relatively to one another by the tilting of said car, each of said photo-electric cells being shielded to receive illumination from said light source during different positions of tilt of said car whereby to vary the resisting force applied to the car according to the degree of tilt experienced by the car.

10. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell unit comprising a light source on a pendulum and a photo-electric cell attached to the car body, said photo-electric cell being shielded to receive the illumination from said light source only during the tilting of said pendulum by reason of the tilting of said car.

11. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell control unit comprising a light source on a pendulum and a pair of photo-electric cells shielded to receive light at different degrees of tilt of said pendulum, each of said photo-electric cells causing the application of a different amount of resisting force to said car according to the tilt of said pendulum.

12. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell unit comprising a light source on a pendulum and a photo-electric cell mounted on each side of said pendulum to receive the illumination from said light source only during opposite tilts of said pendulum, one of said photo-electric cells being adapted when energized to operate the tilt-resisting means in one direction and the other photo-electric cell being adapted to operate the tilt-resisting means in the opposite direction.

13. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, tilt-resisting means in the succeeding cars controlled by said unit, and a pair of photo-electric cells mounted on each side of said pendulum, each pair of said cells being shielded to receive the illumination from said light source only during the tilting of said pendulum in one direction, the photo-electric cells on a given side of said pendulum being arranged to operate the tilt-resisting means in one direction but at different amounts according to the degree of tilt signalled to said cells by the differing tilt of said pendulum.

14. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell unit comprising a light source on a pendulum, a mirror, and a photo-electric cell mounted on each side of said pendulum to receive the illumination from said light source only as reflected from said mirror during opposite tilts of said pendulum, one of said photo-electric cells being adapted when energized to operate the tilt-resisting means in one direction and the other photo-electric cell being adapted to operate the tilt-resisting means in the opposite direction.

15. In combination, a plurality of cars connect-

ed in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell control unit comprising a light source mounted on a pendulum, a mirror, and a pair of photo-electric cells mounted on each side of said pendulum and arranged to receive the light reflected from said mirror, one photo-electric cell on each side of said pendulum being arranged to receive light rays when the pendulum is tilted through a narrow angle and the other photo-electric cell being arranged to receive light rays only when the pendulum is tilted through a wide angle, whereby said photo-electric cells are arranged to operate the tilt-resisting means by different degrees according to the degree of tilt of said pendulum as caused by differing degrees of tilt of the car.

16. A photo-electric cell control unit for regulating the tilt-resisting devices in a vehicle car, comprising a light source mounted on a pendulum, and a photo-electric cell arranged on each side of said light source, said photo-electric cells being screened to receive illumination only during opposite tilts of said pendulum as caused by opposite tilts of the car, said oppositely arranged photo-electric cells being adapted to actuate the tilt-resisting devices in opposite directions according to the opposite tilts given to said pendulum.

17. A photo-electric cell control unit for regulating the tilt-resisting devices of a vehicle car, comprising a light source mounted on a pendulum, a mirror, and a photo-electric cell arranged on each side of said light source to receive the radiation reflected therefrom by said mirror, said photo-electric cells being screened to receive illumination only during opposite tilts of said pendulum as caused by opposite tilts of the car, said oppositely arranged photo-electric cells being adapted to actuate the tilt-resisting devices in opposite directions according to the opposite tilts given to said pendulum.

18. A photo-electric cell control unit for regulating the tilt-resisting devices in a vehicle car, comprising a light source mounted on a pendulum and a pair of photo-electric cells mounted on each side of said pendulum, said photo-electric cells of each pair being shielded to receive illumination only during different amounts of tilt of said pendulum, each of said photo-electric cells of each pair being adapted to operate the tilt-resisting devices by a different degree according to the amount of tilt given to said pendulum by the motion of the car.

19. A photo-electric cell control unit for regulating the tilt-resisting devices in a vehicle car, comprising a light source mounted on a pendulum, a mirror, and a pair of photo-electric cells mounted on each side of said pendulum and adapted to receive the illumination reflected from said mirror, said photo-electric cells of each pair being shielded to receive illumination only during different amounts of tilt of said pendulum, each of said photo-electric cells of each pair being adapted to operate the tilt-resisting devices by a different degree according to the amount of tilt given to said pendulum by the motion of the car.

20. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell

unit comprising a light source operatively connected to a pendulum and a photo-electric cell attached to the car body, said photo-electric cell being shielded to receive the illumination from said light source only during the tilting of said pendulum by reason of the tilting of said car.

21. In combination, a plurality of cars connected in series, a tilt-responsive photo-electric cell control unit arranged in the foremost car, and tilt-resisting means in the succeeding cars controlled by said unit, said photo-electric cell control unit comprising a light source operatively connected to a pendulum and a pair of photo-electric cells shielded to receive light at different degrees of tilt of said pendulum, each of said photo-electric cells causing the application of a

different amount of resisting force to said car according to the tilt of said pendulum.

22. A photo-electric cell control unit for regulating the tilt-resisting devices in a vehicle car, comprising a light source operatively connected to a pendulum, and a photo-electric cell arranged on each side of said light source, said photo-electric cells being screened to receive illumination only during opposite tilts of said pendulum as caused by opposite tilts of the car, said oppositely arranged photo-electric cells being adapted to actuate the tilt-resisting devices in opposite directions according to the opposite tilts given to said pendulum.

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