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METHOD AND APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE: ELECTRIC MOTOR CONTROL

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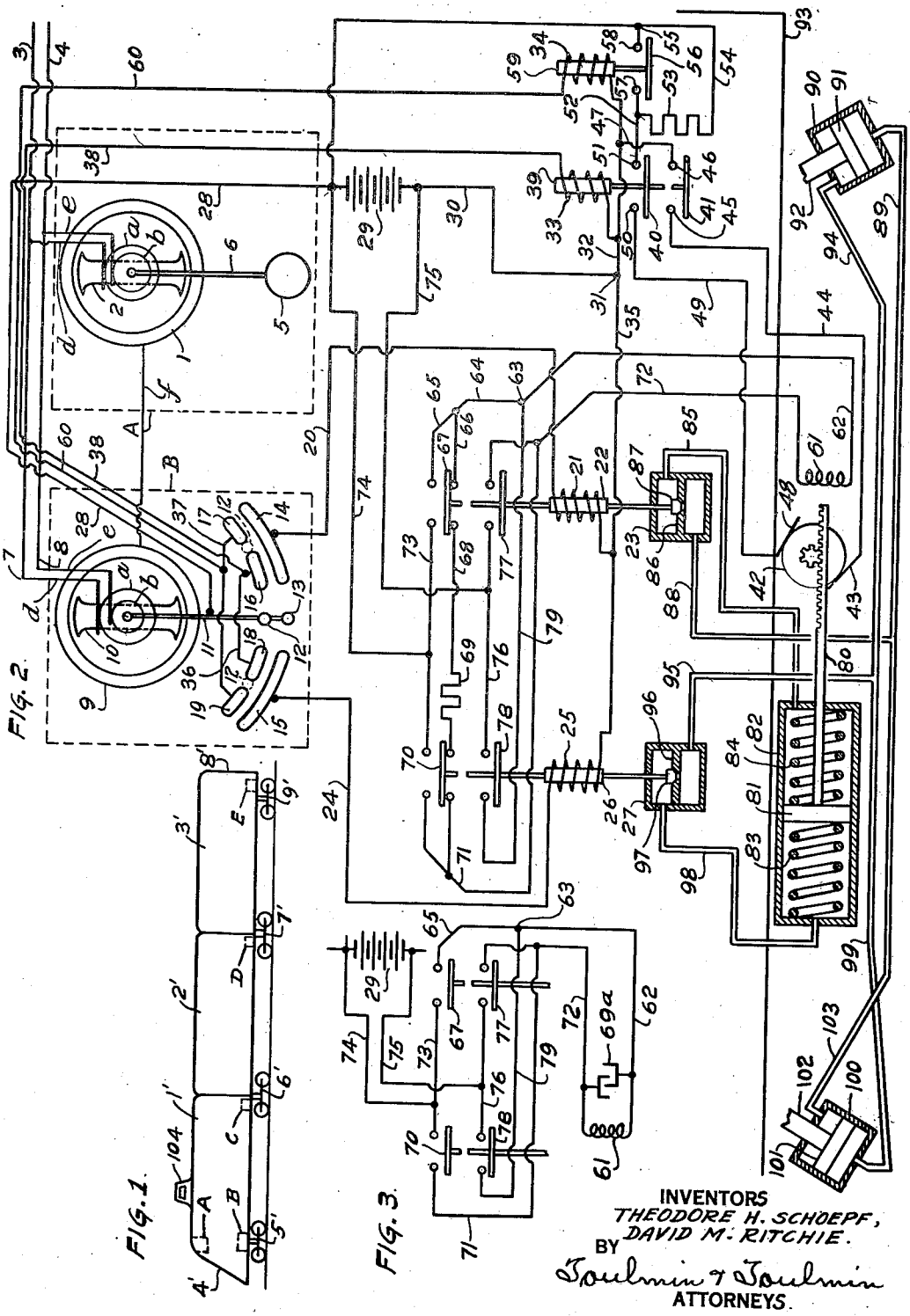


FIG. 2.

FIG. 1.

FIG. 3.

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METHOD AND APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE—ELECTRIC MOTOR CONTROL

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12 Claims. (Cl. 105—199)

It is the object of our invention to provide an automatic control for movements of a vehicle body, particularly a railway car.

It is our object to provide such a means for resisting the downward movement of one part of the car, the upward movement of another part of the car, and for dampening all of the movements and for reducing the vibrations of the car.

In particular, this invention relates to the control of the car as indicated from a remote point, where the control mechanism is located, because of the maximum movements of the car body, to the important point where the force must be applied to regulate and control the car body movement.

One of the difficulties to be overcome in apparatus of this type is apparatus connections, both in number and complication, between the controlling element, technically called the transmitter, and the controlled mechanism, technically called the receiver, as they must be located remote from one another, but at the same time the control must be sensitive and instantaneous and must be responsive to the movements of the vehicle.

Furthermore, in connection with a train of railway cars, it is frequently necessary to so arrange the control or transmitter mechanism that it can anticipate the forces that will be subsequently applied to the cars, and by so anticipating them set the mechanism or receiver in operation for the correction of the effect of the anticipated forces. For instance, in a train of cars, when the locomotive or leading car enters a curve, the effect upon that leading element will be subsequently duplicated on every one of the remaining cars in the train. If this effect is anticipated by correction mechanism, then the correction mechanism will have time to operate and gradually effect a reduction of the rolling of the cars by anticipating this rolling with adjustments.

In trains, particularly articulated trains, where the coordination of the car floors and car bodies is important, and where high speeds to which such trains are subjected aggravate normal conditions found in railway operation, it is particularly necessary to have the controlled mechanism or receiver located at such points in the train as will effect the objects herein related.

Referring to the drawing:

Figure 1 is a diagram of an articulated train comprising a pilot car and two coaches.

Figure 2 is a diagram of the control mechanism.

Figure 3 is a diagram of the modification of the control circuit.

Referring to the drawing in detail, 1′ designates the pilot or motor car of an articulated train having coaches 2′ and 3′. The forward end 4′ of the forward car is supported on the truck 5′, and the rear end is supported jointly with car 2′, on the articulated truck 6′. The rear end of car 2′ and the front end of car 3′ are supported on the articulated truck 7′. The rear end 8′ of car 3′ is supported on the truck 9′.

While this invention is applicable to trains that are not articulated, yet we have shown it in connection with articulated trains because the problem is aggravated in connection with such trains for the reasons stated.

Control mechanism

The control mechanism is located at A at the top of the car 1′, at the forward end 4′. The controlled mechanism is located at the points B, C, D, and E, adjacent the trucks 5′, 6′, 7′ and 9′.

When the train enters a curve, where the centrifugal force, super-elevation of the outside rail and other factors will tend to rock the body or bodies and will tend to twist them torsionally about their horizontal axes, the control apparatus A will be the first to feel the effect and will move, as hereinafter described, for the adjustment of the controlled apparatus B, C, D and E.

In the electrical art, apparatus comprising a self-synchronous system is well known, an illustration of which will be found in United States Letters Patent No. 684,579, dated October 15, 1901, showing means for operating electrical machines synchronously. We employ the principle of a self-synchronous arrangement as a factor or component in our apparatus which is the subject of this application.

Referring particularly to Figure 2, there will be seen the controlling apparatus A, which comprises a self-synchronous transmitter consisting of the frame and fields, designated 1, and the armature 2. This transmitter is supplied with current from any desired alternating current source.

The leads for this purpose are designated 3 and 4. The armature 2 is adjusted in its position by the pendulum 5 on the pendulum shaft 6, which is attached to the armature. As the train rolls or tilts this pendulum will be moved. In doing so it will effect a corresponding self-synchronous device, or more properly, a receiver, located at B, C, D and E. A typical device for

this purpose is indicated in Figure 2 at B. The lead wires 3 and 4 are in electrical connection with the transmitter at the right and are connected with the receiver at the left through the cables 7 and 8 which are extensions of the lead lines 3 and 4. Each of these instruments has contact rings *a* and *b*; the branch lines *d* contacting with the contact rings *a* and the branch lines *e* contacting with the contact rings *b*; and each of these latter wires terminates in a brush contacting, respectively, with the rings *a* and *b*. The fields 1 and 9 are interconnected by the usual lead lines *f*. All that is here described is shown, essentially, diagrammatically in the upper part of Fig. 2.

The self-synchronous device 9 likewise has an armature 10, which moves in synchronism with the movement of the armature 2. This device carries the contact switch arm 11, and thereby the contacts made and broken by this arm 11 are controlled by the movement of the pendulum 5, which in turn, is affected by the tilting of the forward end of the train, which tilt will be also imparted to subsequent portions of the train as they pass over the same track which caused the tilt.

Controlled mechanism

The pendulum switch 11 is provided with contact points 12 and 13. These contact points are adapted to engage contact strips. The contact point 13 engages the strip 14 when it swings to the right-hand and the strip 15 when it swings to the left-hand. The contact 12 when the pendulum swings to the right-hand first engages the strip 16 and then, upon a further swing to the right-hand, it engages the strip 17. The contact 12 on swinging to the left-hand first engages the contact 18 and then the contact 19.

It will be observed that the contact 12 of the pendulum is sufficiently large to contact both strip 16 and strip 17 at one and the same time (see the dotted lines showing contact 12 in touch with strips 16 and 17, and 18 and 19 in Fig. 2) in response to an extreme tilting of the car body, thereby simultaneously and coincidentally energizing both solenoids 33 and 34, so that the armature 42 will be connected into the circuit, with the resistance 53 switched out of the circuit.

The contact 14 is connected by the wire 20 to the solenoid coil 21. This coil operates the solenoid core 22. This core 22 controls the hydraulic valve 23, the function of which will be hereinafter described. It corrects, through the associated mechanism, the rolling of the car to the right-hand. The contact 15 is connected by the wire 24 to a similar solenoid coil 25, having a core 26 operating a valve member in the valve 27, which is used to control the tilting of the car to the left-hand.

The switch arm 11 is connected by the line 28 to the battery 29, the other side of which is connected by the line 30 to the junction point 31. The right-hand of the junction point is connected by the wire 32 to the solenoid coils 33 and 34, regulating the armature series resistance, as described hereinafter. The left-hand of the terminal 31 is connected to the wire 35. This wire is connected to the ends of the solenoid coils 21 and 25, thus completing the circuit with those coils in circuit. This arrangement effects electrically the control of the application of hydraulic pressure to resist the rolling movement of the car. The degree of the rolling movement and the degree of resistance to that rolling movement are determined by the engagement of the contact 12 with the contact plates 16 and 17 or 18 and 19. The contact 16 is connected by the wire 36 to the contact 18, and the contact 17 is connected by the wire 37 to the contact 19.

A common wire 38 is connected to the contacts 16 and 18. At its other end it is connected to the solenoid coil 33, which has the solenoid core 39. On this core are mounted switch blades 40 and 41. The switch members 40 and 41 control the armature series resistance conditions of the armature 42 of a motor used for creating hydraulic pressure through a suitable hydraulic system which is employed for controlling the rocking or rolling of the car. The armature 42 is provided with a brush 43, which is connected by the wire 44 to the terminal 45, that is engaged by the switch arm 41, which in turn, connects it to the terminal 46 connected to the wire 47. This wire is connected into the wire 32.

The other side of the armature is connected through the brush 48 by the wire 49 to the contact 50, which is connected by the switch arm 40 to the contact 51 and wire 52. Connected into the wire 52 is the armature series resistance 53, the other side of which is connected by the wire 54 to the terminal 55. This resistance is short-circuited out of the system by the closing of the switch 56, connecting the wire 52 directly to the terminal 55 through the contacts 57 and 58. This switch 56 is actuated by the solenoid core 59 of the coil 34, one end of which is connected to the wire 32 and the other end of which is connected by the wire 60 to the interconnected contact plates 17 and 19, which are joined by the wire 37. Thus, the armature condition is controlled by the extent to which the rocking of the car or its tilting carries the contact 12.

Turning again to the motor 42, its field 61 is connected to line 62 on one side, and the line 62 at the junction point 63 is connected to the wire 64, which has the branches 65 and 66. The branch 66 is normally connected by switch arm 67 to the wire 68, containing the field discharge resistance 69. The other side of this resistance is connected by the switch 70 to the wire 71, which in turn, is connected to the wire 72 that leads to the other side of the field 61.

Upon energization of the coil 21 the switch blade 67 connects the wire 65 to the wire 73. The wire 73 is connected by the line 74 to one side of the battery 29. The other side of this battery is connected by the line 75 to the line 76. The line 76 is connected to the line 72 by the switch arm 77. When this occurs the field discharge resistance 69 is cut out of circuit. Likewise, when the contact 15 is engaged the coil 25 will be energized, moving switch arm 70 to connect the wire 73 to the wire 71, cutting out of circuit the field discharge resistance 69. The switch arm 78 connects the wire 76 to the terminal 63 through the wire 79. In Figure 3 is shown the capacitator 69*a* used in place of the field discharge resistance 69.

Hydraulic control system

The electric motor 42 heretofore described operates a piston rod 80 having a piston 81. This piston and piston rod operate within the cylinder 82 against the springs 83 and 84. One end of this hydraulic cylinder is connected by the pipe 85 to the valve 23, above the ported partition 86. The port in this partition is controlled by the valve member 87 and the solenoid valve stem 22. The other end of the valve 23 is connected by the

pipe 88 to the pipe 89, which leads to the bottom of the cylinder 90.

The cylinder 90 is provided with a piston 91 and a piston rod 92, which may, in any well-known manner, engage with the bottom of the car 93. A pipe 94 is connected to the cylinder 90, and extends to the pipe 95, and thence to the valve 27, beneath the ported partition 96. The port in this partition is controlled by the valve member 97 and the solenoid valve stem 26. The pipe 98 connects the upper end of the valve 27 to the opposite end of the cylinder 82. The pipe 94 has an extension 99 that leads to the bottom of the cylinder 100 on the left-hand side of the body 93. The piston 101 in the cylinder has a piston rod 102 which engages the bottom of the body 93 when the car tips at that side. The top of this cylinder 100 is connected by the pipe 103 to the pipe 88. This pipe 103 has an extension 89, which connects with the lower end of the cylinder 90.

Thus, as pressure is supplied on the bottom of the piston 91 to resist the downward movement of the body 93, pressure is applied downward on the opposite side through the pipe 103 on the piston 101; and vice versa. Therefore, if the car rocks in a given direction there will be hydraulic pressure applied resisting the downward movement of the car in that direction, and hydraulic pressure will be applied downward on the upwardly moving side of the car. The degree of this pressure will depend upon the extent to which the rocking takes place. This is accomplished by the adjustment of the armature series resistance through the engagement with the multiple contacts 16 and 17 or 18 and 19. The direction of application of the hydraulic pressure is controlled by the engagement of the contact 13 with either contact plate 14 or contact plate 15.

Therefore, the result of these functions is that when either piston 92 and 102 is forced upward toward the low side of the car, the other piston under the high side of the car will be forced downward. Thus the apparatus has a dual function which it will perform to restore a tipped car to a normal lateral horizontal position.

The motor 42 rotates in one direction and then in another responsive to the position of the pendulum 11, which, in turn, is responsive to the tilting of the car body. For instance, if the car body tilts downwardly on the right-hand side, then the contact 13 of the pendulum 11 will engage contact 14 and complete the circuit to energize solenoid 21, which will actuate the contact 67 to complete the circuit between wires 73 and 65. At the same time contact 77 will rise and complete the circuit between wires 76 and 72, thereby completing the circuit between the battery 29 and the motor-field coil 61 to energize the coil 61 for rotation of the motor 42 in a particular sense, and the motor 42 will continue to rotate in that sense until the car body rights itself or is righted and the pendulum 11 assumes the vertical or normal position as shown in Figure 2.

Indeed, assuming the car body tilts downwardly on the left-hand side then the pendulum 11 swings to the left and contact 13 engages contact 15 and completes the circuit to energize solenoid 25, whereupon solenoid 25 actuates contact 70 to close the gap between wires 71 and 73, and contact 78 closes the gap between wires 76 and 79, thereby completing the circuit between the battery 29 and the field coil 61 of the motor to cause the motor armature 42 to rotate in a sense opposite to that described in the previous paragraph hereof. And the armature 42 will continue to rotate in that sense until the pendulum 11 has resumed its normal position as shown in Fig. 2, and contact 13 has discontinued engagement with contact 15.

As to the operation of the cylinder 82 and its piston 81, piston rod 80, and the motor 42, we state that when the piston 81 is being moved to the right by the rotation of the motor 42, it thereby creates pressure on the upper side of piston 101, and the fluid in the cylinder 100 below the piston 101 is forced out through pipes 99 and 95 to the lower chamber of valve 27. This fluid is sufficient to lift the valve 97 off its seat, because the valve 97 is only held seated by the weight of itself and associated parts. Then the valve 27 is thereby exhausted through its upper chamber and the pipe 98 into the left-hand chamber of pump 82, wherein the pressure has been reduced by virtue of the fact that piston 81 is traveling to the right. By these means lineal motion is imparted to the piston 81 and its rod 80. Accordingly the motor 42 is energized and will operate to actuate the piston rod 80 and its piston 81 alternately in both directions—right and left.

Referring to Figure 1, there is provided in some cases an observation and operating control room 104 on top of the car. It is preferred to locate the pendulum control at this point, where it can be readily observed and where the maximum degree of movement will be found.

In our copending application Ser. No. 2,074, filed January 16, 1935, we have disclosed certain subject matter which is also disclosed in this present application filed eight days later, namely, January 24, 1935, but in this later or present application, we do not claim what is claimed in said application of January 16, 1935. And furthermore there are features of importance in this later application, Serial Number 3,346, that are not at all included in application Serial Number 2,074; for instance, as the controlling mechanasm 1 and 2, and the controlled mechanism or receiver 9 and 10, shown particularly in Figure 2 of the drawing, which mechanism is not present in application Ser. No. 2,074.

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

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

1. In combination, a car body and a truck, means for controlling the rocking of the car, an adjacent self-synchronous device comprising a motor, a switch control associated with the armature of said motor and moved thereby for regulating said controlling means, a remotely located interconnected synchronous motor having an armature, and a weighted pendulum mounted on said armature, whereby the rocking of the car will move said pendulum in a given direction and the first-mentioned self-synchronous motor will have its armature likewise moved for selectively operating said switch.

2. In combination, a car body and a truck, means for controlling the rocking of the car, an adjacent self-synchronous device comprising a motor, a switch control associated with the armature of said motor and moved thereby for regulating said car-rocking controlling means, a remotely located interconnected synchronous motor having an armature, a weighted pendulum mounted on said armature, whereby the rock-

ing of the car will move said pendulum in a given direction and the first-mentioned self-synchronous motor will have its armature likewise moved for selectively operating said switch, and means associated with the controlling means for varying the effect thereof according to the extent of swing of said pendulum means connected to the synchronous motor armature.

3. In combination, a car, a truck, hydraulically actuated means for resisting the movement of the car relative to the truck whereby hydraulic pressure is set up, such resisting means being located on either side of the truck, electrical means for controlling the application of said hydraulic pressure, a self-synchronous motor, or receiver, having an armature switch for selectively, according to the tipping of the car, operating said electrical means, and a remotely located synchronous motor or transmitter having a pendulum-operated armature electrically connected to the first-mentioned self-synchronous motor, whereby the movement of the pendulum motor will actuate the other motor to the same extent and in the same direction for the correction of the rocking of the car.

4. In combination, a car, a truck, hydraulically actuated means for resisting the movement of the car relative to the truck, such resisting means being located on either side of the truck; electrical means and its accessories for controlling the application of said hydraulic means; a self-synchronous motor or receiver having an armature switch for selectively, according to the tipping of the car, operating said electrical means; a remotely located synchronous motor or transmitter having a pendulum-operated armature electrically connected to the first-mentioned self-synchronous motor, whereby the movement of the pendulum motor will actuate the other motor to the same extent and in the same direction for the correction of the rocking of the car, said electrical means including means for controlling the extent of the application of hydraulic pressure depending upon the extent of movement of the armatures of said synchronous and said self-synchronous motors.

5. In combination, a railway car, hydraulically applied means for resisting the rocking of the car, electrically controlled means, and its accessories, for controlling the application of said hydraulic means to the car, said electrical means comprising a direction selection circuit depending upon the direction of tilt of the car body for its selection, and a pressure-increasing circuit depending for its operation upon the degree of tilt of the body; a self-synchronous electric motor or receiver having an armature switch for selectively engaging said electrical circuits, and an electrically interconnected synchronous electric motor, or transmitter, having an armature and an actuating pendulum connected thereto affected by the tilting of the car, whereby the direction of tilt and the extent of tilt result in the control of the direction and amount of resistance applied to the tilt of the car body.

6. In combination in a train of cars, a plurality of cars and trucks, means associated with each car and with at least one of its trucks for resisting the tilting of the body on the truck, such means comprising hydraulically-actuated devices between the car body and the truck, and electrically operated devices for selectively determining the place and direction of application of the hydraulic means; said electrically operated devices including a self-synchronous electric motor or receiver having a selective switch for operating selectively from the armature movement of said self-synchronous motor or receiver the particular circuit that is to be operated; a common remotely located synchronous motor or transmitter electrically interconnected with the first-mentioned self-synchronous motor or receiver so that their armatures move together; and a pendulum attached to the armature of the second motor or transmitter, whereby the tilt of the car carrying the last-named motor or transmitter will adjust the mechanism for controlling the tilt of the several cars.

7. In combination in a train of cars, a plurality of cars and trucks, means associated with each car and with at least one of its trucks for resisting the tilting of the body on the truck, such means, comprising hydraulically-actuated means between the car body and the truck and electrically-operated means for selectively determining the place and direction of application of the hydraulic means; said electrically operated means including a self-synchronous electric motor or receiver having a selective switch for operating selectively from the armature movement of said motor or receiver the particular circuit that is to be operated; a common remotely located synchronous motor or transmitter electrically interconnected with the first-mentioned self-synchronous motor or receiver so that their armatures move together; and a pendulum attached to the armature of the said second motor or transmitter, whereby the tilt of the car carrying the second motor or transmitter will adjust the mechanism for controlling the tilt of the several cars, said controlling synchronous motor with the pendulum being located at the top of the car.

8. In combination in a train of cars, a plurality of cars and trucks, means associated with each car and with at least one of its trucks for resisting the tilting of the body on the truck, such means comprising hydraulically-actuated devices between the car body and the truck, and electrically operated devices for selectively determining the place and direction of application of the hydraulic devices; said electrically operated devices including a self-synchronous electric motor or receiver having a selective switch for operating selectively from the armature movement of said self-synchronous motor or receiver the particular circuit that is to be operated; a common remotely located synchronous motor or transmitter electrically interconnected with the first-mentioned self-synchronous motor or receiver, so that their armatures move together; and a pendulum attached to the armature of said second motor or transmitter, whereby the tilt of the car carrying this motor or transmitter will adjust the mechanism for controlling the tilt of the several cars, said controlling synchronous motor or transmitter having its pendulum located at the top of the car, such motor or transmitter being mounted on the first car of the series of cars in the train.

9. In combination in a train of cars, resisting means on each car for resisting any side tipping movement thereof, a gravity operated device mounted on the forward car of the train, and power transmitting connections from said device to the tipping-resisting means on each car, whereby upon operation of said device upon the tipping of the forward car the tipping-resisting means of the other cars in the train are operated to control the tipping movements of said other cars.

10. In a method of controlling the tipping movements of railway cars, the following steps: the step of transmitting electrical energy from a gravity-operated transmitter in one car to a receiver in said car and in each of one or more other railway cars; automatically closing an electric circuit by a switch on each of said receivers responsive to the operative position of said transmitter, and causing such circuit to open a source of fluid supply into a distributing instrumentality; delivering such fluid supply to contact with a movable instrumentality on each car; and applying the force of such movable instrumentality to either side of each car for restoring said other cars to a level condition in accordance with the position of said first-mentioned car.

11. In a method of controlling the tipping movements of railway cars, the following steps: transmitting electrical energy from a gravity-operated transmitter in one railway car to a receiver in said car and on each one or more other railway cars; automatically closing an electric circuit by a switch on each of said receivers responsive to the operative position of said transmitter and causing such circuit to open a source of fluid suply into a distributing instrumentality; delivering such fluid supply and causing it to contact with two enclosed movable instrumentalities on each car; effecting a balance of such fluid supply by conveying it from the upper part of the enclosure of one of said movable instrumentalities to the lower part of the enclosure of another of said instrumentalities, and vice versa, whereby the fluid is caused to exert a pressure upon the opposite sides of each of said instrumentalities and is permitted to discharge from one side of one instrumentality to the opposite side of the other of said instrumentalities; controlling the flow of fluid to the distributing instrumentality which conveys the fluid to said enclosures, and applying the force of such movable instrumentality to either side of the car for restoring said other cars to a level condition in accordance with the position of said first-mentioned car.

12. In combination, a car, hydraulic instrumentalities located upon opposite sides thereof for resisting the tipping movement of the car, a gravity-operated transmitting means on said car, a receiver having a switch located a suitable distance from said transmitting means, power transmitting electrical devices and hydraulic connections between said receiver and said hydraulic car tipping means whereby automatic operation of said receiver will effect through said connections operation of the hydraulic means for resisting the tipping movement of the car under the automatic control of the gravity operated transmitting means to restore said car from a tipped to a level condition.

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