July 16, 1946. J. H. PORTEUS 2,404,091

RAILWAY CAR TILTING APPARATUS

Filed April 22, 1944 4 Sheets-Sheet 1

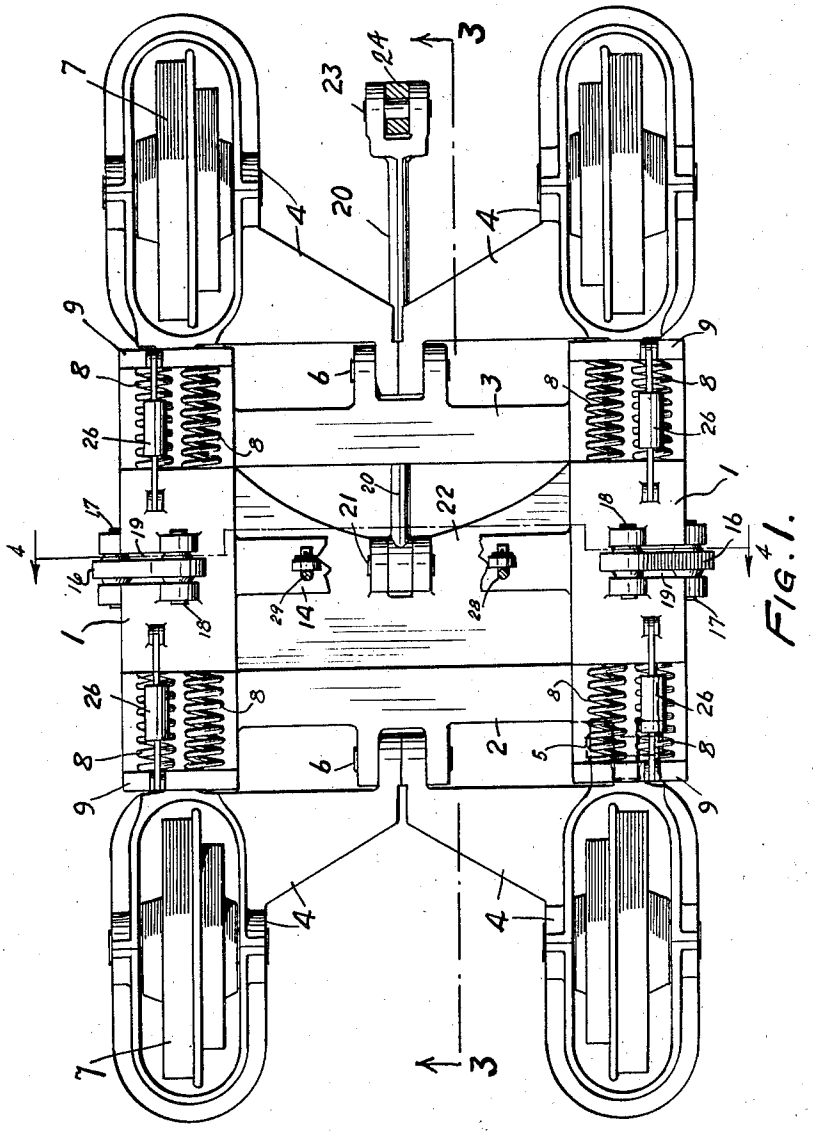


FIG. 1.

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RAILWAY CAR TILTING APPARATUS

Filed April 22, 1944 4 Sheets-Sheet 2

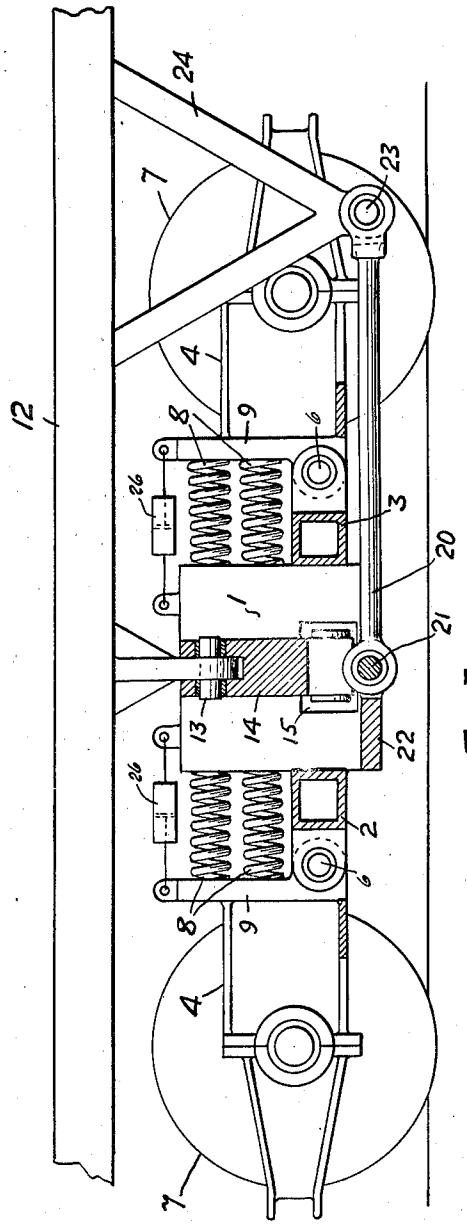


FIG. 3.

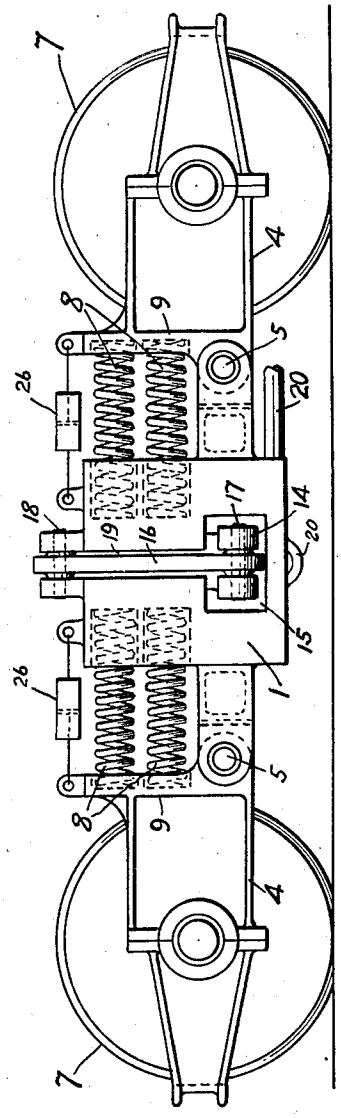


FIG. 2.

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July 16, 1946. J. H. PORTEUS 2,404,091

RAILWAY CAR TILTING APPARATUS

Filed April 22, 1944 4 Sheets-Sheet 3

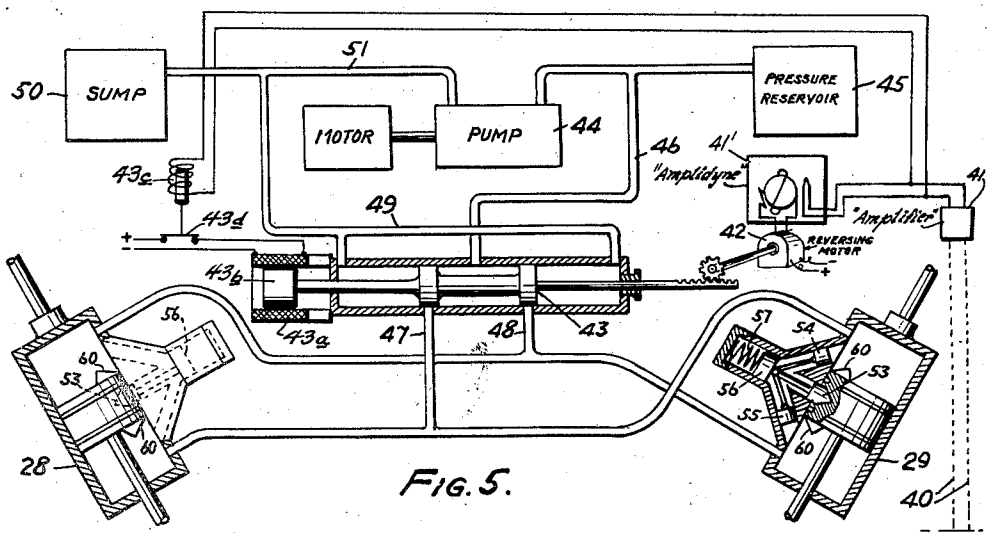


FIG. 5.

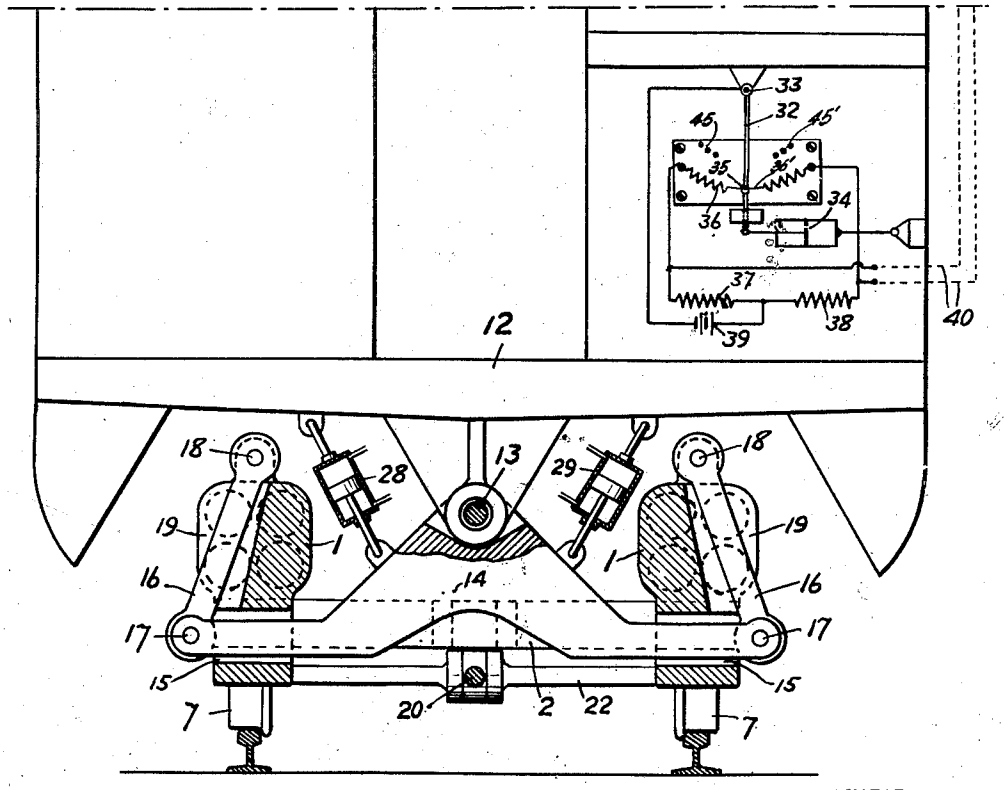


FIG. 4.

WITNESS:

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July 16, 1946. J. H. PORTEUS 2,404,091

RAILWAY CAR TILTING APPARATUS

Filed April 22, 1944 4 Sheets-Sheet 4

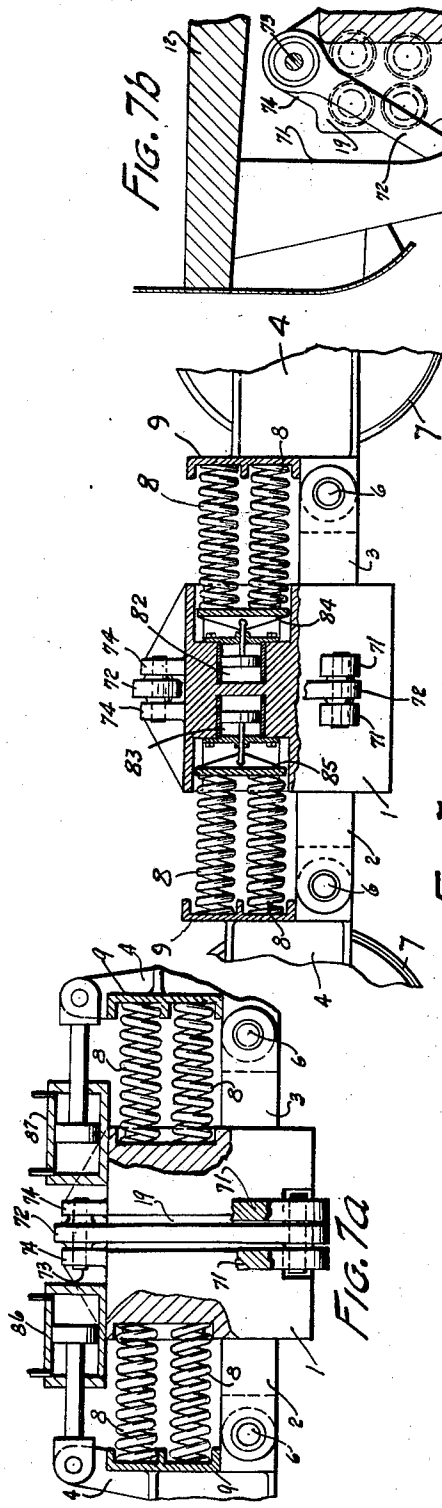


FIG. 7b

FIG. 7.

FIG. 7a

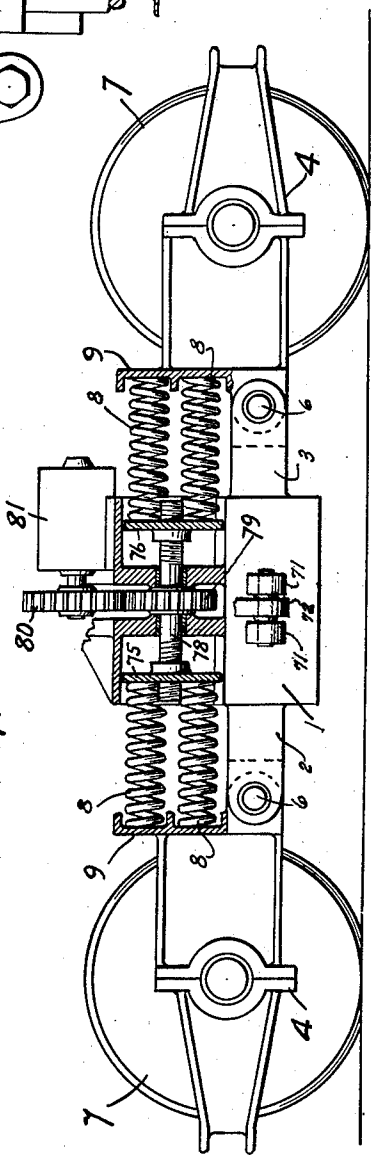


FIG. 6.

INVENTOR

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Patented July 16, 1946

2,404,091

UNITED STATES PATENT OFFICE

2,404,091

RAILWAY CAR TILTING APPARATUS

John H. Porteus, Wellesley, Mass., assignor to The Baldwin Locomotive Works, a corporation of Pennsylvania

Application April 22, 1944, Serial No. 532,341

2 Claims. (Cl. 105—199)

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This invention relates generally to railway cars and more particularly to car body tilting means.

Various arrangements have heretofore been proposed and used for banking a railway car body on a curve in addition to the usual banking of the tracks thereby allowing the passengers to have a normal relation to the car at all times with consequent increased riding comfort. One of these prior arrangements employs a very elaborate car support whereby the car body acts in the nature of a pendulum swinging from points above the center of gravity of the car body. However, such an arrangement requires the car body to be not only specially built for this purpose with consequent increased cost of manufacture but it consumes substantial space within the interior of the car that would otherwise be used for revenue producing passengers. Moreover, such an arrangement is not a free pendulum, since as the car rotates about the axis of rotation the main suspension springs are deflected. The work thus done on the main springs in tilting sharply limits the swing of the pendulum and does not permit the car to assume the ideal position which would be assumed by a free pendulum. Furthermore, since the pendulum swing in itself changes the loading on the main springs, the riding characteristics of the car will be different while rounding a curve from those obtaining on tangent track. Finally, since the springs permit but little actual pendulum swing, the speed range (over or under) from that for which a particular curve is super-elevated is small.

One object of my invention is to provide an improved means for tilting a car body to the ideal free pendulum position in which the floor of the car will at all times be substantially normal to the resultant of gravity and centrifugal forces. This will insure maximum riding comfort without requiring any substantial alteration of the body or of loss of revenue producing space, and will with perfect safety and comfort permit of speeds on curves much over or under those for which the curves are super-elevated.

A further object is to provide an improved combination of cooperative elements that is relatively simple and positive in operation combined with sufficient flexibility of control that tilting manipulations and restoring of the car body to a normal position will be accomplished in a simple and effective manner.

Another object is to provide an improved body tilting arrangement that can be applied to car bodies of standard and existing designs with minimum change thereto and which may be used in

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cooperation with a highly flexible truck thereby providing maximum riding comfort against the adverse effects of centrifugal force and irregular tracks and road bed conditions.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings in which:

Fig. 1 is a plan view of an improved truck with which my improved car body tilting means are employed but with the car body removed and parts broken away to show certain details of construction;

Fig. 2 is a side elevation of Fig. 1;

Fig. 3 is a longitudinal section taken substantially on the line 3—3 of Fig. 1;

Fig. 4 is a transverse section of the truck taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is a diagram of the hydraulic circuits and controls together with the body tilting servomotors;

Fig. 6 is a longitudinal section of a truck having body tilting means formed as a self-contained part of the truck, the tilting mechanism being operated by electric motors so as to lower one side of the truck and raise the other side, or vice versa;

Fig. 7 is a modification of Fig. 6 in which hydraulic tilting motors are employed;

Fig. 7*a* is a fragmentary side elevation of a truck of the general type disclosed in Figs. 6 and 7 but with modified forms of means for raising one side and lowering the other side of the truck; and

Fig. 7*b* is a fragmentary transverse section of one side of the type of truck shown in Figs. 6, 7 and 7*a*.

My invention may be applied to various types of trucks and for purposes of illustration in Figs. 1 to 4 I have shown a truck of the general type disclosed in my copending application Serial No. 518,633, filed January 17, 1944, but with certain improvements thereto. This truck consists of side frame pieces 1 connected by transverse members 2 and 3 to which wheel yokes generally indicated at 4 are pivotally connected at their outside lateral points by pins 5 and at their inner points by a common pin 6, Fig. 1. Usual wheels 7 are supported preferably upon individual axles suitably journalled in the wheel yokes 4 in any one of the various manners disclosed in said copending application. Sets of horizontal springs 8 are interposed between the side frames 1 and upright portions 9 of the respective yoke frames 4 of each wheel, whereby as shown in Fig. 1 the

wheels may have individual knee action movement, although it will be seen from the disclosure herein that my invention may be applied to trucks having straight through axles as well as other arrangements of springs. The car body generally indicated at 12, Fig. 3, is laterally tiltable by being horizontally pivotally supported at 13, Fig. 4, on a swing bolster 14 which extends laterally through suitable openings 15, Fig. 4, in the side frame pieces 1. The bolster is suitably shaped as shown in Fig. 4 to provide a relatively high point of support 13 and has its laterally extending arms of reduced depth to extend through the side frames 1. Swing links 16 are connected to the bolster by pins 17 and to the side frame 1 at 18, there being suitable slots 19 formed in the side frames 1 to receive the swing links whose upper and lower pivots have universal action to allow turning of the trucks without center pins, all as disclosed in said copending application. A draft tongue 20, Fig. 3, is suitably pivotally connected at 21 to a frame member 22 connected as shown in Fig. 4 to the two side frames 1 at their lowermost portion. The tongue extends substantially horizontally beneath the truck and is pivotally connected at 23, Fig. 3, to an arm 24 rigidly connected to and depending from the car body frame 12. As shown in my said copending application hydraulic stabilizers 26 may be interposed between the individual wheel yokes and the frame but these stabilizers do not constitute a part of my present invention. Two trucks of the foregoing type are provided, one at each end of the car so that the description of one will suffice for both.

My car body tilting means as shown in Fig. 4 includes a pair of tilting motors 28 and 29 having outwardly inclined piston and cylinder elements respectively pivotally connected to the car body 12 and to the swing bolster 14. Hydraulic fluid under pressure is supplied simultaneously to one end of one cylinder and to the opposite end of the other cylinder and fluid is exhausted from the other opposite ends thereof, or vice versa, depending upon the direction in which it is desired to tilt the car body 12 in passing around a curve.

To control the hydraulic fluid for the tilting motors 28 and 29, I have provided means that is operable automatically in accordance with the speed of the car and the degree of curvature of the track. This means is specifically illustrated herein as comprising a suitably weighted pendulum 32 pivoted at a fixed point 33 to some part of the car body above its pivotal connections 13 while the lower end of the pendulum is connected to a suitable dash pot diagrammatically shown at 34. An electrical contact 35 is secured to the pendulum to slide over and vary an electrical resistance 36 which is rigidly connected to the car body, the resistance constituting two arms of a bridge whose other two arms are indicated by suitable resistances 37 and 38. To cause the bridge to be insensitive to negligible car movements and operating conditions the central portion 36' of the resistance 36 consists of a straight wire which, for a desired extent of pendulum movement, maintains the bridge in a balanced condition. Hence, minor movements of the contact 35 or vibrations near its central or neutral position do not cause a tilting action. The bridge is energized by a battery 39 and is connected through wires 40 to a suitable electronic amplifier 41 which in turn is connected to any suitable motor controlling apparatus such, for example,

as a General Electric "Amplidyne" 41' for controlling a reversible motor 42. The direction of rotation of motor 42 depends upon whether the bridge is unbalanced in one direction or the other in accordance with swinging of the car body beyond the predetermined limits of neutral section 36'. Motor 42 adjusts a two spool valve 43 through a suitable rack and pinion so that hydraulic fluid under pressure is supplied from a motor driven pump 44 and reservoir 45 through a pipe 46 to one or the other of a pair of pipes 47 and 48, depending upon which one is opened in accordance with the action of pendulum 32, while the other of said pipes is connected to an exhaust pipe 49 which leads to a sump 50 and to the suction side of pump 44.

Once the pendulum swings beyond the neutral or bridge balancing section 36' and initiates actuation of the tilting motors, the car body will continue to be tilted until it is substantially normal to the lengthwise axis of the pendulum. It will be understood that in accordance with the magnitude of the centrifugal force arising from passing around a given curve, the pendulum 32 will assume some position offset from its neutral position, and this offset position will be held so long as the centrifugal force continues. Also the speed of operation of the "Amplidyne" will be proportional to the displacement of the pendulum. As the car body is tilted to its banked position it carries with it the pivot 33 which has the effect of shifting the pendulum and its contact 35 back across the resistance 36 until the pendulum has the same neutral position, relative to the resistance, as is shown in Fig. 4 but in the displaced or banked position. When the foregoing neutral position of the pendulum is reached, it is also necessary to return or restore the control valve 43 to its neutral position to prevent continued tilting of the car body by the tilting motors and at the same time to hold the fluid in the motors so that they remain in the desired tilted position. To neutralize the valve 43, I provide a solenoid 43*a* having a core 43*b* on an extension of the valve. When the solenoid is energized the core will center itself and automatically neutralize valve 43. When the bridge is unbalanced, current from the bridge flows to motor 42 and also to a switch solenoid 43*c* to open a switch 43*d* and thereby deenergize neutralizing solenoid 43*a*. This allows the valve 43 to be moved in either direction to adjust the tilting motors. When the bridge is balanced by contact 35 being in the balance zone 36', then there is no bridge current and switch solenoid 43*c* is energized to close switch 43*d*. Solenoid 43*a* is thus energized and valve 43 neutralized to hold the servo-motors in their tilting position. As the curve of the track decreases, the pendulum will now move toward its vertical position to unbalance the bridge circuit in the opposite direction to cause the tilting motors to shift the car body towards its level position. As the car body moves toward its level position, a follow-up or restoring action takes place, as just previously described, to return valve 43 to neutral and thus stop the tilting motors when the car is substantially horizontal. It will be understood that the extent of the neutral bridge section 36' can be made so small that the car always returns so closely to its actual horizontal position that any variation therefrom is not detectable by a passenger. Also, under certain conditions it may be desirable to limit the extent of maximum tilting to any one of various desired degrees. To do this, a series of holes 45',

Fig. 5, are formed in a suitable panel and stop pins are placed in any selected holes, one on each side of the pendulum, to limit maximum movement of the pendulum and accordingly limit the amount of tilting of the car body.

It will be understood that in the foregoing operations the pendulum and associated controls and tilting motors will gradually change and shift from one position to another in accordance with varying degrees of increasing or decreasing speeds or degrees of curvature.

To hold the tilting piston and cylinder elements in their neutral position, in which case the car body is level, I have provided a locking bolt 53 with straight side and tapered end portions, this bolt being received within a correspondingly shaped recess in one side of the piston element. The straight sides of this bolt extend sufficiently into the piston recess so as to provide a positive block against axial movement of the piston. To release this lock when fluid is supplied to either end of the cylinders, I have diagrammatically shown one mechanism, among other equivalent arrangements that may be used, consisting of a pair of pistons 54 and 55 pivotally connected by links to a crosshead 56 which in turn is biased inwardly by a suitable spring 57. The pistons 54 and 55 are positioned in cylinders having their inner ends open to the opposite ends of tilting motor cylinders whereby upon admission of fluid to either end thereof the pistons 54 or 55, as the case may be, will be forced outwardly against spring 57 to lift locking bolt 53 out of the piston recess. Thereupon one of the tilting motor pistons will be moved upwardly and the other downwardly to bank the car body 12 in addition to whatever banking may occur by reason of the banked trackway.

When the tilting motors have moved a substantial distance to tilt the car body and have reached a stabilized banked position, the pistons of the servo-motors 28 and 29 will have moved past the locking bolt 53 and spool valve 43 will be in its neutral position shown in Fig. 5. Thereupon the fluid pressure in the ends of the cylinders may not be sufficient to cause pistons 54 or 55 to hold locking bolt 53 in its retracted position. Accordingly, the bolt will move back into the servo-motor cylinders and might, under certain circumstances, remain in the path of the next movement of the piston towards neutral in case pistons 54 and 55 are not suitably actuated to lift the bolt. To insure that bolt 53 will be moved out of the path of the piston a pair of inclined cam surfaces 60 are provided on each end of the piston thereby to engage the complementary tapered surfaces of bolt 53 to force it outwardly and allow the piston to move past.

In the modifications of Figs. 6, 7 and 7*a*, the tilting action is accomplished in a truck of the specific type shown in my said copending application in which no bolster is used but instead the car body is supported by arms 71, Fig. 7*b*, depending from the car and universally pivotally connected directly to the lower ends of swing links 72 which are also universally pivotally connected at 73 directly to the main truck frame 74, Figs. 7 and 7*b*. The parts in Figs. 6 and 7 that have identical corresponding parts in Figs. 2 and 3 are given the same reference numbers. The car body is supported on the truck frame but is not adapted to tilt thereon except to a negligible degree by links 72. To perform a tilting function, one side of the truck frame is lowered and the other side raised, or vice versa. To do this,

the horizontal springs 8 on each side of the truck are provided with shiftable seats 75 and 76 which are controlled so that the springs are pushed apart on one side of the truck while simultaneously being brought together on the other side thereby lifting the first side of the truck and lowering the other side or vice versa, depending upon the direction of centrifugal force. To adjust seats 75 and 76 they are threaded upon a screw 78 which is rotated by gears 79 and 80 driven by an electric motor or other suitable means 81. The gear 79 may be fixed to the shaft so as to anchor it in an axial direction whereby rotation of the shaft in one direction will cause the left and right handed threads thereof to move the plates 75 and 76 outwardly or inwardly as the case may be. To accomplish this adjustment of the spring seats by hydraulic means two cylinders 82 and 83, Fig. 7, may be formed in the truck side frame and pistons disposed therein for connection to the shiftable spring seats 84 and 85. In Fig. 7*a*, pneumatic pistons and cylinders are interposed between the truck frame and wheel yoke arms 9 to compress the springs on one side and extend them on the other side, or vice versa, thereby to tilt the truck frame accordingly. These pneumatic motors perform not only a tilting function but also constitute air springs which are in parallel with the regular coil springs 8. The arrangements of Figs. 6, 7 and 7*a* employ the same fundamental type of control shown in Fig. 5, it being understood that in Figs. 7 and 7*a* the motors 86 and 87 or 82 and 83 correspond to the motors 28 and 29 of Fig. 4, while in Fig. 6 the motor 81 would correspond to reversible motor 42 of Fig. 5. As previously stated, the electric, hydraulic and pneumatic motors on opposite sides of the truck will operate simultaneously in opposite directions. Also when the electric tilting motors are used, a neutralizing solenoid such as 43*a* is not needed because the electric motors will not receive current when the bridge is completely balanced and accordingly will stop rotating. It will also be evident that the arrangements of Figs. 6 and 7 do not change the forces in or deflections of the main suspension springs 8.

From the foregoing disclosure, it is seen that I have provided an improved car tilting and control system that is not only sensitive, positive and simple in operation but has a high degree of stability arising from the automatic restoring or follow-up action as the car body reaches either its desired tilted or level position. This automatic restoring of the control valve 43 to its neutral position utilizes the car body itself as an operating element to shift the pendulum relative to the resistance. It will of course be understood that tilting motors such as 28 and 29 are provided at each truck so that both ends of the car are uniformly tilted. While Fig. 5 shows my control system applied to only two such tilting motors, yet this same control system commonly serves all additional tilting motors on the second truck.

It will of course be understood that various changes in details of construction and arrangement of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A railway car truck having a frame and wheel yokes pivotally mounted thereon at each side of the truck, horizontal springs interposed between said yokes and truck frame, power operated means for banking the truck frame by mov-

ing the springs away from each other on one side of the truck and for moving them toward each other on the other side thereby to tilt the truck frame, and means for controlling said power means so as to effect said banking action.

2. A railway car truck having a frame and wheel yokes pivotally mounted thereon at each side of the truck, horizontal springs interposed between said yokes and truck frame, power operated means for banking the truck frame including movable spring seats and electric motor driven screws on opposite sides of the truck and threaded in said seats whereby screw rotation causes the seats to move away from each other on one side and toward each other on the other side thereby to tilt the truck frame, and means for controlling said power means to effect said banking action.

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