June 6, 1939. T. H. SCHOEPF ET AL 2,161,687

APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE

Filed March 5, 1937 6 Sheets-Sheet 1

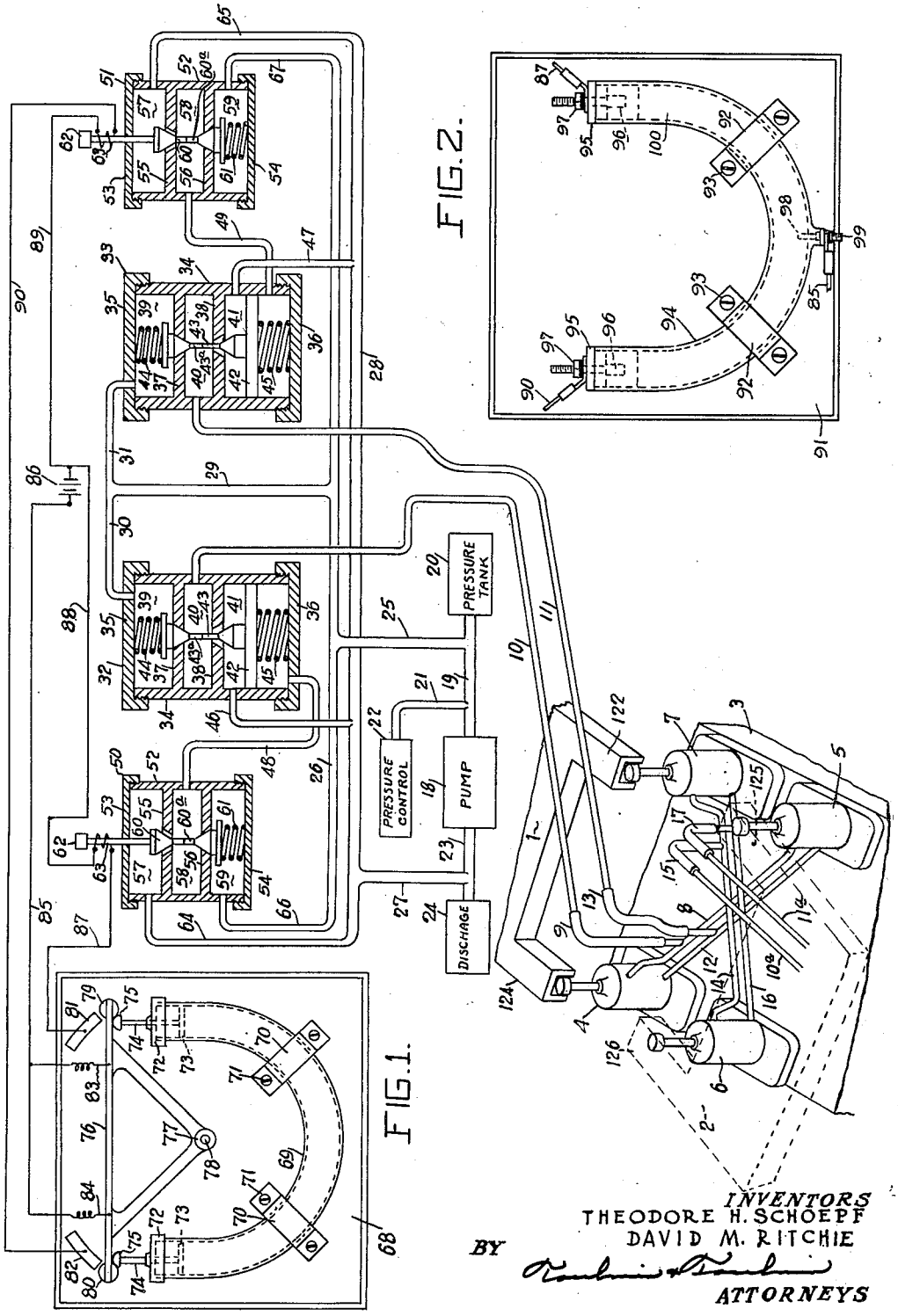


FIG. 1.

FIG. 2.

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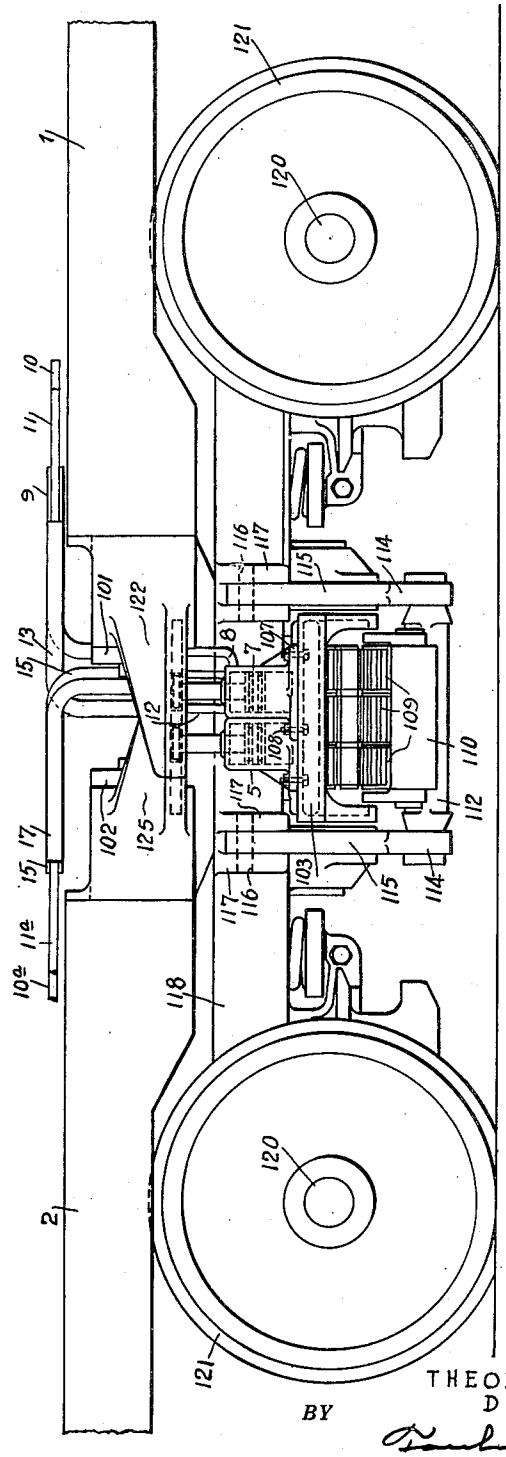
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FIG. 3.



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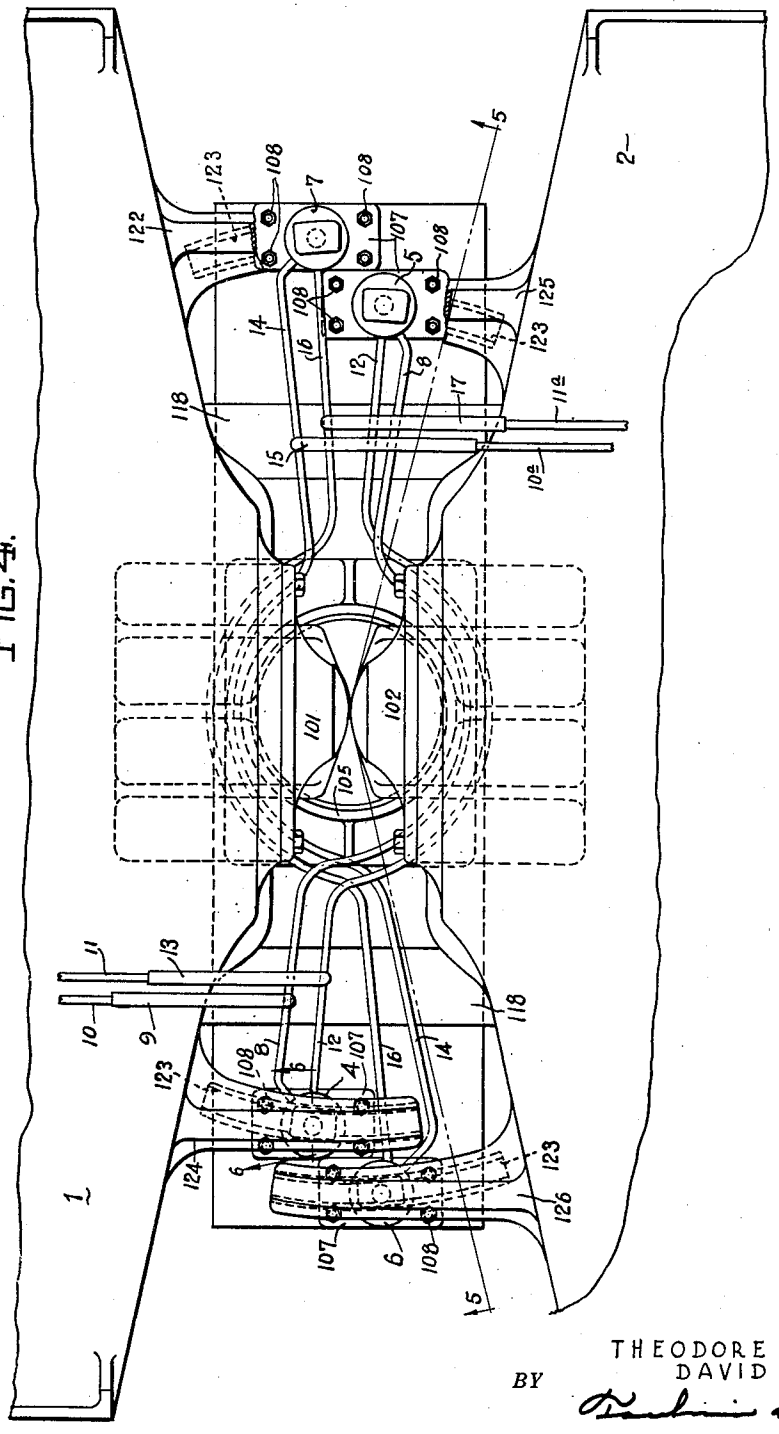
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APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE

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FIG. 4.



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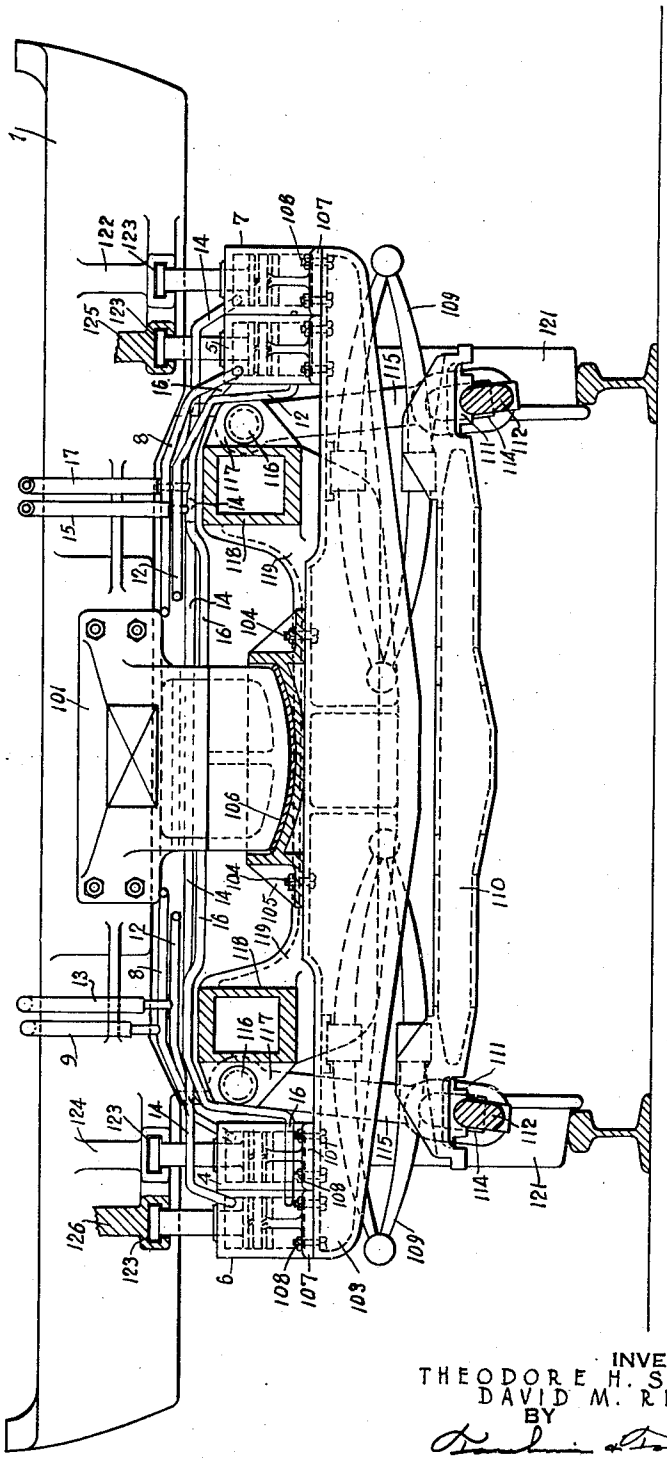
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APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE

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FIG. 5.



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APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE

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FIG. 6.

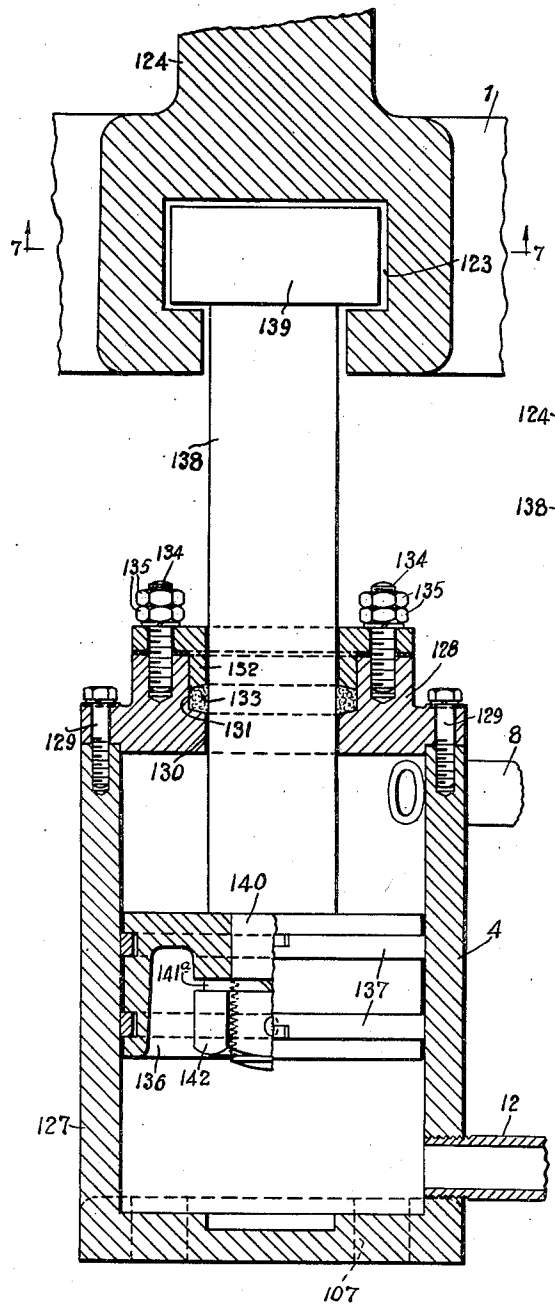
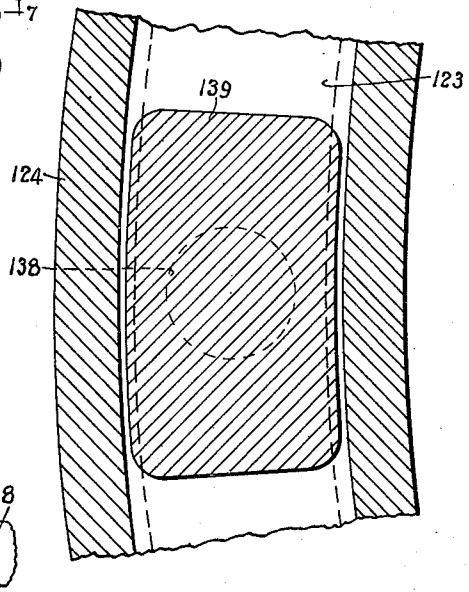


FIG. 7.



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FIG. 8.

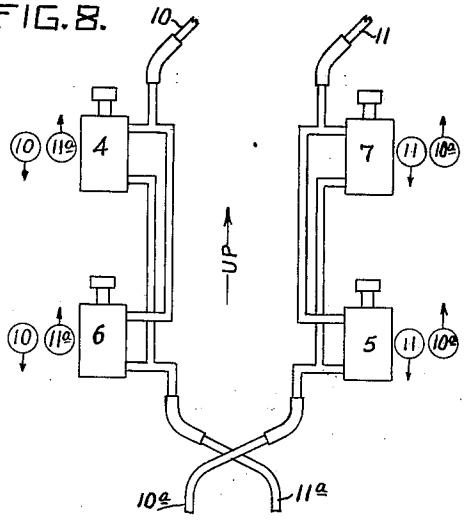


FIG. 9.

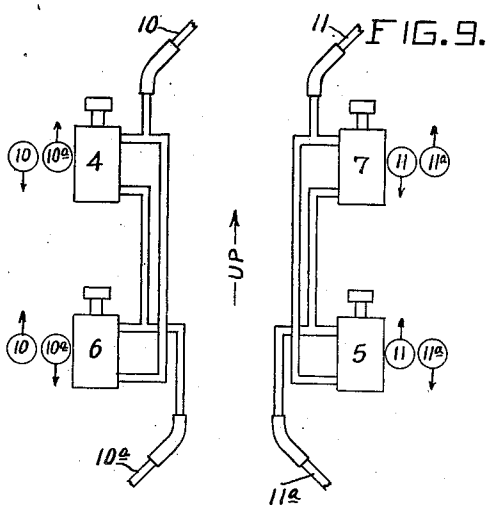


FIG. 10.

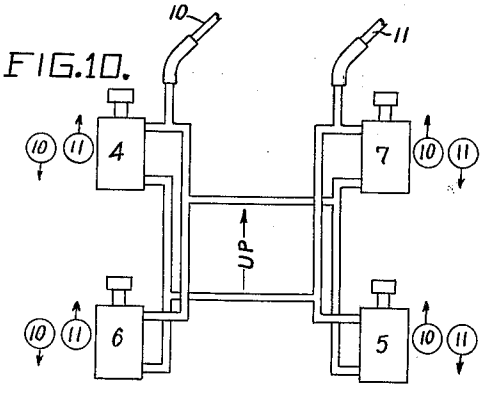
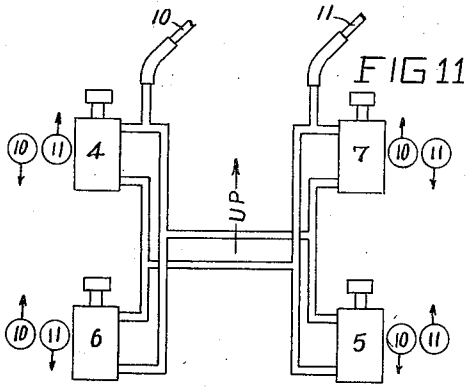


FIG 11



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Patented June 6, 1939 2,161,687

UNITED STATES PATENT OFFICE

2,161,687

APPARATUS FOR MAINTAINING ADJACENT RAILWAY CARS ON A LEVEL PLANE

Theodore H. Schoepf and David M. Ritchie, Cincinnati, Ohio, assignors to The Cincinnati Traction Building Company, Cincinnati, Ohio, a corporation of Ohio

Application March 5, 1937, Serial No. 129,200

2 Claims. (Cl. 105—164)

This invention relates to a means of maintaining the equilibrium of railway cars.

It is the object of this invention to provide pendulum control means for controlling the application of hydraulic pressure to the side bearings of railways cars and particularly articulated cars, in order to resist the rocking or swaying of the cars and, upon occurrence of such rocking or swaying, to return the cars to a position wherein the floors of adjacent connected cars are parallel and disposed substantially in a horizontal plane in order to minimize rocking and swaying of railway vehicles.

It is a particular object of this invention to provide hydraulic means associated with the side bearing arms of railway vehicles, and particularly connected articulated vehicles, for applying to the vehicles in a direction opposite to the swinging movement of the vehicles a corrective thrust in order to return the platforms of the vehicles to their normal position with respect to the trucks, or common truck thereof.

It is a further object of this invention to provide hydraulic connection between a track common to two connected articulated cars, hydraulic connections adapted to retain the car platforms in parallelism and adapted, upon loss of such parallelism, to return the platforms to such parallelism.

It is a further object of this invention to provide, in such relation, simultaneously operative connections between the common truck and adjacent car platforms, which will apply, at the same time, an upward or downward thrust to one side of one car platform and to the other side of the other car platform.

It is a further object of this invention to provide such hydraulic connections as may be quickly reversed during operation by the gravity responsive switch or pendulum control means provided therefor, which gravity responsive switch or pendulum control means is responsive to sway of the vehicles or departure of the platforms thereof from horizontal position.

It is a further object of this invention to provide such means which will resist departure of the car platforms from the horizontal and which will operate, upon occurrence of unpreventable rocking, to return the platforms to the horizontal and to parallelism with respect one to the other.

It is a further object of this invention to provide means responsive to the departure of the respective vehicle platforms from the horizontal to initiate operation of the mechanism.

It is a further object of this invention to provide, in such relation, hydraulically operated thrust means.

It is a further object of this invention to provide separate operating means for each adjacent connected end of cars articulated upon a common truck.

These and other objects and advantages will appear from the following description taken in connection with the drawings.

This application is a continuation in part of our copending application Serial No. 2,074, filed January 16, 1935, which has now matured into Patent No. 2,124,124, issued July 19, 1938, to Schoepf et al.

In the drawings:

Fig. 1 is a diagrammatic view, partly in elevation, partly in section and partly in perspective, showing the interconnection between the bolster of a common truck and adjacent ends of opposite car platforms, showing the hydraulic interconnection of the respective connections and one of the two complete means for controlling a pair of the connections which connect the bolster of the common truck and opposite sides of the adjacent car platforms;

Figure 2 is a view, in elevation, of a modification of the pendulum control illustrated in Figure 1;

Figure 3 is a side elevation, partially broken away, illustrative of the interconnection between adjacent ends of car platforms articulated upon a common truck;

Figure 4 is a top plan view of the structure shown in Figure 3;

Figure 5 is a section taken on the line 5—5 of Figure 4;

Figure 6 is a section taken on the line 6—6 of Figure 4;

Figure 7 is a section taken on the line 7—7 of Figure 6; and

Figures 8 to 11 inclusive are diagrammatic views illustrating various methods, other than that illustrated in Figure 1, for interconnecting the respective force applying means illustrated in Figures 1 to 7 inclusive.

Referring to the drawings in detail and with reference particularly to Figure 1, the platform of one of the cars, hereinafter referred to as car No. 1, is designated 1. The adjacent end of the connected car (hereinafter designated car No. 2 and shown in dash lines) is designated 2. 3 generally designates the common truck. 4 generally designates the cylinder of the hydraulic connection provided between the common truck 3 and the lefthand side of car No. 1. 5 generally

designates the cylinder of the hydraulic connection provided between the common truck and the righthand side of car No. 2. The cylinder of the hydraulic connection provided between the common truck 3 and the righthand side of car No. 1 is designated 7. The cylinder of the hydraulic connection provided between the common truck 3 and the lefthand side of car No. 2 is designated 6.

The details of the hydraulic connection having the cylinder 4 are shown in Figure 6; the construction of the respective connections is identical. The trunnions on the respective car platforms and the socket plate provided on the common truck 3 for their accommodation are omitted, in Figure 1, for the sake of clearness of disclosure. Each of the cylinders 4, 5, 6 and 7 contains a reciprocable piston having rigidly attached thereto a piston rod having thereon an enlarged head adapted to engage an appropriate arcuate slot in an appropriately disposed side bearing arm on a car platform, as illustrated in Figures 5, 6 and 7. The upper end portions of the cylinders 4 and 5 are connected by the pipe 8 having an appropriate extension which is connected by means of the flexible connector 9 with the feed pipe 10, which is supported on the platform of car No. 1 and connected to hydraulic feeding means (hereinafter described), also supported on that car platform.

The lower end portions of cylinders 4 and 5 are connected by means of pipe 12 having an extension which is connected by means of the flexible connector 13 with the feed pipe 11 which is also connected to hydraulic feed means supported on the platform of car No. 1. The upper portions of cylinders 6 and 7 are connected by the pipe 14 which has a suitable extension which is connected by the connector 15 with the feed pipe 10a which is supported on the platform of car No. 2 which is similar to the feed pipe 10 and which is similarly provided with connection to like mechanism which is supported on the platform of car No. 2.

The lower end portions of cylinders 6 and 7 are connected by the pipe 16 which has a suitable extension which is connected by the flexible connector 17 to the feed pipe 11a which is supported upon the platform of car No. 2. The feed pipe 11a corresponds to the feed pipe 11 of car No. 1 and is connected in the same manner as is feed pipe 11 to similar supply means which is supported, however, by the platform of car No. 2.

Due to the above-described connection of cylinders 4 and 5, when fluid under pressure is supplied from the pipe 10 through connector 9 and pipe 8 to the top portion of the cylinders 4 and 5, pressure will be built up in the top portion of the cylinders 4 and 5 which will cause downward movement of the pistons in the cylinders to apply downward pressure to the lefthand side of car No. 1 and the righthand side of car No. 2. Fluid will escape from the lower portions of the cylinders 4 and 5 through pipe 12 and connector 13 to the feed pipe 11.

When fluid under pressure is supplied through feed pipe 11, connector 13 and pipe 12 to the lower end portions of cylinders 4 and 5, the pistons and piston rods in the cylinders will move upwardly to apply upward pressure to the left-hand side of car No. 1 and the righthand side of car No. 2. At this time, fluid will escape from the top portions of the cylinders 4 and 5 through pipe 8 and connector 9 to feed pipe 10.

When fluid pressure is supplied, by the feeding means on car No. 2 (not shown) through feed pipe 10a, connector 15 and pipe 14 to the top end portions of cylinders 6 and 7, the pistons and piston rods of cylinders 6 and 7 will move downwardly to apply downward pressure to the lefthand side of car No. 2 and the righthand side of car No. 1. At this time, fluid below the pistons in the cylinders 6 and 7 will escape through pipe 16 and connector 17 to the feed pipe 11a.

When pressure is supplied from feed pipe 11a through connector 17 and pipe 16 to the lower end portions of cylinders 6 and 7, the pistons and piston rods of the cylinders 6 and 7 will move upwardly to apply upward pressure to the lefthand side of car No. 2 and the righthand side of car No. 1. At this time, fluid above the pistons in the cylinders 6 and 7 will escape through pipe 14 and connector 15 to feed pipe 10a.

The means for supplying fluid under pressure to the feed pipes 10a and 11a is not illustrated because it is contemplated that this means shall be identical with that provided for supplying fluid under pressure to the feed pipes 10 and 11 of car No. 1, save that the pendulum mechanism and feed mechanism provided for the feed pipes 10a and 11a will be supported on the platform of car No. 2, while that provided for the feed pipes 10 and 11 will be supported on the platform of car No. 1. It is possible, however, that the pendulum means illustrated in Figure 2 may be substituted for the pendulum means illustrated in Figure 1 in either one or both of the mechanisms supported upon the adjacent car platforms 1 and 2.

The means for supplying fluid under pressure alternately to feed pipes 10 and 11 comprises a suitable source of pressure, such as a pump having pendulum responsive valve means for connecting the pressure side thereof, either to the feed pipe 10 or the feed pipe 11. In Figure 1, the source of pressure comprises any suitable pump means 18 having its pressure side connected by means of pressure pipe 19 with the pressure tank 20. The pipe 19 is connected by means of pipe 21 with a suitable pressure responsive pump control device 22. The suction side of the pump 18 is connected by means of discharge pipe 23 with the discharge tank 24. The pressure pipe 19 is connected by means of pipe 25 with the pressure header 26. The discharge pipe 23 is connected by means of pipe 27 with the discharge header 28. Leading centrally from the pressure header 26 in the pressure header branch 29 having opposite extension pipes 30 and 31.

A hydraulic valve 32 has the top chamber thereof connected to the extension pipe 30. This valve 32 is adapted to provide means for controlling the supply of fluid under pressure from the pressure header 26 to the feed pipe 10 which is also connected to the hydraulic valve 32. The hydraulic valve 33 which is of construction identical with that of the hydraulic valve 32 has the top chamber thereof connected to the extension pipe 31. The valve 33 has the feed pipe 11 connected thereto in a manner similar to the connection of the feed pipe 10 with the hydraulic valve 32. The valves 32 and 33 which are of identical construction each comprises a cylindrical casing 34 provided at the upper end with a schew threaded cap 35 and at the lower end with the screw threaded cap 36. The casing 34 is provided with a pair of spaced parallel walls, the top wall being designated 37 and the bottom wall 38. These walls are disposed adjacent the cen-

tral portion of the casing **34**. Each of the walls **37** and **38** is provided with similar conical valve ports. The walls **37** and **38** with the top cap **35** and the bottom cap **36** of the valve form three chambers: the upper chamber being designated **39**, the intermediate chamber being designated **40** and the lower chamber being designated **41**.

The lower chamber **41** contains a slidable piston **42** having rigid therewith a stem **43** provided with an upwardly tapered valve member adapted to cooperate with the conical valve seat in the wall **38**. A similar stem **43***a* is oppositely disposed with respect to the stem **43** and has its lower end in engagement with the upper end of the stem **43**. Due to the engagement of the ends of the stems **43** and **43***a* the upper valve member is adapted normally to close the port in the wall **37** while thrusting the lower valve member from engagement with the cooperating seat in the wall **38**. The spring **44** which is disposed between the upper end of the stem **43***a* and the cap **35** is stronger than the opposed spring **45** which is disposed between the lower end of the piston **42** and the cap **36**. These springs retain the adjacent ends of the stems **43** and **43***a* in constant engagement and the stronger spring **44** normally retains the valve members in the position illustrated in Figure 1. However, when the sum of the force of fluid pressure and the force of pressure of spring **45** exerted upon the piston **42** exceeds the force of spring **44** the stem **43** and **43***a* move upwardly to engage the lower valve member with the conical seat in the wall **38** and disengage the upper valve member from the conical seat in the wall **37**.

The extension pipe **30** extends through the top cap **35** of the valve **32**, and the extension pipe **31** extends through the top cap **35** of the valve **33** and, by means of this connection, fluid pressure is constantly communicated from the pressure branch header **29** and the pressure header **26** to the upper chambers **39** of the pneumatic valves **32** and **33**. When the stems **43** and **43***a* of the valves **32** and **33** are in the position illustrated in Figure 1, the engagement of the top valve member with the cooperating port in the top wall **37** of each valve prevents escape of fluid from the top chamber **39** of each valve.

The feed pipe **10** is connected to the intermediate chamber **40** of the valve **32**, and the feed pipe **11** is connected to the intermediate chamber **40** of the valve **33**. The discharge header **28** is connected to the upper portion of the lower chamber **41** of the valve **32** by means of pipe **46**. The upper end portion of the lower chamber **41** of the valve **33** is connected to the discharge header **28** by means of pipe **47**.

When the valves are in the position shown in Figure 1, fluid pressure from the extension pipes **30** and **31** is communicated to the upper chambers **39** of each valve **32** and **33**. The engagement of the top valve members with the ports in the walls **37** prevents this fluid pressure from being communicated to the intermediate chambers **40** of the valve. Due to the disengagement of the lower valve members of each valve from their cooperating ports, fluid pressure from the feed pipes **10** and **11** communicates through the ports in the lower walls **38** of the valves with the upper part of the lower chambers **41**, which is above the pistons **42**. These portions of the lower chambers **41** communicate through pipes **46** and **47** respectively with the discharge header **28**.

In order to cause upward movement of the piston **42** of the valve **32**, the inlet pipe **48** communicates with the lower part of the lower chamber **41** of the valve below the piston **42**. When fluid under pressure is introduced below the piston **42** through the pipe **48**, the piston moves upwardly to unseat the upper valve member from the port in the wall **37** and to seat the lower valve member in the port in the lower wall **38** of the valve **32**. An inlet pipe **49** is likewise provided for the valve **33**, which inlet pipe is disposed in the same manner as the inlet pipe **48**. When pressure is introduced to the lower chamber **41** of the valve **33**, through inlet pipe **49**, the piston **42** of this valve moves upwardly to seat the lower valve member and unseat the upper valve member in the manner above described.

Pressure is introduced from the pressure header **26** to the inlet pipe **48** through the solenoid operated valve or magnetic valve device **50** and a similar solenoid operated valve or magnetic valve device **51** is provided for introducing pressure from the pressure header **26** to the inlet pipe **49**. The valve devices **50** and **51** are identical and each comprises a cylinder **52** having a top cap **53** at one end and a bottom cap **54** at the opposite end and being divided by means of the upper wall **55** and the lower wall **56** into three chambers, namely, top chamber **57**, intermediate chamber **58**, and bottom chamber **59**. The walls **55** and **56** are provided with conical ports similar to the ports in the walls **37** and **38** of the valves **32** and **33**. The valve stem **60** extends through the upper port in the wall **55** and is provided with a rigidly attached upper conical valve member adapted for engagement with the conical port in the wall **55** in the same manner in which the valve members of the stems **43***a* engage the ports in the walls **37** of the valves **32** and **33**. The lower stem **60***a* is provided with a valve member similar to that of the stem **60** but oppositely disposed.

At its lower end below the lower valve member, the stem **60***a* (which has its lower end in abutment with the stem **60**) is provided with an enlarged plate-like member, between which plate member and the bottom cap **54** is disposed the compression spring **61** which constantly urges the lower valve member into seating engagement with the port in the lower wall **56**, while simultaneously urging the upper valve member from engagement with the port in the upper wall **55**, due to the abutment of the adjacent ends of the stems **60** and **60***a*, as shown in Figure 1. The upper valve stem **60** extends upwardly a substantial distance above the upper valve member, being accommodated by a suitable aperture in the top cap **53** of the valve. Suitable armature means **62** is provided thereon, which cooperates with the solenoid **63**. Normally, when the solenoid is de-energized, the valve stems **60** and **60***a* take the position illustrated in Figure 1, due to the force of the spring **61**. When, however, the solenoid **63** is energized, the valve stem **60** moves downwardly until the upper valve member engages the valve port in the wall **55** of the valve, while due to the abutment of the stems **60** and **60***a* the lower valve member is unseated.

The upper chamber **57** of the magnetic valve device **50** is connected to the discharge header **28** by means of the pipe **64**. The upper chamber **57** of the magnetic valve device **51** is connected to the discharge header **28** by means of the pipe **65**. The lower chamber of the magnetic valve device **50** is connected to the pressure header **26** by means of a pipe **66**. The lower chamber **59** of the magnetic valve device **51** is connected with

the pressure header 26 by means of the pipe 67. Fluid pressure is constantly supplied from the pressure header 26 through pipe 66 to the lower chamber of the valve device 50 and through the pipe 67 to the lower chamber 59 of the valve device 51. The upper chamber 57 of the valve device 51 is likewise connected by means of the pipe 65.

When the valve devices 50 and 51 are in the position illustrated in Figure 1, the fluid pressure from the lower chamber 59 of each is prevented, by seating of the lower valve members, from reaching the intermediate chambers 56 thereof and likewise prevented from reaching the inlet pipes 48 and 49. Communication is provided, however, from the lower part of the lower chamber 41 of the valve 32 through the inlet pipe 48 to intermediate chamber 58 of the valve device 50 and thence through the open upper port to the upper chamber 57 which communicates through pipe 64 with the discharge header 28. Communication is likewise provided from the lower portion of the lower chamber 41 of the valve 33 through inlet pipe 49 to intermediate chamber 58 of the valve device 51 and thence through the upper port thereof to the upper chamber 57 thereof, and thence through pipe 65 to the discharge header 28.

At this time, the hydraulic valve devices 32 and 33 will also be in the position illustrated in Figure 1, whereby communication is provided between the feed pipe 10 and the discharge header 28 through intermediate chamber 46, open lower valve port, upper part of lower chamber 41 and pipe 46. Communication will likewise be provided between the feed pipe 11 and the discharge header 28 through intermediate chamber 46 of the valve device 33, through the open lower port and upper part of lower chamber 41 thereof and through pipe 47.

Gravity responsive means is provided for energizing the solenoid 63 of the magnetic valve device 50 upon the occurrence of tilting of the platform of car No. 1 to the right or in clockwise direction, as seen in Figure 1. Upon actuation of the valve device 50 through energization of the solenoid 63 thereof, fluid under pressure will be supplied to the feed pipe 10 to cause downward movement of the piston rod of the cylinder 4 and downward movement of the piston rod in the cylinder 5 to impart counteracting force in counterclockwise direction to car No. 1; while, at the same time, applying force in clockwise direction to the platform of car No. 2. The same mechanism will energize the solenoid 63 of the valve device 51 upon occurrence of tilting in the opposite direction in order to apply corrective force in a direction opposite the tilt sought to be corrected.

The gravity responsive means for properly alternately energizing the solenoids 63 comprises the panel 68 and associated switch mechanism, which panel is supported on the platform of car No. 1 with the lower edge thereof in substantial parallelism to the platform 1.

Rigidly attached to the panel 68 is the U-shaped tubular member 69 of suitable material which is preferably non-conducting. The means of attachment comprises the brackets 70 and screws or bolts 71. At each end, the tubular member 69 is provided with a cap 72 provided with a suitable aperture for receiving the piston rod 74 of a piston 73 slidable in the cylindrical end portion of the tubular member 69. At the upper end opposite the piston 73 is a substantially hemispherical head 75. The tubular member 69 is preferably filled with a column of fluid, preferably mercury, upon the ends of which column the pistons 73 are supported. The switch bar 76 is provided with a pair of arms which are inwardly inclined and which terminate in the bearing member 77 which is pivotally supported on the pin 78 which is secured to the panel 68. At its right end, the switch bar 76 is provided with a switch contact 79, while a similar switch contact 80 is rigidly attached to the opposite end thereof.

Also rigidly secured to the panel 68 adjacent and above the contact 79, in its normal position and in its path of swing, is the stationary switch contact 81 which comprises a flat arcuate conducting member. A similar stationary switch contact 82 is provided adjacent and in the path of swing of the switch contact 80. The switch contact 79 is electrically connected to the branch wire 83, and the switch contact 80 is likewise electrically connected to the branch wire 84. The branch wires 83 and 84 are each connected to the circuit wire 85 which is electrically connected to one terminal of a suitable source of power 86. One terminal of the solenoid 63 of the valve device 50 is connected by means of wire 87 with the stationary switch contact 81. The opposite terminal of this solenoid is connected by means of wire 88 with the other terminal of the source of power 86. This terminal is likewise connected to one terminal of the solenoid 63 of the valve device 51 by means of wire 89. The opposite terminal of the last-named solenoid is connected by means of wire 90 with the stationary switch contact 82.

As will be understood, the panel 68 will tilt to the right, as seen in Figure 1, with the platform of car No. 1; it will tilt to the left when the platform of car No. 1 tilts to the left. When the panel 68 tilts to the right, the fluid will move upwardly in the righthand arm thereof and urge the righthand piston rod 74 upwardly whereby to engage the contacts 79 and 81. Upon this engagement, a circuit will be completed from the source of power 86 through circuit wire 85, through branch wire 83, contact 79, contact 81, wire 87, solenoid 63 of the valve device 50 and wire 88 to the source of power 86. This energizes the solenoid 63 of the valve device 50, whereby to introduce fluid under pressure to the feed pipe 10 to apply corrective thrust to the platform of car No. 1.

When the panel 68 tilts to the left, the contact 80 is engaged with the contact 82 to complete a circuit from the source of power 86 to circuit wire 85, branch wire 84, contact 80, contact 82, wire 90, solenoid 63 of the valve device 51, and wire 89 to the source of power 86. This causes energization of the solenoid 63 of the magnetic valve device 51, whereby to introduce fluid under pressure to the feed pipe 11 in order to apply corrective thrust which will, in this case, cause the piston rod of cylinder 4 to move upwardly and apply upward pressure of the lefthand side of the platform of car No. 1.

A modified form of gravity responsive solenoid energizing switch means is illustrated in Figure 2. This means comprises the panel 91 having rigidly attached thereto, by means of brackets 92 and bolts or screws 93, the tubular U-shaped member 94 which is formed of suitable non-conducting material such as glass, plastic composition, or the like. Suitable resilient shock insulating means is preferably provided between the brackets 92 and the member 94. At each end, the

member 94 is provided with a suitable plug closure 95 which may preferably, though not necessarily, be of insulating material, through which extends into the interior of the tubular member 94 a contact member 96 having the end thereof reduced and threaded and provided with a nut or the like 97 to provide for attachment of a suitable wire thereto.

At the lower central portion, a third contact 98 is provided, which is also equipped with suitable means 99 for securing thereto a suitable circuit wire. The non-conducting tubular member 94 is partially filled with a suitable conducting fluid, preferably mercury. The upper surface of each of the arms of the column of fluid 100 is preferably spaced a predetermined distance from the lower end of the adjacent contact 96 when the lower edge of the panel 91 is horizontal.

In substituting the gravity responsive switch means of Figure 2 for that illustrated in Figure 1, the wire 87 is connected to the righthand contact 95, the circuit wire 85 is connected to the contact 98 and the wire 90 is connected to the lefthand contact 96.

As may be readily understood, when panel 91 is tilted to the right or in clockwise direction, due to like tilting of the platform of car No. 1 upon which it is supported in the same manner as the panel 68, the surface of the righthand arm of the column of fluid 100 will move upwardly beyond the bottom of the righthand contact 96 and complete a circuit between wires 87 and 85 to cause energization of the solenoid 63 of the valve device 50. Likewise, upon tilting of the panel 91 to the left or in counterclockwise direction, a circuit will be completed between wire 90 and wire 85 to energize the solenoid 63 of the magnetic valve device 51.

Operation

When the platforms of car No. 1 and car No. 2 are level and parallel, one with respect to the other, the parts are in the position illustrated in Figure 1. The contacts 79 and 81 are separated as are the contacts 80 and 82. The solenoids 63 of the valve device 50 and of the valve device 51 are de-energized and the valve stems 60 and 60*a* of these valve devices are in upward position. The valve stems 43 and 43*a* of the valve devices 32 and 33 are in their lowermost position. The feed pipe 10 is connected to the discharge header 28, as is also the feed pipe 11. The upper chambers 39 of the valve devices 32 and 33 are each in communication with the pressure header 26, but the seating of the upper valve member prevents communication between the upper chambers 39 of the hydraulic valve devices and the intermediate chambers 40 thereof, which are connected respectively with feed pipes 10 and 11.

Upon the occurrence of tilting of the platform of car No. 1 to the right, in clockwise direction with respect to the common truck 3, the fluid level will rise in the righthand upper end of the tubular member 69, as described above, and cause engagement of the contacts 79 and 81 to energize the solenoid 63 of the magnetic valve device 50. The valve stem 60 will be thrust downwardly by energization of the solenoid, whereby to seat the upper valve member on the valve stem 60 to prevent communication between the upper chamber 57 and the intermediate chamber 58 of the valve device 50, while placing the intermediate chamber 58 and the lower chamber 59 of the valve device 50 in communication. Fluid under pressure will flow from the pressure header 26 through the lower chamber 59 of the valve device 50, through the intermediate chamber thereof and through the pipe 48 to the lower portion of the lower chamber 41 of the valve 32 below the piston 42 thereof. This will build up sufficient pressure to seat the lower valve member on the valve stem 43 of the valve 32, whereby to block off communication between the feed pipe 10 and the pipe 46 which is connected to the suction header 28.

Simultaneously, the upper chamber 39 of the valve 32 which is under fluid pressure will be placed in communication with the intermediate chamber 40 of the valve 32, which chamber 40 is connected to the feed pipe 10. Fluid will then flow from the pressure header 26 through pressure header branch 29 through extension pipe 30, through chambers 39 and 40 of valve 32 to and through feed pipe 10 and connector 9 to the pipe 8 which connects the upper portions of the cylinders 4 and 5. A pressure will be built up in the cylinders 4 and 5 above the pistons therein, whereby to cause the piston rods thereof to be drawn downwardly to exert downward thrust to the left hand side of car No. 1 and the righthand side of car No. 2 to impress upon car No. 1 a corrective counterclockwise tilting force, and upon car No. 2 a clockwise tilting force. Fluid below the pistons in the cylinders 4 and 5 will flow through pipe 12, connector 13 and feed pipe 11 to the intermediate chamber 40 of the valve device 33 and thence through the open connecting port into the upper side of the lower chamber 41 and through pipe 47 to discharge header 28.

Preferably, the cylinders 6 and 7 will be simultaneously operated by their operating mechanism in such wise that the downward force exerted by the piston rod of the cylinder 4 will be aided by upward force applied by the piston rod of the cylinder 7, and likewise downward force applied by the piston rod of the cylinder 5 will be aided by the application of upward force by the piston rod of cylinder 6. This will be accomplished by the introduction of fluid under pressure to the lower portions of the cylinders 6 and 7 when it is introduced into the top portions of cylinders 4 and 5. The accomplishment of this will be achieved by the connection of the feed pipe 11*a* to its source of fluid under pressure simultaneously with the introduction of fluid under pressure to the feed pipe 10.

Where the gravity responsive control means illustrated in Figure 2, is substituted for that illustrated in Figure 1, the above cycle of operation will be unchanged because tilting of the panel 91 toward the right will complete the circuit between wires 85 and 87 to energize the solenoid 63 of the valve device 50.

Return of the platform of the car to a level position will disengage contact 79 from contact 81, whereby to de-energize the solenoid and permit the valve devices to return to the position illustrated in Figure 1, wherein both feed pipes 10 and 11 are connected to the discharge header 28.

When the platform of car No. 1 is subjected to leftward or counterclockwise tilting, the panel 68 will tilt to the left and the contacts 80 and 82 will be engaged to cause energization of the solenoid 63 of the valve device 51. The valve stem 60 will move downwardly to block communication between the upper chamber 57 and the intermediate chamber 58 of the valve device 51 and to provide communication between the intermediate chamber 58 and the lower chamber 59 of the valve device 51. Fluid under pressure will flow from the pressure header 26 through pipe 67 to the

lower chamber 59 and thence to the intermediate chamber 58 of the valve device 51, whence it flows through inlet pipe 59 through the lower part of the chamber 41 of the valve device 33 to cause upward movement of the piston 42 therein to block communication between chambers 40 and 41 of the valve device 33 and provide communication between the upper chamber 39 and the intermediate chamber 40 of the valve device 33. Fluid under pressure will then flow from extension pipe 31 through upper chamber 39 and intermediate chamber 40 of the valve 33 to feed pipe 11 and thence through connector 13 and pipe 12 to the lower portion of the cylinders 5 and 6, where the building up of pressure will cause the pistons and attached piston rods to be thrust upwardly.

The upward movement of the pistons of the cylinders 4 and 5 will exert upward thrust at the left of car No. 1 and at the right of car No. 2. Fluid from the portions of the cylinders 4 and 5 above the piston will flow outwardly through pipe 8, connector 9 and feed pipe 10 to intermediate chamber 40 of valve 32 and thence through the open port into the lower chamber 41 of this valve above the piston 42 and thence through pipe 46 to discharge header 26. Upward movement of the piston rods of cylinders 4 and 5 will be accompanied by downward movement of the piston rods of cylinders 6 and 7 due to the introduction of fluid under pressure to the upper portions of the cylinders 6 and 7 through the feed pipe 10a by operation of the hydraulic supply means and its control which is supported upon the platform 2 of car No. 2.

Details of connection of the car platforms 1 and 2 with the common truck 3 are illustrated in Figures 3, 4 and 5, wherein the end of the platform 1 is provided with a downwardly depending trunnion 101 and the adjacent end of the platform 2 is provided with a like downwardly depending trunnion 102. The trunnions are rigidly secured to the respective car platforms by means of bolts or the like. The abutting surfaces of the trunnions 101 and 102 are arcuate, as shown particularly in Figure 4, and the lower end portions thereof are also arcuate, as shown in Figure 5. The lower ends of the trunnions are supported in the socket plate 105 which is rigidly secured by suitable means such as bolts 104 to the bolster 103 of the truck 3.

A suitable antifriction bushing 106 is provided between the bottom surfaces of the trunnions 101 and 102 and the socket plate 105. Each of the cylinders 4, 5, 6 and 7 are provided with pedestals 107 which are secured by means of bolts 108 to the side portions of the top surface of the bolster 103. The bolster 103 is supported by the elliptical springs 109 suitably secured therebeneath, which springs 109 are likewise suitably supported by and secured to the spring platform 110 of the truck, which spring platform is disposed beneath, spaced from and substantially parallel to the bolster 103. The spring platform 110 is provided at each end with suitable bearings 111 having arcuate surfaces complementary to the upper surfaces of the support links 112 upon which they rest.

The end portions of the support links 112 are supported in eyes 114 of the hangers 115. The hangers 115 are each pivotally supported at their upper ends by means of hanger support pins 116. The hanger support pins 116 are each, in turn, supported by a pair of spaced ears 117 provided on the longitudinal side frame members 118. The side members 118 are an integral part of the truck frame which is generally designated 119, which is rotatably supported on the axles 120 which are provided with wheels 121. The spring platform 110, due to its connection by the support links 112, the hangers 115 and pins 116, to the frame 119, is permitted to swing sidewise with respect to the truck frame 119. The bolster 103 which is supported on the springs 109 which rest upon the spring platform 110 is likewise permitted to move in like manner. The platforms 1 and 2 are permitted to swing horizontally with respect one to the other and also vertically with respect to one another because of the arcuate surfaces provided on the trunnions 101 and 102 and the complementary surfaces of the socket plate 105. The axis of horizontal swing is substantially concentric with the center of the socket plate 105.

The platform 1 is provided at its right side with an extension or side bearing arm 122 having therein an arcuate undercut slot 123 which slidably receives the head or enlarged portion at the upper end of the piston rod in the cylinder 7. A similar side bearing arm 124 is provided at the left side of the platform 1, which arm has a slot 123 therein similar to the slot 123 of the arm 122. The platform 2 is likewise provided at its right side with an oppositely directed side bearing arm 125 provided with a slot 123 similar to the slots of the side bearing arms 122 and 124, and a side bearing arm 126, similarly equipped with a slot 123, is also disposed at the left side of the platform 2. The slots 123 of the respective arms are concentric with respect to the center of the socket plate 105, but the radius of the slots 123 of the arms 122 and 126 is greater than that of the slots 123 of the arms 124 and 125. The arms 122 and 126 are likewise disposed at greater distance from the center of the socket plate 105 than are the arms 124 and 125. By means of this disposition of the arms, the arms 122 and 125 may freely pass one another, and the arms 124 and 126 may freely pass one another during swinging movement between platforms 1 and 2. The slot 123 of the arm 124 receives the head on the piston rod of the cylinder 4; the slot 123 in the arm 125 receives the head on the piston rod of the cylinder 5, and the slot 123 in the arm 126 receives the head on the piston rod in the cylinder 6.

The details of the cylinders 4, 5, 6 and 7 are identical, and the details of the cylinder 4 and its associated piston rod and connection to the arm 124 of the platform 1 are illustrated in Figures 6 and 7. The cylinder 4 comprises the cylindrical side wall portion 127 having integrally formed therewith the pedestal 107 which is, as described above, adapted to be secured by means of bolts 108 to the bolster 103 of the common truck 3. Secured to the upper end of the cylinder by means of bolts 129 or the like is the cylinder head 128 provided with a central aperture 130, through which the piston rod extends.

A packing recess 131 is provided in the head plate 128 concentric with the aperture 130 therein and the packing gland 132 has a lower annular flange which cooperates with the packing recess 131 to secure therein the packing 133. The means for adjustably securing the packing gland 132 to the head plate 128 comprises the studs 134 and nuts 135. Slidable in the cylinder is the piston head 136 having suitable piston rings 137. The piston rod 138, which has integrally formed on the upper end thereof the head 139 which is slidably received in the slot 123 of the arm 124, is rigidly attached at its lower end to the piston

head 136. For this purpose, a reduced portion 140 is provided with threads 141 at its lower end and formed on the piston rod 138. This reduced portion 140 is received in a complementary central aperture in the piston head 136, and the piston rod 138 and piston head 136 are rigidly secured together by means of the spring washer 141a and nut 142, which engages the threads 141 on the reduced portion 140 of the piston rod 138.

Below the zone of reciprocation of the piston head 136, a suitable aperture is provided in the side wall 127 for receiving the pipe 12, while a similar aperture is provided above the zone of reciprocation of the piston head 136 for receiving the pipe 8. As above described, when fluid under pressure is introduced through pipe 8, above the piston head 136, the piston rod 138 is drawn downwardly, and by means of the engagement of the head 139 with the slot 123 in the arm 124 at the left side of the platform of car No. 1, downward force is applied to the left side of car No. 1. Likewise, when fluid under pressure is introduced in the cylinder below the piston head 136 through pipe 12, the piston rod 138 is thrust upwardly to apply, through arm 124, upward force to the left side of car No. 1. Introduction of fluid under pressure to the upper sides of the respective cylinders 5, 6 and 7, or to the lower sides thereof, will cause application of corrective pressure to the respective sides of the respective platforms through the respective arms 125, 126 and 122 in the manner above described.

It will thus be seen that comprehended within the structure disclosed as illustrative of the principles of our invention, is the gravity responsive electric switch means supported on the panels 68 and/or 91, and responsive to the tilt of the panels to energize one or the other of the magnetic valve devices 50 or 51 to cause operation of one of the hydraulic valves 32 or 33 to supply fluid under pressure from the pressure header 26, either to the feed pipe 10 or the feed pipe 11, whereby to simultaneously cause upward movement of the pistons of the cylinders 4 and 5 or downward movement thereof, the movement and the ensuing thrust being applied in a direction opposite to the tilt which initiates the actuation of the fluid pressure supply means through the gravity responsive electric switch means. The use of similar means for controlling the supply of fluid pressure alternately to the feed pipe 10a and the feed pipe 11a of the platform 2 is, of course, comprehended.

It is, of course, to be understood that any suitable means may be provided for supplying fluid pressure to the pressure header 26, the structure shown being merely illustrative and, for that reason, shown diagrammatically. Other gravity responsive switch means such as that illustrated in our copending application Serial No. 2,074, filed January 16, 1935, which has matured into Patent No. 2,124,124, issued July 19, 1938, may be utilized. Likewise, the intensity of the pressure applied may be made dependent upon the amplitude of the tilting movement sought to be corrected or of the tilting force sought to be offset by means, such as that illustrated and described in the above-mentioned copending application, of which this application is a continuation in part.

Various alternative connections may be provided between the respective fluid pressure supply means 10, 10a, 11, and 11a and the respective cylinders 4, 5, 6 and 7, as illustrated in Figures 8 to 11 inclusive. In these figures, the directions of the numbered arrows adjacent the respective cylinders designate the direction of application of force to the pistons within the respective cylinders upon application of fluid pressure through the various supply means.

As shown in Figure 8, the pipe 10 is connected to the top ends of cylinders 4 and 6, while the pipe 11a is connected to the bottom ends of cylinders 4 and 6, while the pipe 11 is connected to the top ends of cylinders 5 and 7 and the pipe 10a is connected to the bottom ends of cylinders 5 and 7. Upon the application of fluid pressure through pipe 10 to cylinders 4 and 6, the pistons therein will move downwardly as indicated by the arrows, whereby to collapse the connections including cylinders 4 and 6 and apply downward pressure at the left sides of the platforms of cars 1 and 2. When fluid pressure is supplied to cylinders 4 and 6 through pipe 11a, the connections are expanded and the pistons move upwardly in the cylinders 4 and 6, as indicated by the arrows. When fluid pressure is supplied through pipe 11 to cylinders 5 and 7, the connections including these cylinders are collapsed and downward pressure is applied at the right side of each car platform. When fluid pressure is supplied through pipe 10a to the cylinders 5 and 7, the connections are expanded and upward pressure is applied at the right side of each car platform. By means of these connections, the force exerted on the pistons by the supply of fluid through pipe 10 is counterbalanced by the force applied in opposite direction by fluid supplied through pipe 11a and vice versa; and likewise, force applied to the pistons in cylinders 5 and 7 by supplying fluid pressure through pipe 11 is counterbalanced by force applied by the supply of fluid pressure through pipe 10a.

As shown in Figure 9, the pipe 10 is connected to the top end of cylinder 4 and the bottom end of cylinder 6, while the pipe 10a is connected to the bottom end of cylinder 4 and the top end of cylinder 6. The pipe 11 is connected to the top end of cylinder 7 and the bottom end of cylinder 5, while the pipe 11a is connected to the bottom end of cylinder 7 and the top end of cylinder 5. When fluid pressure is supplied through pipe 10, the piston in cylinder 4 moves downwardly and the piston in cylinder 6 moves upwardly, as indicated by the arrows. Likewise, when fluid pressure is supplied through pipe 10a, the piston in cylinder 4 moves upwardly and the piston in cylinder 6 moves downwardly, as indicated by the arrows. When fluid pressure is supplied through pipe 11, the piston in the cylinder 7 moves downwardly and the piston in the cylinder 5 moves upwardly as indicated by the arrows. Likewise, when fluid pressure is supplied through pipe 11a, the piston in the cylinder 7 moves upwardly and the piston in the cylinder 5 moves downwardly, as indicated by the arrows. When the connections illustrated in Figures 8 and 9 are utilized, similar fluid pressure supply means and gravity responsive control means therefor must be provided on each car platform, as in the construction illustrated in Figure 1, or the above described modifications thereof. It is to be noted that, when the method of connection illustrated in Figure 8 is utilized, the pistons in cylinders 4 and 6 move upwardly simultaneously and downwardly simultaneously, and likewise, the pistons in cylinders 5 and 7 move downwardly simultaneously and upwardly simultaneously.

In Figures 10 and 11 we have illustrated a method of connection whereby it is possible to control all four expansible and collapsible con-

nections from the fluid supply and control means on one car platform. As illustrated in Figure 10, the pipe 10 is connected to the top end of cylinder 4, to the top end of cylinder 6, to the bottom end of cylinder 7 and to the bottom end of cylinder 5. The pipe 11 is connected to the bottom end of cylinder 4, to the bottom end of cylinder 6, to the top end of cylinder 7, and to the top end of cylinder 5. When fluid pressure is supplied through pipe 10, the pistons in cylinders 4 and 6 move downwardly and the pistons in cylinders 5 and 7 move upwardly, as indicated by the arrows; while, when fluid pressure is supplied through pipe 11, the pistons in cylinders 4 and 6 move upwardly and the pistons in cylinders 5 and 7 move downwardly, as indicated by the arrows.

In the method of connection illustrated in Figure 11, the pipe 10 is connected to the top end of cylinder 4, to the bottom end of cylinder 6, to the bottom end of cylinder 7, and to the top end of cylinder 5. The pipe 11 is connected to the bottom end of cylinder 4, to the top end of cylinder 5, and to the bottom end of cylinder 7. When fluid pressure is supplied through pipe 10, the piston in cylinder 4 moves downwardly, the piston in cylinder 6 moves upwardly, the piston in cylinder 7 moves upwardly and the piston in cylinder 5 moves downwardly, as illustrated by the arrows. When fluid pressure is supplied through pipe 11, the piston in cylinder 4 moves upwardly, the piston in cylinder 6 moves downwardly, the piston in cylinder 7 moves downwardly, and the piston in cylinder 5 moves upwardly, as indicated by the arrows. The forces applied, when fluid pressure is supplied through pipe 10 of the connection illustrated in Figure 11, are thus counterbalanced, as will appear from Figure 11.

The arrangement illustrated in Figures 8 and 10 is preferably where it is desired to correct the tilt resultant from centrifugal force when a train passes, at high speed, about a sharp curve and where it is desired to apply upward thrust to the outer side of each car passing about the curve and downward force to the inner side of each car passing about the curve. By the use of this structure, it is possible to operate lightweight and high speed trains over railroads constructed for the operation of slower and heavier rolling stock. The connections illustrated in Figures 9 and 11 are preferable where it is desired to achieve utmost smoothness and comfort of operation over rough road beds which are suited to the rolling stock operating thereover and where it is desired to retain the adjacent car platforms in substantially the same plane irrespective of curves and/or roughness in the railroad.

The truck construction illustrated in the drawings and described above is, of course, merely illustrative, it being clearly understood that the principles of this invention may be applied to widely varying structures, wherein adjacent ends of railway cars are provided with joint connection to a common truck with respect to which they are each articulated.

It will be understood that the above-described structure is merely illustrative of the manner in which the principles of our invention may be utilized and that we desire to comprehend within our invention such modifications as come within the scope of the claims and the invention.

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

1. In tilt control means for articulated railway cars having a common truck, a pair of hydraulic cylinders on said truck having pistons reciprocable therein and connected each to one car, hydraulic connections between the tops of said cylinders, hydraulic connections between the bottoms of said cylinders, a source of fluid under pressure, and means to alternately supply fluid to said connections, said last-named means including a pair of hydraulically operated valves between said connections and said fluid supply and alternately operating electrically operated valves hydraulically connected to said fluid supply and to said hydraulically operated valves for operating said hydraulically operated valves from said fluid supply.

2. In tilt control means for articulated railway cars having a common truck, a pair of hydraulic cylinders on said truck having pistons reciprocable therein and connected each to one car, hydraulic connections between the tops of said cylinders, hydraulic connections between the bottoms of said cylinders, a source of fluid under pressure, means to alternately supply fluid to said connections, said last-named means including a pair of hydraulically operated valves between said connections and said fluid supply and alternately operating electrically operated valves hydraulically connected to said fluid supply and to said hydraulically operated valves for operating said hydraulically operated valves from said fluid supply, and a gravity responsive switch means on one of said cars, responsive to the tilt of said car to operate one of said electrically operated valves to initiate the operation of one of said electrically operated valves and its connected hydraulically operated valve to supply fluid under pressure to one of the connections between said cylinders.

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