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[54] **RAILWAY TRUCK POSITIONING APPARATUS**

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[52] **U.S. Cl.** ..... **105/176,** 105/18 Z, 105/199 R, 105/200

[51] **Int. Cl.** **B61f 5/24,** B61f 5/50, B61f 13/00

[58] **Field of Search** ..... 105/4 R, 174, 176, 190 R, 105/200, 182 R, 199 R

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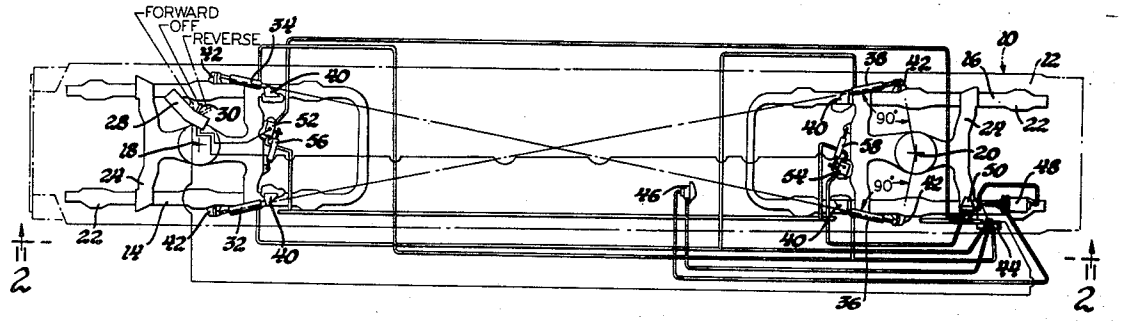
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[57] **ABSTRACT**

Truck guiding means for reducing flange loads of railway vehicle wheels due to skewing of the trucks during curve negotiation. In a preferred embodiment, the powered trucks of a diesel electric locomotive are connected with hydraulic cylinders controlled by a combination of pneumatic and electric control devices. The cylinders are actuated to apply guiding forces or moments to the trucks at predetermined rotational positions during curve negotiation. The guiding forces are applied in amounts and directions to oppose and reduce the frictional forces which cause skewing of the trucks during curve negotiation, thereby reducing the wheel flange and rail wear resulting therefrom. The application of the guiding forces is controlled both as a function of the direction of truck rotation in a curve and the direction of locomotive movement. The hydraulic cylinders are arranged in pairs which act simultaneously on both locomotive trucks and are located in approximate alignment with a vertical plane diagonally traversing the locomotive body. With this arrangement, reaction forces of the cylinders on the car body yield little or no rotational moments which could result in undesired transverse loads being applied to the trucks through the locomotive body.

5 Claims, 4 Drawing Figures



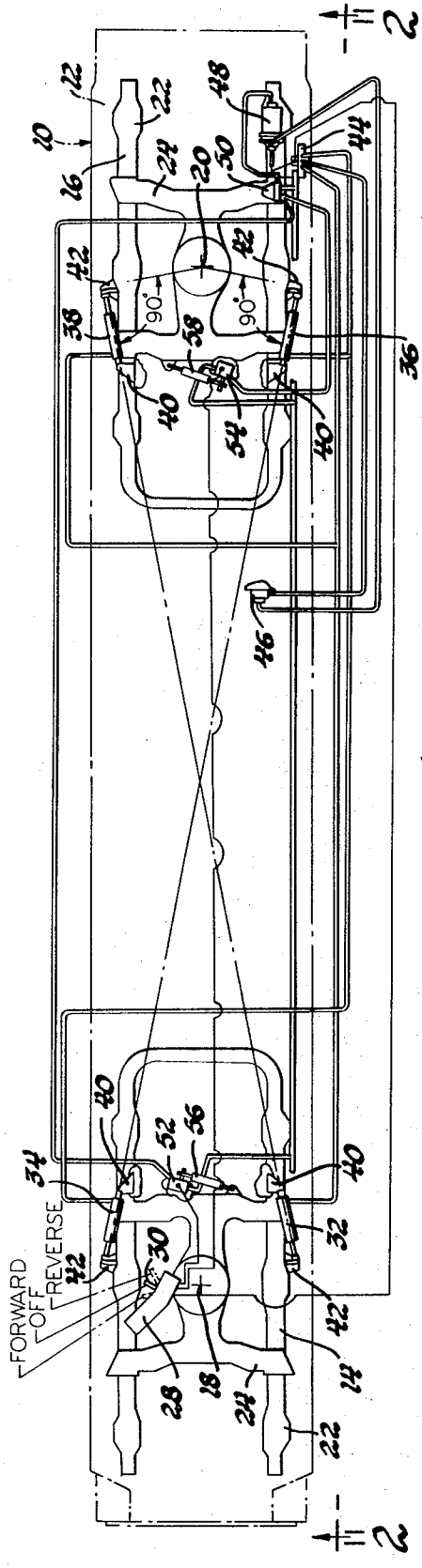


Fig. 1

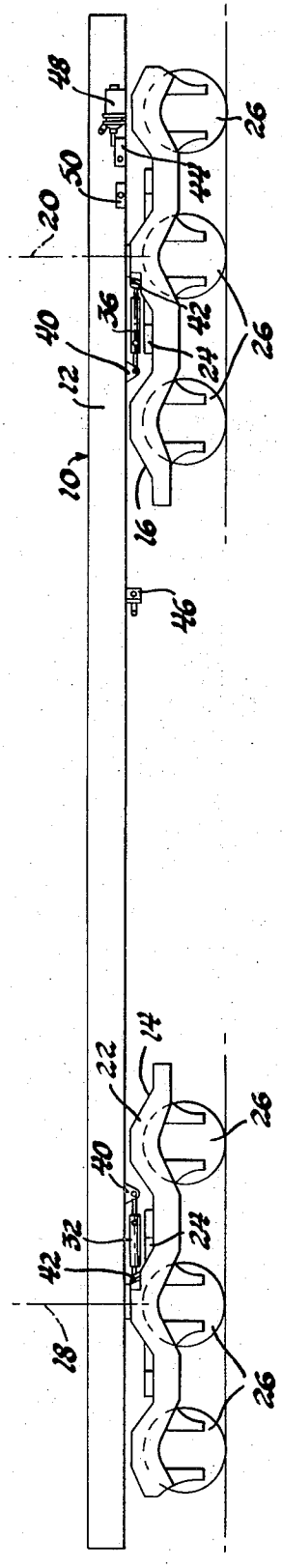


Fig. 2

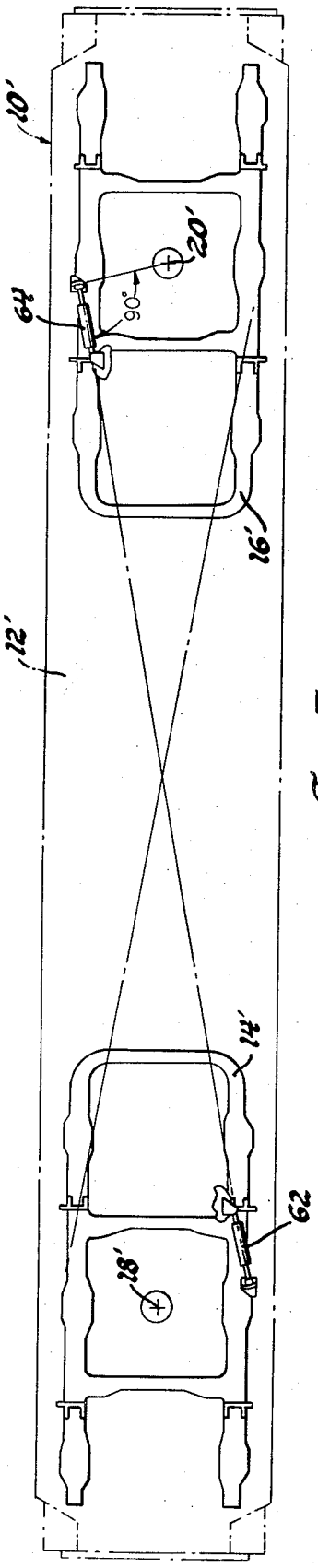


Fig. 3

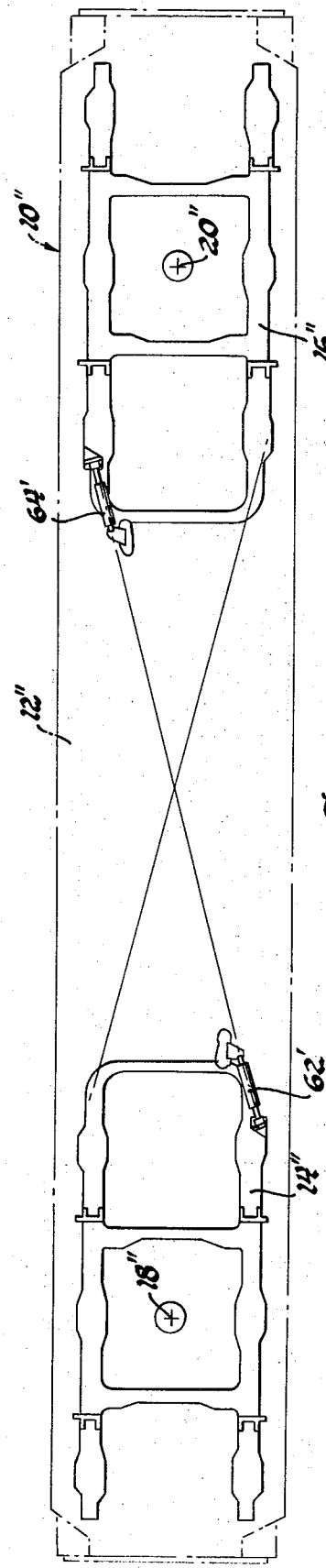


Fig. 4

RAILWAY TRUCK POSITIONING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to guiding of trucks for railway vehicles and, more particularly, to the arrangement of a fluid powered system for paritially offsetting skewing forces on railway locomotive trucks during curve negotiation.

Railway vehicles, such as locomotives, are commonly equipped with two or more longitudinally spaced trucks, pivotally mounted to and supporting the vehicle body and frame, each truck being conventionally equipped with two or more longitudinally spaced pairs of wheels having flanges on their inner edges for supporting and guiding the vehicle on a two rail track. In operation of such vehicles, it is known that during negotiation of curves, frictional forces between the wheels and rails normally cause the trucks to take a skewed position with respect to the rails. The direction of misalignment or skew is such that the outside leading wheel of each truck tends to nose into and bear more heavily against the outer rail of the curved track while the inside trailing wheel of each truck tends to bear against the inner rail. As a result of this skewing action, significant wear of the rails and wheel flanges, particularly of the leading wheel pairs, is encountered. Further discussion of curve negotiation mechanics and forces which cause the above described skewing action may be found in the American Society of Mechanical Engineers paper No. 65–WA/RR–4 entitled "Lateral Loading Between Locomotive Truck Wheels and Rail Due to Curve Negotiation" by L. F. Koci and H. A. Marta, presented at the ASME Winter Annual Meeting in Chicago, Nov. 7–11, 1965.

To reduce or overcome this skewing action and its resultant rail and wheel flange wear, it has been known to mechanically interconnect the inboard ends of the two trucks of a railway locomotive so that the skewing forces of the two trucks due to curve negotiation oppose one another and skewing is reduced or prevented. Such devices are not, however, readily applicable to or desirable in all railway vehicles. For example, in many diesel electric locomotives, the space between the trucks on the locomotive underframe is largely taken up with provision for fuel and air storage tanks and other equipment, leaving little room for truck interconnecting linkages or devices.

SUMMARY OF THE INVENTION

The present invention provides a novel truck guiding arrangement and system in which mechanical connection between the trucks is avoided. Instead, means such as hydraulic cylinders are provided which act between the vehicle body or underframe and the truck frames to apply guiding forces or moments to the trucks in order to partially overcome the frictional skewing forces normally present when rounding curves.

A feature of this invention is that the hydraulic cylinders or other force applying means are connected between the trucks and the vehicle body or underframe in a manner such that the application of substantial turning moments to the body and consequent undesirable transverse forces on the trucks are largely avoided.

Another feature is that the system is arranged to apply turning moments in the same direction to both trucks at the same time through an arrangement of diagonally oppositely disposed fluid cylinders having their axes approximately aligned with a diagonally extending vertical plane crossing the longitudinal axis of the vehicle between the pivot axes of the two trucks.

Yet another feature is that sensing and control means are provided to apply guiding moments to the trucks according to a predetermined schedule related to the rotational displacement of the trucks from their straight ahead or centered positions.

Still another feature is that the control system is interconnected with the forward and reverse controls of locomotive vehicles so that the application of the guiding forces is reversed upon reversal of the direction of movement of the locomotive.

These and other features of the invention will be more clearly understood from the following description of certain preferred embodiments of the invention taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, FIG. **1** is a plan view illustrating in part diagrammatically a dual truck locomotive having truck guiding means according to the invention;

FIG. **2** is a side elevational view of the arrangement of FIG. **1** as viewed from the plane indicated by the line **2—2**; and

FIGS. **3** and **4** are plan views illustrating, in part diagrammatically, locomotive arrangements of the type shown in FIG. **1**, but having alternative arrangements of truck guiding means according to the invention.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

FIGS. **1** and **2** of the drawings illustrate a diesel electric locomotive generally indicated by numeral **10.** Locomotive **10** includes a carbody having an underframe **12.** The carbody underframe is supported by a pair of trucks **14, 16** which are pivotally connected with the underframe **12** for oscillation around spaced vertical axes **18, 20,** respectively, to permit normal curve negotiation.

Trucks **14, 16** each include truck frames **22** supporting span bolsters **24** which are pivotally connected with the locomotive underframe by conventional center bearing means not shown. Each truck is carried by six wheels **26** flanged on their inner edges and arranged in three longitudinally spaced pairs of wheels, each pair being secured to a common axle, not shown, and laterally spaced for engagement of the opposing rails of a railway track by which the locomotive is supported and guided.

To control the operation of the locomotive, it is provided with an operator's control stand **28** mounted on the carbody in the locomotive cab, not shown. The control stand includes various control equipment and operating handles among which is a reverser handle **30** which is movable by the operator into forward and reverse as well as off positions in order to control the direction of operation of the locomotive.

The locomotive is also equipped with truck guiding means according to the present invention which include hydraulic cylinders **32, 34, 36, 38** each of which is connected at one end to the locomotive underframe and at its other end to the frame of one of the locomotive trucks. Cylinders **32** and **34** are connected to opposite sides of the frame of truck **14** while cylinders **36**

and **38** are likewise connected to opposite sides of the frame of truck **16.**

The cylinders are longitudinally extendable and are capable of exerting linear extending forces in response to the supply of hydraulic fluid under pressure thereto. They are arranged so as to apply guiding moments to the trucks to which they are connected when under hydraulic pressure. In each case the cylinders are connected at one end with a bracket **40** secured to the locomotive underframe **12** and at the other end with a bracket **42** fixed to the outer portion of the truck frame of the respective locomotive truck.

Cylinders **32** and **38** form a first pair or set of cylinders which are disposed in diagonally opposite positions of the locomotive underframe with their points of connection to the underframe and their respective trucks when the trucks are centered lying in a vertical plane extending diagonally across the longitudinal center line of the locomotive between the truck pivot axes **18, 20.** Cylinders **34** and **36** likewise form a second pair or set of cylinders disposed at diagonally opposite positions of the locomotive underframe and, when the trucks are aligned in their centered positions, having their points of connection with the underframe and with their respective trucks lying in a second vertical plane diagonally crossing the longitudinal axis of the carbody and the first vertical plane intermediate the pivotal axes **18, 20** of the trucks. Preferably, the cylinders **32, 34, 36, 38** are also arranged with their axes substantially horizontal in which case the axes of the cylinders of each of the first and second pairs are coaxial when the trucks are in their straight ahead, or centered, positions.

In order to maintain the positions of the cylinders of each pair or set as close as possible to coaxial when the trucks are rotated away from their centered positions, the connections of the various cylinders with their respective truck brackets **42** are made at points on the truck frame which lie on a line passing through the pivotal axis of the respective truck and normal to the diagonal plane with which the cylinders are aligned when the trucks are in their centered positions. In this way, the deviation of the attachment points of the cylinders to the trucks from their respective diagonal planes upon turning movements of the trucks is minimized, thus minimizing the deviation of the paired cylinders from their coaxial or aligned positions. This is important since, to the extent the force lines of the paired cylinders deviate from their common vertical plane, the application of turning moments on the trucks will also result in reaction moments applied to the locomotive underframe. Such moments will, in turn, cause undesirable transverse (or side) forces to be applied to the center bearings of the locomotive trucks.

In order to actuate and control the operation of the hydraulic cylinders, the locomotive **10** is provided with a suitable control and actuation system which, in the illustrated instance, involves a combination of hydraulic, pneumatic and electric means. These means include a hydraulic four-way magnet valve **44** connected with a separate oil sump **46** both mounted on the locomotive underframe. Magnet valve **44** is also connected with each of the hydraulic cylinders, with the connections to the two cylinders of each aligned pair or set being from the same supply port while the two pairs are fed from different ports. A hydraulic pneumatic booster, mounted on the locomotive underframe, is also connected in the hydraulic system to receive oil from the sump and supply it under controlled pressure to the hydraulic four way valve. The valve is in turn selectively operable to direct the pressure oil through one of the two supply ports to pressurize the selected sets of aligned cylinders.

Booster **48** is pneumatically connected with an underframe mounted pneumatic relay valve **50** which is in turn connected with the locomotive main air reservoir not shown from which it receives pressurized air. The relay valve **50** also connects with a pair of detector and control valves **52, 54** which are mounted on the locomotive underframe respectively adjacent the trucks **14** and **16.** A pair of actuator rods **56, 58** connect the detector and control valves **52, 54** respectively with the trucks **14, 16** in a manner to actuate the control valves **52, 54** in response to rotational movement of the responsive trucks.

Electrical portions of the magnet valve **44** and the detector and control valve **52** and **54** are each electrically connected with the locomotive control stand **28** for operation in response to movement of the reverser lever **30** in a manner to be subsequently described.

OPERATION

In operation, the truck guiding mechanism is effective to sense the turning movements of the locomotive trucks and, when the locomotive rounds curves having a sufficient curvature to apply guiding moments to the trucks in a direction to reduce lateral loads due to the normal skewing tendency by which the trucks tend to climb the outer rail of a curve. The detector and control valves **52, 54** combine with their respective actuator rods **56, 58** to sense the direction and amount of rotation of the trucks in response to curve negotiation and to control the direction and amount of the guiding moments applied to the trucks in response thereto.

Electrical connection of the control valves **52, 54** to the magnet valve **44** through the control stand **28** provides an interconnection with the reverser to determine the direction of turning forces applied to the trucks as a function of the direction of operation of the locomotive. When the reverser handle is in a forward or reverse position, oscillation (turning) of the two trucks in opposite directions from the centered position, as occurs when rounding a curve, causes the detector and control valves **52, 54** to energize the magnet valve in a position, as determined by the position of the reverse handle, to connect one set of hydraulic cylinders with the hydraulic output of the booster **48.** At the same time the hydraulic output of the booster is pneumatically controlled through connection with the control valves **52, 54** as a function of the degree of rotation of the trucks from their centered positions. The hydraulic forces applied to the selected pair of set of hydraulic cylinders then act to apply guiding moments to both trucks in the same direction, reducing the skewing forces and the resultant wheel flange loads and rail were caused thereby.

In a preferred arrangement the system is programmed to exert no guiding forces on the trucks when their deviation from the centered positions does not exceed a small amount such as one-half degree in either direction. For greater deviations guiding forces are increasingly applied until the rotation of the trucks reaches a greater amount such as one and one-half degrees in either direction at which point the maximum

guiding force is applied for deviations from the centered positions up to their maximum turning positions of about seven degrees in either direction.

As a specific example, let it be assumed that the locomotive is operating in a leftwardly direction as shown in FIGS. **1** and **2** with the reverser lever in a forward position. As long as the locomotive operates in a straight line on tangent track, the system will remain inoperative and no guiding forces will be applied to the trucks. Assume then that the locomotive begins to round a right hand curve of a sufficient curvature to rotate the trucks more than one-half degree. In this condition, the skewing tendencies of both trucks will tend to turn them counterclockwise from their ideal positions, that is, the lead truck **14** will tend to turn to a lesser rotation than called for by the track curvature while the trailing truck **16** will tend to turn to a greater rotation than called for by the track curvature.

The detector and control valves **52, 54,** sensing the rotational positions of the trucks, will energize their electrical connections through the control stand **28** to the four way magnet valve **44,** energizing this valve in position to connect the hydraulic output of the booster **48** with the hydraulic cylinders **32, 38** of the first pair. These cylinders then apply forces between the truck frame and the trucks in proportion to the amount of hydraulic force tending to extend them which, in view of the location of the cylinders, causes clockwise guiding moments to be applied to both trucks, thereby reducing the lateral reaction forces between the wheel flanges and rails. The amount of hydraulic force applied is controlled by the degree of rotation of the trucks as sensed by the detector and control valves **52, 54.** These supply a pneumatic signal to the relay valve **50** that in turn transmits pneumatic pressure to the booster **48.** The hydraulic output of the booster is in turn a direct function of the pneumatic pressure applied thereto. As a result, the turning moments hydraulically applied to the trucks are controlled in a predetermined fashion as a function of the amount of rotation of the trucks resulting from the degree of curvature of the rails traversed by the locomotive.

ALTERNATIVE EMBODIMENTS

Referring now to FIG. **3,** there is shown an alternative embodiment of truck guiding system applied to a locomotive in which components corresponding to the first described embodiment are identified by corresponding primed reference numerals. In the FIG. **3** embodiment a single pair of double-acting hydraulic cylinders **62, 64** are connected in the diagonally opposite fashion of the first pair of cylinders of the arrangement of FIGS. **1** and **2.** The double-acting cylinders take the place of the four single-acting cylinders in the first described embodiment, the remainder of the system being arranged in the same or an equivalent manner to control the operation of the cylinders to accomplish the same results as those of the first described embodiment.

Obviously the cylinders **62, 64** would be identically energized either in an expansion mode to apply clockwise turning moments to the trucks or in a contraction (or retraction) mode to apply counterclockwise turning moments to the trucks. In either case it is apparent that the alignment of the cylinder axes with a diagonal vertical plane will cause reaction forces on the locomotive underframe to directly offset one another without creating any turning moments on the frame which might result in undesired transverse forces being applied to the trucks through the frame.

In FIG. **4** another alternative arrangement is shown, primed reference numerals identifying parts corresponding to the previously described embodiments. The arrangement of FIG. **4** is similar to the arrangement of FIG. **3** but differs in that the connections of the double-acting cylinders **62', 64'** to the trucks and underframe do not lie on lines perpendicular to the vertical plane common to the cylinder axes and passing through the pivotal axes **18'', 20''** of the trucks. With this arrangement, the turning movements of the trucks when rounding a curve, laterally displace the ends of the cylinders connected to the trucks to a much greater degree than in arrangements previously described. This then results in a greater misalignment of the cylinders when they are applying guiding moments to the trucks than is the case in the previously described arrangements. The amount of misalignment is, of course, a function of the distance of the connecting points of the cylinders to the trucks from the ideal positions and the actual lengths of the cylinders themselves as well as of the magnitude of turning of the trucks. To the degree such misalignment occurs, however, the system of FIG. **4** results in the application of some reaction moments to the locomotive underframe when guiding forces are applied directly to the trucks. These reaction forces then result in a corresponding degree of undesirable transverse forces being applied to the trucks from the underframe. Nevertheless, though the arrangement of FIG. **4** may not be ideal in a sense of avoiding transverse forces on the trucks, it may, nevertheless, be very suitable in a practical situation in which the magnitude of the resulting transverse forces is not significant and wherein practical considerations require the mounting of the hydraulic cylinders at positions other than the ideal locations of the FIGS. **1** through **3** embodiments.

While the invention has been described by reference to certain illustrative embodiments it should be understood that numerous changes could be made within the scope of the inventive concepts disclosed and the invention accordingly should not be limited except by the language of the following claims.

We claim:

1. A railway vehicle having in combination

a body,

a pair of trucks each having two pairs of flanged wheels mounted in tandem, said trucks being connected with and supporting said body and pivotable about separate longitudinally spaced vertical axes passing through said body, and

a pair of axially extendable actuators, each connected between one of said trucks and said body, said actuators each being connected to said trucks with their axes offset from the vertical pivotal axes of their respective trucks whereby said actuators will apply guiding moments to said trucks upon the application of extending or retracting forces by said actuators,

said actuators being disposed such that the effective points of connection of both said actuators with said body and with said trucks lie approximately in the same vertical plane, said plane being offset from the pivot axes of said trucks and diagonally traversing the longitudinal axis of said body be-

tween said pivot axes, whereby the reaction forces applied to said body by said actuators during the application of guiding moments to said trucks will be directed generally along said plane and resultant turning moments on said body with consequent transverse reaction forces on said trucks will be largely avoided.

2. A railway vehicle having in combination

a body,

a pair of longitudinally spaced trucks pivotally connected to and supporting said body, each truck having at least two pairs of laterally disposed flanged wheels, said pairs of wheels being arranged in tandem in their respective trucks, and

a pair of axially extendable fluid cylinders disposed at diagonally opposite portions of said body and being effectively connected with said body and one to each of said trucks at points lying approximately in the same vertical plane when said trucks are in their centered positions, said plane being offset from the pivot axes of said trucks and diagonally traversing the longitudinal axis of said body between said pivot axes, whereby the application of extending or retracting forces of said cylinders to said trucks generally along said vertical plane will apply rotational guiding moments to said trucks but resultant turning moments on said body and consequent transverse reaction forces on said trucks will not be excessive.

3. The combination of claim 2 wherein the points of connection of said cylinders with said trucks lie proximate lines intersecting the pivot axes of the respective trucks and normal to said vertical plane when said trucks are centered in their straight-ahead positions, whereby resultant turning moments on said body due to the application forces by said cylinders will be minimized.

4. Truck guiding means in combination with a railway vehicle having a body and a pair of longitudinally spaced trucks supporting said body and pivotally connected therewith for oscillation about longitudinally spaced vertical axes intersecting a longitudinal axis of said body, each truck being supported by at least two longitudinally spaced pairs of laterally opposed flanged wheels, said truck guiding means being adapted for applying guiding forces to said trucks to reduce wheel flange loads during curve negotiation and comprising

first and second pairs of axially extendable fluid cylinders each connected with said body and one of said trucks for exerting forces therebetween along the axes of the respective cylinders,

said first pair of cylinders being connected one to each of said trucks adjacent diagonally opposite portions of said body and having their axes approximately coplanar with a first vertical plane diagonal to the longitudinal axis of said body, whereby application of extension forces by said cylinders generally along said first vertical plane applies rotational guiding moments in the same direction to both trucks,

said second pair of cylinders being connected one to each of said trucks adjacent diagonally opposite portions of said body laterally opposite said first named portions, the cylinders of said second pair having their axes approximately coplanar with a second vertical plane diagonal to the longitudinal axis of said body in the direction opposite to said first vertical plane, whereby application of extension forces by the cylinders of said second pair generally along said second vertical plane applies rotational guiding moments in the same direction to both trucks and in the direction opposite those applied by said first pair of cylinders,

means to selectively supply pressure fluid to one of said pairs of cylinders,

sensing means connected with said supply means to control the supply of pressure fluid to said cylinders, said sensing means being responsive to relative turning movements of said trucks in one direction from a centered position to pressurize one of said pairs of cylinders and being responsive to relative turning movements of said trucks in the opposite direction from said centered position to pressurize the other of said pairs of cylinders, and

means controlling the direction of operation of said vehicle and including means acting upon said sensing means to reverse the selection of cylinders pressurized by relative turning movements of said trucks in a particular direction upon reversal of the direction of operation of said vehicle.

5. Truck guiding means in combination with a railway locomotive having a carbody with forward and reverse movement control means and a pair of longitudinally mounted power trucks pivotally connected with and supporting said carbody, said trucks including at least two pairs of flanged wheels for guiding and supporting said trucks on a dual rail track, said truck guiding means comprising

force applying means connected between said trucks and said carbody to selectively apply clockwise or counterclockwise guiding moments to said trucks,

means to control the direction of application of said guiding moments by said force applying means in response to the direction of rotational movements of said trucks from their centered positions,

means connecting said direction control means to said locomotive forward and reverse movement control means in a manner to reverse the operating effect of said direction control means upon reversal of said forward and reverse movement control, and

means connected with said trucks to control the magnitude of force exerted by said force applying means in response to and in a predetermined relation to the amount of pivotal movement of said trucks from their centered positions,

said means being arranged such that when said locomotive is traversing a curve, the guiding moments applied to both trucks are in the same direction as the angular change in direction of the locomotive caused by traversing said curve regardless of the direction of locomotive operation.

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