April 22, 1969 G. W. COPE 3,439,631

HYDRAULICALLY DAMPENED CROSS-EQUALIZED TRUCK

Filed Feb. 24, 1965 Sheet 1 of 2

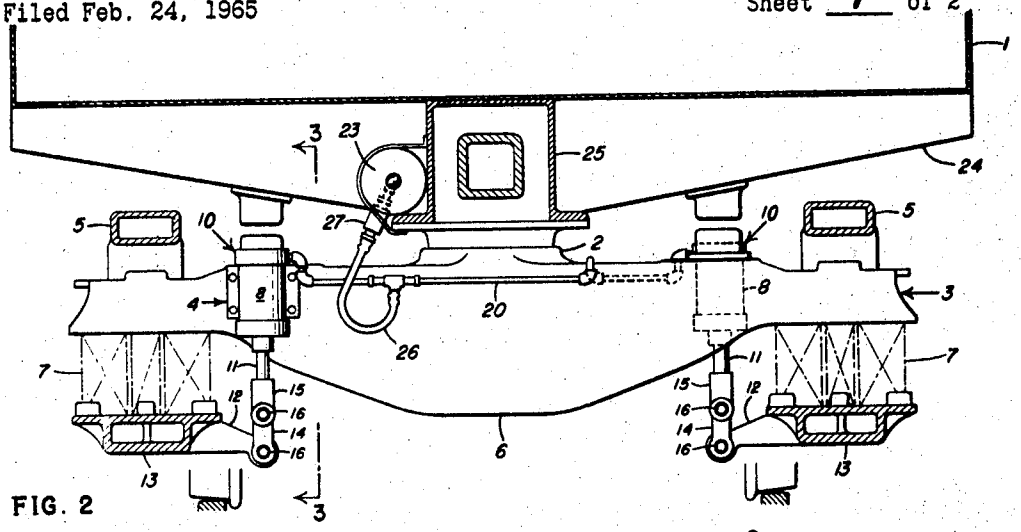


FIG. 2

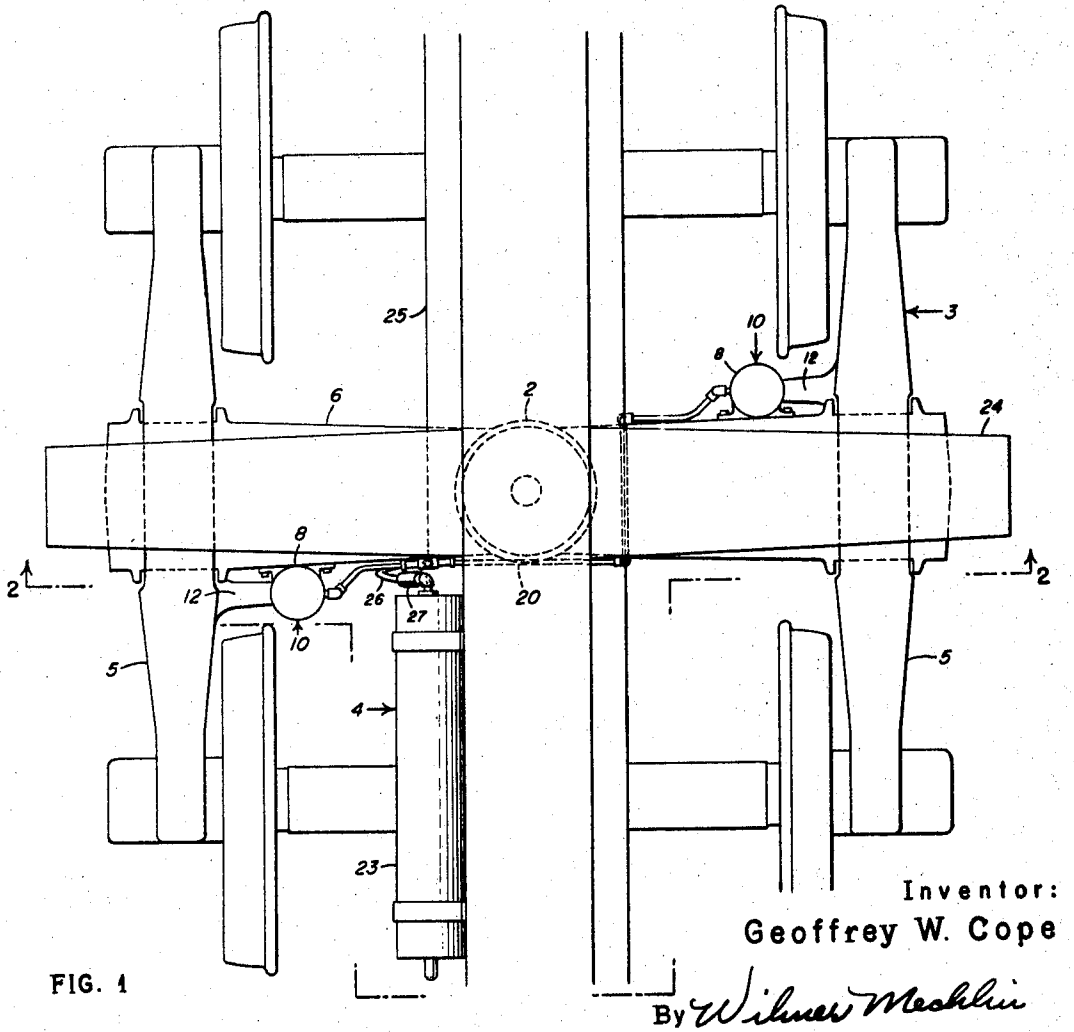


FIG. 1

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Filed Feb. 24, 1965 Sheet 2 of 2

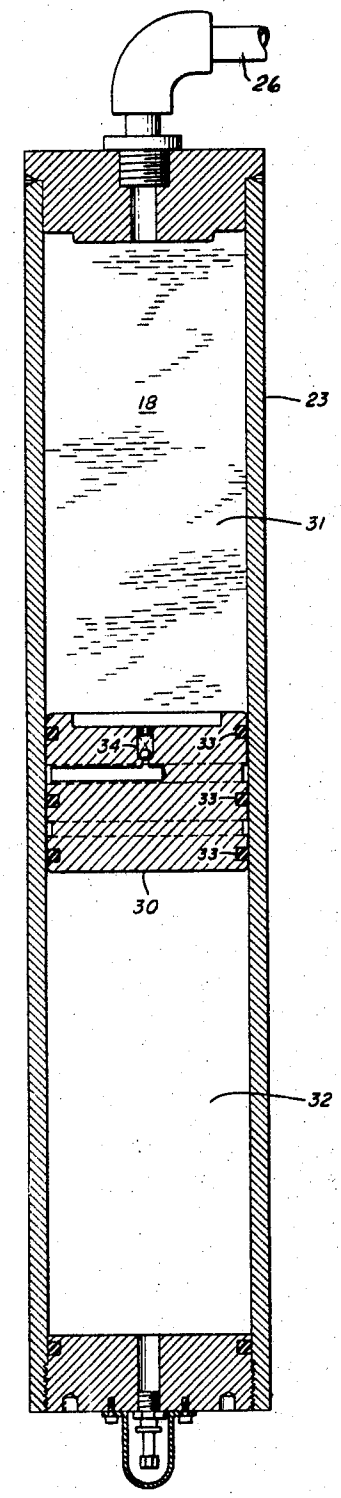


FIG. 4

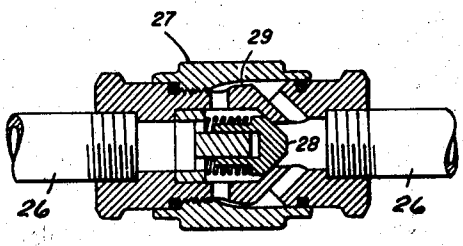


FIG. 5

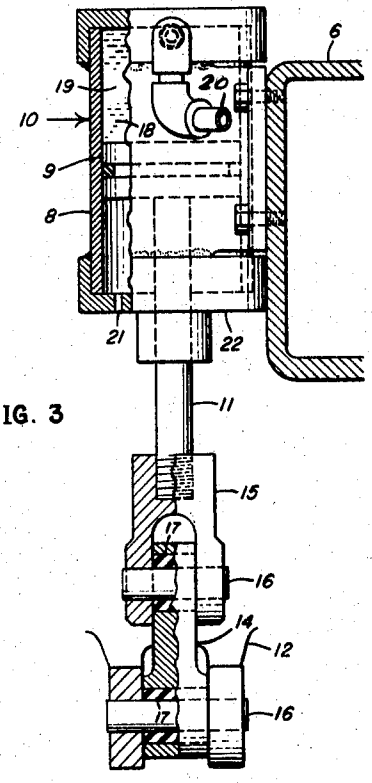


FIG. 3

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3,439,631

HYDRAULICALLY DAMPENED CROSS-EQUALIZED TRUCK

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Int. Cl. B61f 5/12
U.S. Cl. 105—197 10 Claims

ABSTRACT OF THE DISCLOSURE

A railway truck cross-equalized against the development of a periodic roll in the associated car body by vertically acting hydraulic cylinder units at opposite sides of the truck, each of which is connected and responsive to relative vertical movement of a side frame or other supporting member and a bolster or other supported member, the units being hydraulically connected to each other for distributing between them a vertical force initiated at either side.

This invention relates to equalized railway trucks and has for its primary object the provision in a railway truck of an improved hydraulic cross equalizer for preventing a car body from developing a periodic lateral roll due to vertical irregularities in the track.

The present demand of the railroads for high capacity freight cars, except in the case of flat cars, have usually been met by increasing the height, as well as the length, of a car and correspondingly raising its center of gravity relative to a run-of-the-mill freight car of the same type. This not only aggrevates the tendency of a car body to roll laterally under forces resulting from vertical track irregularities, but when, as in the case of high capacity cars of at least one type, the natural period of the lateral roll frequency matches or synchronizes the rail joints at a speed as low as 15 to 20 miles per hour, the car at this critical speed literally walks along the track with its wheels raised clear of the track, first on one side and then the other. A number of derailments have occurred as the result. This problem this invention effectively solves by hydraulic transmitting vertical forces due to track irregularities between the sides of a car such that a lifting force on one side will produce a lifting force on the other and thus generate its own counterforce opposing lateral roll of the body.

Another object of the invention is to provide an improved railway truck having supporting springs wherein hydraulic means are so associated with each other and the supporting springs as not only to oppose periodic lateral roll of the car body, but also to snub or dampen vertical oscillation of the supporting springs.

An additional object of the invention is to provide in a railway truck a hydraulic cross equalizer, which, while opposing the development of a periodic lateral roll in the car body due to vertical deviations in the track and capable of snubbing oscillations of supporting springs, does not interfere with the normal response of the car and the truck to the forces to which they are subjected in service.

A further object of the invention is to provide in a railway truck a hydraulic device which in addition to opposing periodic lateral roll of the car body and snubbing oscillation of supporting springs, absorbs high frequency low amplitude shocks initiated at the wheels.

Another object of the invention is to provide in a railway truck, a hydraulic cross equalizer which can serve as a load supporting means, as well as to oppose

the development of a periodic lateral roll in the car body.

Other objects and advantages of the invention will appear hereinafter in the detailed description, be particularly pointed out in the appended claims, and be illustrated in the accompanying drawings in which:

FIGURE 1 is a fragmentary plan view with the body removed of a railway truck and associated structure of a railway car in which has been incorporated a preferred embodiment of the improved hydraulic cross equalizer of the present invention;

FIGURE 2 is a vertical sectional view taken along lines 2—2 of FIGURE 1, with a car floor added and other parts removed to more clearly illustrate certain of the details of construction;

FIGURE 3 is a fragmentary vertical sectional view on an enlarged scale taken along lines 3—3 of FIGURE 2;

FIGURE 4 is a longitudinal sectional view of the accumulator of the equalizer on the scale of FIGURE 3; and

FIGURE 5 is a longitudinal sectional view on the scale of FIGURES 3 and 4 of the flow control valve for the accumulator.

Referring now in detail to the drawings in which like reference characters designate like parts, the improved hydraulic cross equalizer of this invention is to be distinguished at the outset from the many devices in the prior art which are designed to maintain a body of a car or truck level despite unequal distribution of the load or lading. The equalizer of this invention neither purports to be nor is a leveling device. Instead, while usable generally upon railway cars and applicable to railway trucks of any suitable type, the improved equalizer is primarily a device for equalizing or distributing between the sides of a car a lifting or upward vertical force initiated at one side by a vertical deviation at a point or other point in a rail.

The concept upon which the present invention is based is that a car body **1**, in developing a periodic lateral roll from vertical rail deviations, acts as an inverted or upside down pendulum, with its axis of lateral oscillation or swing substantially centered laterally upon the center bearings **2** of the railway trucks **3** upon which it is supported. Although termed vertical deviations, the deviations deemed actually responsible for the periodic lateral rolls that have caused derailments, are upward vertical deviations of such order as to compress the supporting spring or springs at that side of the truck. Considering the car body **1** as a pendulum and that a vertical or, more strictly, upward vertical deviation initiates the periodic lateral roll or oscillation by lifting the side of the car at which the deviation occurs, the solution of this invention is to cause the lifting force on one side to generate at its inception a lifting force on the other. Thus, instead of being unresisted, the swing of the car body **1** away from the side on which the deviation occurs, under the lifting force applied at that side, is opposed by the counter lifting force on the other side. Substantially equal to the initial lifting force and applied before the swing has gained momentum, the counter lifting force, by counter-balancing the lifting force on the initiating side, effectively prevents the development of the unwanted periodic lateral roll.

As exemplary of the invention, the illustrated embodiment of the improved hydraulic cross equalizer, designated as **4**, has been applied to or incorporated in a railway truck **3** of the type in which the spring-supporting and supported members at either side of the truck are, respectively, a side frame **5** at each side and a bolster **6** common to the sides, and the spring means supporting the bolster on each side frame are a coil spring group **7**.

If desired, each spring group 7 may include any of the various friction devices (not shown) with which high speed freight car trucks conventionally are fitted for snubbing for periodicity of vertical oscillation of the coil springs. However, as will be pointed out, such a friction-snubbing device is not necessary since the equalizer 4 itself is incidentally capable of snubbing such oscillations.

Energized by the upward movement of the side frame 5 at the initiating side relative to the bolster 6, the equalizer 4 is comprised for the illustrated truck 3 of a pair of vertically disposed cylinders 8 which, while mountable on either the side frame or the bolster, conveniently are mounted diagonally opposite each other on opposite sides of the bolster, each inwardly of and adjacent one of the side frames. Each of the cylinders 8 is fitted with a piston 9 and with it forms a preferably single acting hydraulic cylinder or unit 10. Each hydraulic unit 10 is connected to the bolster 6 and the adjoining, associated or related side frame 5, across the interposed spring group 7, in this case by connecting the free or lower end of the piston rod 11 to an arm or bracket 12 integral or rigid with and instanding from the lower or tension member 13 of the side frame.

Downstanding from its cylinder 8, the piston rod 11 of each hydraulic unit 10 should be pivotally connected to the associated arm 12 to accommodate relative vertical angling of the side frames 5 and bolster 6. Since it will usually be desirable that there be limited so-called "lateral motion" in which the bolster moves horizontally normal or at right angles to the side frames, the pivotal connection preferably includes a link 14. Normally upright or vertically disposed, the link 14 conveniently is pivotally connected at its upper end to a clevis 15 on the lower end of the piston rod 11 and at its lower end to the arm 12 which for the purpose is bifurcated. The pivoted link 14 not only accommodates the relative service movements of each side frame 5 and the bolster 6, but, by being fitted about the pivot pins 16 with rubber shear bushings 17, preferably is made to absorb and relieve the associated hydraulic unit 10 of the high frequency low amplitude shocks to which a truck is subjected in normal running and which themselves are at too low a force level to initiate the objectionable periodic lateral roll of the car body 1.

Each of the cylinders 8 is filled above its piston 9 with oil or other suitable liquid, indicated at 18, and this oil-filled chamber or space 19 is directly connected to the corresponding chamber in the other or opposite cylinder by a connecting pipe or line 20. Always open and filled with the oil or other hydraulic liquid contained in the cylinders 8, the pipe 20 provides a constant or continuous connection between the liquid sides of the cylinders 8. Required to act in preventing the development of the periodic lateral roll only on upward movement of the side frame 5 at the initiating side relative to the bolster 6, each cylinder, below the piston 9, preferably is open to atmosphere or air through a breathe or bleed port 21 in its bottom wall 22.

To operate as intended in preventing periodic lateral roll of the car body 1, the equalizer 4 must have both the liquid chambers 19 in the cylinders 8 and the connecting pipe 20 filled at all times with the oil or other liquid used. Too, to permit the frequent simultaneous or concurrent compression of the spring groups 7 at opposite sides of the truck, there must be provision on the consequent concurrent contraction of the oil spaces 19 of both cylinders 8 for escape of the excess liquid therefrom. To these ends, the equalizer 4 includes a liquid accumulator, reservoir or supply tank 23, which, while mountable on the bolster 6, more conveniently is mounted on a part of the fixed underframe 24 above the truck bolster 6, as by clamping it to a side of the center sill 25. Connected to the connecting pipe 20 by a suitable flexible lead pipe, tube or line 26 to accommodate the relative movements of the body 1 and the bolster 6, the accumulator 23 has in the connection a check or regulator valve 27 for permitting the liquid to flow freely from the accumulator to the connecting pipe 20, but restrict or choke its flow in the opposite direction.

The illustrated check valve 27 is of a commercially available type in which a "nylon" or other suitable poppet 28 under light spring pressure yields to permit substantially free flow in one direction, but restricts liquid flow in the opposite direction to an annular orifice 29 of variable or adjustable cross-section for controlling or regulating such flow. The accumulator 23, also of a commercially available type, has a free or floating piston 30 separating its liquid side or compartment 31, in which the liquid supply for the cylinders 8 and connecting pipe 20 is stored, from its air or pressure side or compartment 32 which conveniently is pressurized by compressed air. Fitted at its side with several O-rings 33 to prevent escape of fluid between itself and the accumulator's side wall, the illustrated floating piston 30 also has an inbuilt escape valve 34 for dividing pressures above a certain level between adjoining O-rings. Of a construction to withstand high pressures, the accumulator 23 on its air side 32 can be connected to the car's air train line (not shown), but, for minimizing variations in pressure, preferably is charged intermittently as needed from a suitable exterior source. Thus, by suitably pressurizing the accumulator 23 and adjusting the control or regular valve 27, both the pressure at which liquid can flow into the accumulator and the rate of such flow can readily be adjusted and predetermined.

Connected across the spring groups 7 and with their liquid chambers 18 above their pistons 19 in constant hydraulic communication through the connecting pipe 20 and both the chambers and the connecting pipe constantly filled with oil or other liquid, the equalizer 4 provides a system, both sides of which will immediately respond through the incompressible liquid to any upward vertical force initiated at either rail, except for the low-level forces absorbed by the rubber bushings 17 in the preferred links 14. The effect of such non-absorbed forces upon the hydraulic unit 10 at the initiating side, as the related side frame 5 moves upwardly relative to the bolster 6, is to contract the liquid chamber 19 as the piston 11 moves upwardly with the side frame relative to the cylinder 8. The liquid displaced by this contraction is immediately transferred through the connecting pipe 20 to the liquid chamber 19 of the other hydraulic unit 10 at the opposite side of the truck 3. Since, within the latter unit, the displaced liquid can be accommodated only by expansion of the liquid chamber and corresponding longitudinal expansion of the unit, that unit, by reacting downwardly against the related side frame, will exert a lifting force on its end of the bolster 6 concurrently with and of substantially the order of the initiating lifting force on the other side. Accordingly, any upward force produced on one side of the truck 3 by a vertical rail deviation and applied through the interposed spring group 7 as a lifting force on the adjoining end of the bolster 6 will practically immediately distribute or equalize the applied force among the cylinder units 10 of the equalizer 4 and automatically generate a counter lifting force of like order on the opposite end of the bolster and thus counterbalance or snub any tendency of the car body 1 to oscillate laterally under the applied force.

The equalizer 4 must, of course, accommodate upward forces applied concurrently through the rails to both sides of the truck 3, as when a car begins mounting an incline. In such case, the hydraulic units 10 at both sides will be contracted simultaneously or concurrently and it is then that the adjustment of the regulator valve 27 and the pressure in the accumulator 23 come into play to permit the liquid required to be displaced from the cylinders 19 of the hydraulic units to be received in the accumulator. It is to permit liquid to escape as excess under such conditions but restrict it to the cylinders 19 and the connecting pipe 20 under an upward force at one side, as well as to en-

sure that the cylinders and the pipe will remain or be maintained filled at all times, that the accumulator **23** is pressurized or charged with air.

Since, with proper sealing, the liquid and air losses in the system will be negligible, it is not necessary that the pressurizing air be supplied constantly, as by connecting the accumulator to the main air train line, and intermittent charging as needed will suffice. The latter procedure will usually be the more satisfactory in any case, since it will enable the air pressure to be adjusted to suit the particular type or car to which the equalizer **4** is applied without being subject to the fluctuations and maximum limit in pressure of the air in the train line. Also, the intermittent charging of the accumulator **23** will be not only desirable but necessary, if, as will often be the case with freight cars of the large size for which the equalizer **4** is particularly designed, the pressure required to control the selective flow of liquid to the accumulator is above train line pressure and in the range of around 200 p.s.i.

One way or single-acting in the sense that they respond to and distribute, divide or equalize among themselves only an upward force that causes one or another to contract, the interconnected hydraulic units **19** and the equalizer **4** of which they are a part, do not interfere with service movements of the car body **1** under forces of a different character. Thus, when a car is rounding a curve, the centrifugal force will cause a slow outward roll of the car body **1**. This roll in turn will cause a tilting of the bolster **6** relative to the side frames **5** and a compression of the spring group **7** at the side toward which the body rolls and an expansion of the group at the opposite side. However, in such case, as opposed to a roll initiated by an upward force on one of theside frames **5**, the roll, initiated in the body, compresses or contracts the hydraulic unit **10** on the side toward which the body rolls and expands or extends the unit on the other side. The result, therefore, is simply an interchange of liquid between the cylinders which has no effect upon the car body.

By contrast, the hydraulic units **10** do affect the action of the spring groups **7**. While resisting expansion of either spring group only by the friction engendered between the piston **9** and the wall of the cylinder **8**, either cylinder unit **10** can contract only by displacing liquid from its liquid chamber **19** and, if the opposite unit is contracted at the same time, the displacement must be into and against the pressure in the accumulator **23**. By absorbing part of the applied force in acting against this pressure, each hydraulic unit **10** thus will act as a hydraulic snubber with a spring group **7** formed of coil springs for snubbing or damping the periodic oscillations that otherwise would develop. Since resisting contraction, particularly if both are contracted at the same time, the interconnected hydraulic units **10** also are capable together of supporting a vertical load and therefore can be used either to increase the capacity of or to replace units of like capacity in the supporting spring groups **7**.

From the above detailed description it will be apparent that there has been provided an improved hydraulic cross equalizer which not only prevents the development of a periodic lateral roll in a car body, but also can snub supporting springs of the railway truck to which it is applied and itself support at least part of the vertical load. It should be understood that the described and disclosed embodiment is merely exemplary of the invention and that all modifications are intended to be included that do not depart from the spirit of the invention and the appended claims.

I claim:

1. A railway truck comprising side frame means at opposite sides thereof, bolster means spring-supported on and movable vertically relative to said side frame means, vertically acting hydraulic cylinder means at opposite sides of said truck and each connected to and responsive to said relative vertical movement of an adjoining side frame means and the bolster means, and means hydraulically interconnecting said cylinder means for distributing substantially instantaneously therebetween a vertical force initiated at one of said sides.

2. A railway truck comprising side frame means at opposite sides thereof, bolster means spring-supported on and movable vertically relative to said side frame means, vertically acting hydraulic cylinder means at opposite sides of said truck and each connected to and responsive to said relative vertical movement of an adjoining side frame means and the bolster means, and a hydraulic connection between and constantly open to said cylinder means for substantially instantaneously distributing therebetween a vertical force initiated at either of said sides.

3. A railway truck comprising side frame means at opposite sides thereof, bolster means spring-supported on and movable vertically relative to said side frame means, vertically acting hydraulic cylinder means at opposite sides of said truck and each connecting and acting vertically between an adjoining side frame means and the bolster means, means hydraulically interconnecting said cylinder means for substantially instantaneously distributing therebetween a vertical force applied to said truck through one of said side frame means, and means connected to said interconnecting means for maintaining therein and in said cylinder means a full supply of liquid under a predetermined pressure.

4. A railway truck comprising side frame means at opposite sides of said truck, bolster means spring-supported on and movable vertically relative to said supporting means, vertically acting hydraulic cylinder means at opposite sides of said truck and each connecting and acting vertically between an adjoining side frame means and the bolster means, means hydraulically interconnecting said cylinder means for substantially instantaneously distributing therebetween a vertical force applied to said truck through one of said side frame means, and valve means between said interconnecting and maintaining means for permitting controlled flow of liquid from said cylinder means into said maintaining means on substantially concurrent application of vertical forces to said truck through side frame means at opposite sides thereof.

5. In a railway truck having side frame members at opposite sides thereof and a bolster member spring-supported on and movable vertically relative to each supporting member, a hydraulic cross equalizer comprising a single acting hydraulic cylinder unit connected to and acting vertically between each side frame member and the bolster member, and means hydraulically interconnecting said cylinder units for enabling a force applied in one vertical direction to any of said units through the side frame member connected thereto to be substantially instantaneously equalized among said units.

6. In a railway truck having side frame members at opposite sides thereof and a bolster member spring-supported on and movable vertically relative to each side frame member, a hydraulic cross equalizer comprising a single acting hydraulic cylinder unit connected to and acting vertically between each side frame member and the bolster member, and means hydraulically interconnecting said cylinder units for enabling an upward force applied to any of said units through the side frame member connected thereto to be substantially instantaneously equalized among said units.

7. In a railway truck having side frame members at opposite sides thereof and a bolster member spring-supported on and movable vertically relative to each side frame member, a hydraulic cross equalizer comprising a single acting hydraulic cylinder unit acting vertically between each of said side frame members and the bolster member and fixed to one and pivotally connected to the other of said members for permitting relative vertical angling therebetween, means hydraulically interconnecting said units for substantially instantaneously equalizing therebetween an upward force applied to any of said units through the side frame member connected thereto, means

connected to said interconnecting means for maintaining a full supply of liquid at a predetermined pressure in said units and interconnecting means, and valve means between said interconnecting and maintaining means for permitting said liquid to flow freely from said maintaining means to said interconnecting means and regulating the flow thereof in the opposite direction.

8. In a railway truck having side frame members at opposite sides thereof and a bolster member spring-supported on and movable vertically relative to each side frame member, a hydraulic cross equalizer comprising a single acting hydraulic cylinder unit acting vertically between each of said side frame members and the bolster member and fixed to one and pivotally connected to the other of said members for permitting relative vertical angling and horizontal movement of said members, means hydraulically interconnecting said units for substantially instantaneously equalizing therebetween an upward force applied to any of said units through the side frame member connected thereto, means connected to said interconnecting means for maintaining a full supply of liquid at a predetermined pressure in said units and interconnecting means, and means in the pivotal connection between each unit and the related supporting member for absorbing and protecting said unit from high frequency low amplitude vertical forces applied to said side frame member.

9. In a railway truck having a side frame member at each side thereof, a bolster member supported on and movable relative to each side frame member, and spring means acting between each side frame member and the bolster member, the combination of a single acting hydraulic unit acting vertically between each side frame member and the bolster member and fixed to one and having a pivoted link connection to the other of said members for accommodating relative movements other than vertical therebetween, means in each connection for absorbing and thereby preventing transmission of high frequency low amplitude forces from the side frame member to the unit connected thereby, means hydraulically interconnecting said units for substantially instantaneously equalizing therebetween an upward force applied to any unit through the related side frame member, and a reservoir connected to said interconnecting means and pressurized at a predetermined pressure for maintaining a full supply of liquid at said pressure in said units and interconnecting means.

10. In a railway car truck having side frames at opposite sides thereof and a bolster extending between and spring-supported on said side frames for relative movement therebetween, the combination of single acting hydraulic units at opposite sides of said truck and each fixed to one and pivotally connected to the other of said bolster and the adjoining side frame and responsive to upward forces above a predetermined level applied to said side frame, means hydraulically interconnecting said units for substantially instantaneously equalizing therebetween said upward forces applied to one unit, and means connected to said interconnecting means for maintaining a full supply of liquid at a predetermined pressure in said units and interconnecting means.

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