

Jan. 14, 1969

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3,421,262

LOAD BALANCER FOR FREIGHT CAR DOORS

Filed March 23, 1967

Sheet 1 of 4

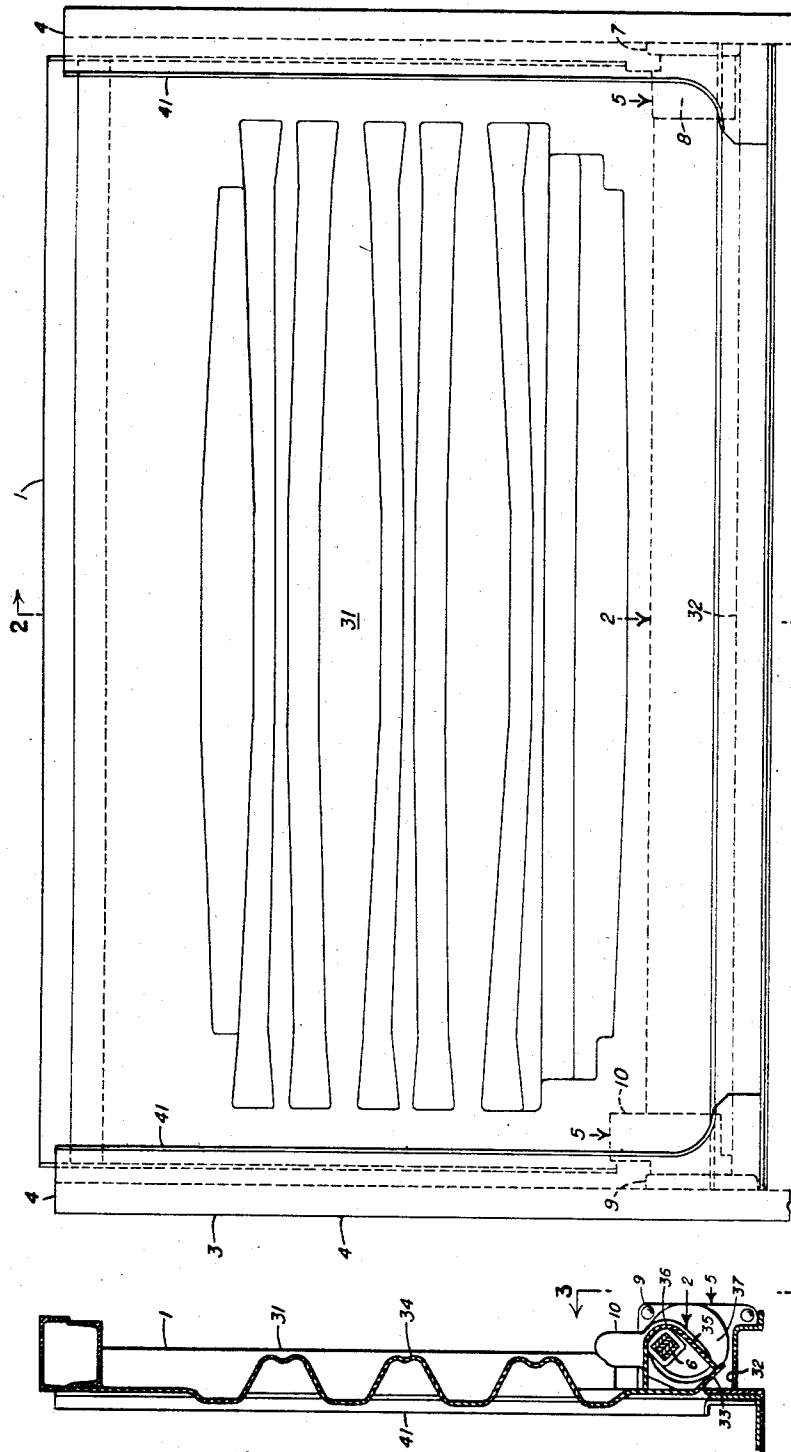


FIG. 1

FIG. 2

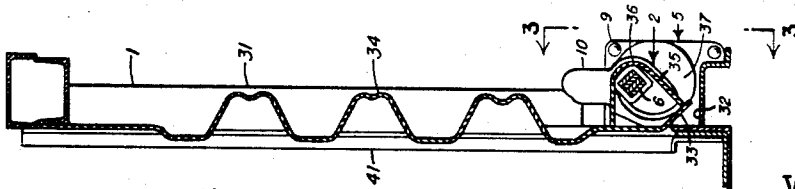


FIG. 2

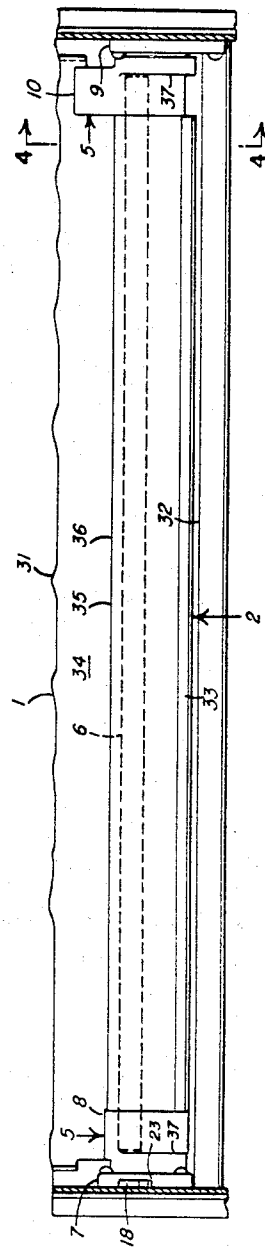


FIG. 3

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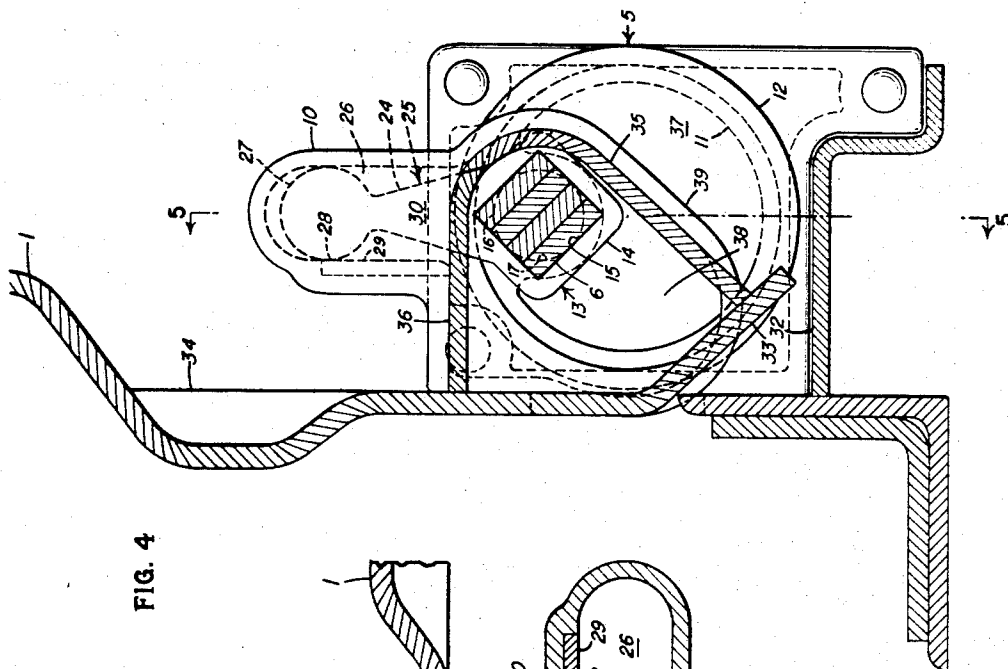


FIG. 4

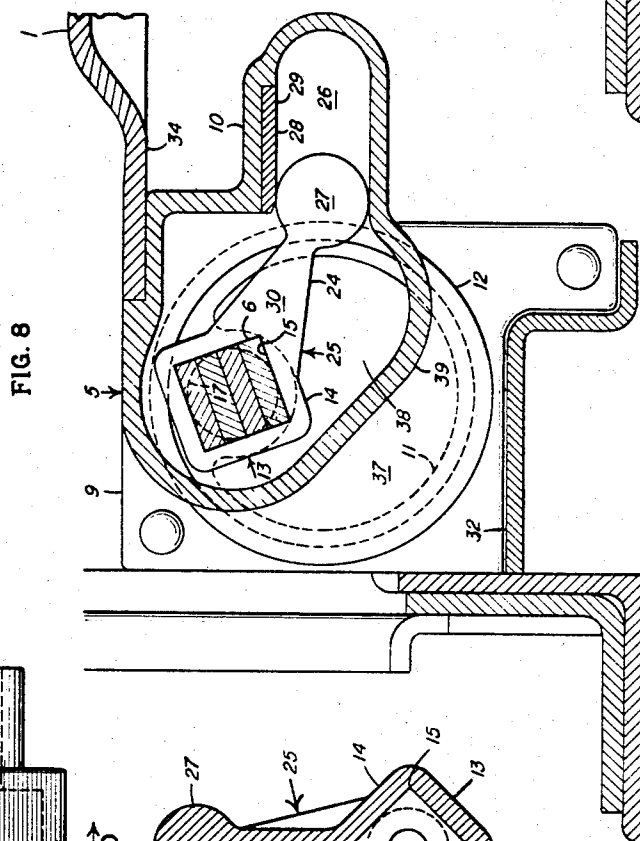


FIG. 8

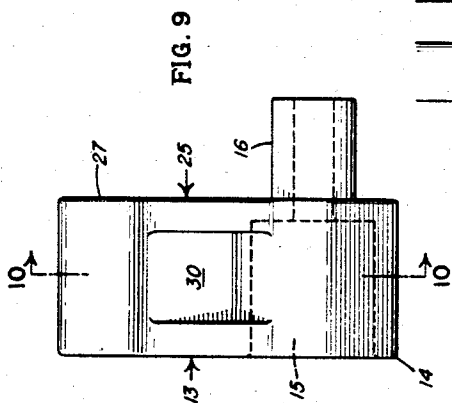


FIG. 9

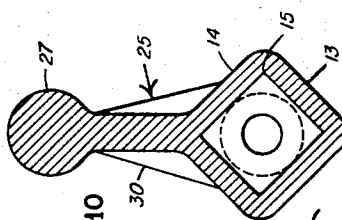


FIG. 10

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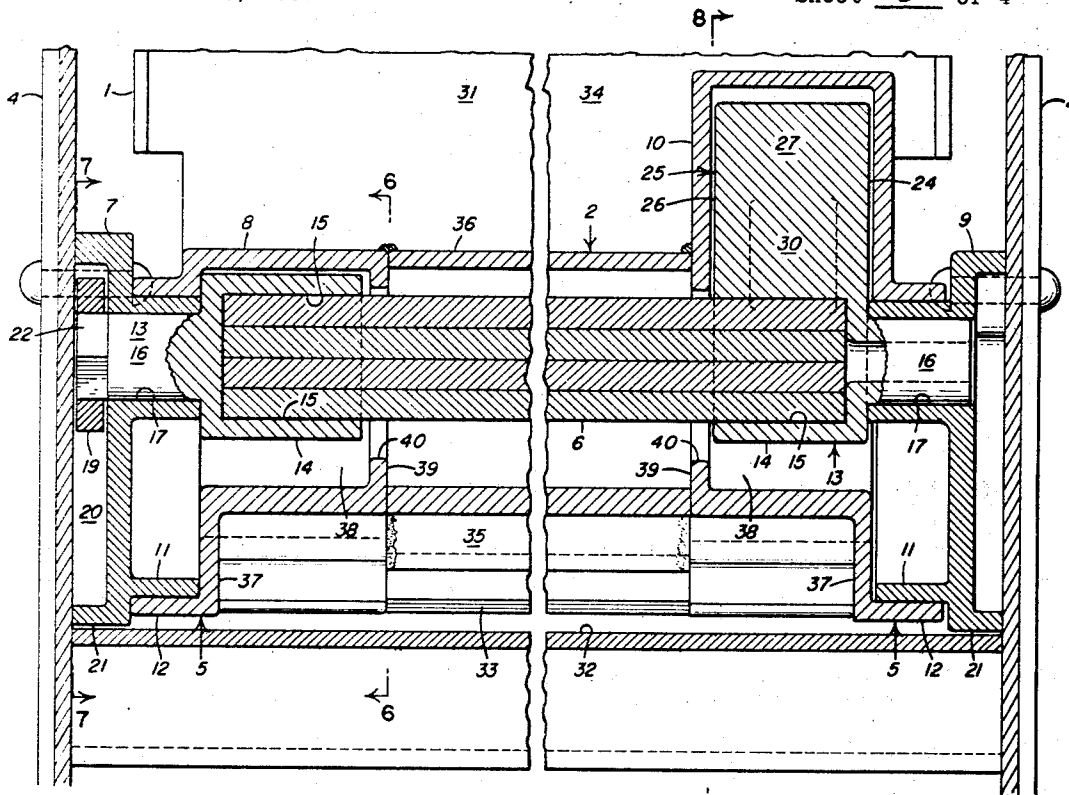


FIG. 5

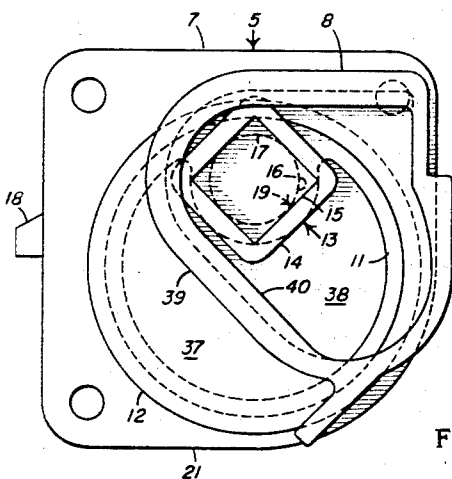


FIG. 6

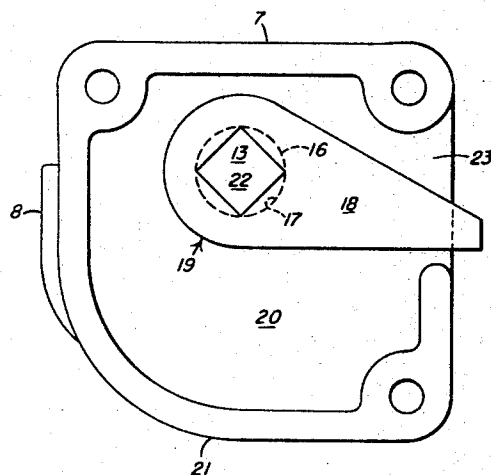
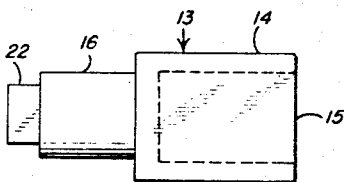


FIG. 7

FIG. 11



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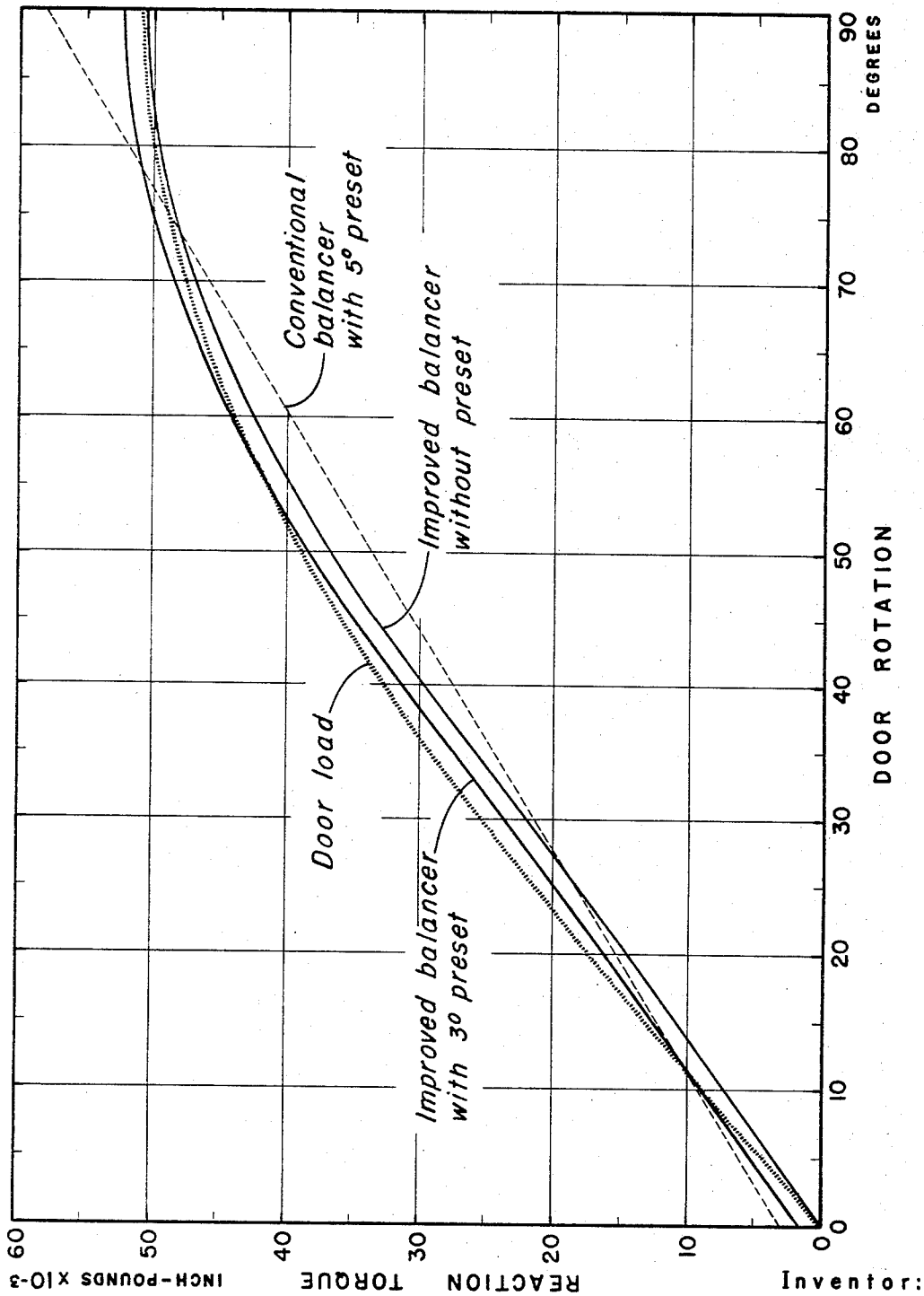


FIG. 12

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LOAD BALANCER FOR FREIGHT CAR DOORS

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U.S. Cl. 49—386

11 Claims

Int. Cl. E05f 1/10

ABSTRACT OF THE DISCLOSURE

A load balancer for a hinged drop end door of a railway gondola car in which a single torsion bar acting between the door and the car body over the full range of movement of the door, is so mounted on the car body and connected to the door as substantially to simulate the load curve of the door in its reaction thereon.

Background of the invention

Whether called doors, gates or covers, hinged or pivoted closure members of railway freight cars, that swing about horizontal axes between open and closed positions, are frequently equipped with torsion springs to counterbalance the resistance of gravity to their opening or closing movements. Typical of such closure members are the bottom hinged drop end doors of railway gondola cars which in opening swing inwardly into the cars from vertical closed positions and, when equipped with torsion spring balancers, energize the springs in opening and are assisted by them in closing.

While, characteristically, the torque curve of a torsion spring is a straight line and the load curve of a vertically swingable closure member is a sine curve, the consequent differences between the load and counterbalancing torque pose no problem for doors of ordinary size. However, for oversize drop end doors such as those 6 ft. high and weighing 1450 lbs. now contemplated, the difference between the straight line torque output of the usual torsion spring and sine load curve of the door are of such order as to make it impractical to balance the door's load with a conventional balancer. It is mainly to the solution of this problem that the present invention is addressed.

The improved balancer of the present invention enables the load of any vertically swinging hinged closure member of a freight car to be balanced effectively by a full range torsion spring by so mounting the spring relative to the hinging axis and connecting it to the hinged member as to develop from the spring a reactance torque that, over the range of movement of the hinged member between open and closed positions, departs from the usual straight line curve or plot of a torsion spring and bends to approximate or simulate to the extent necessary the sine load curve of the door. Applicable for counterbalancing the gravity load of either conventional or oversize drop end doors or other hinged closure members and preferably using as a spring counterbalance a full range torsion spring extending across the hinged member and action therebetween and the car body, the improved balancer modifies the reactance on the closure member of the torque released by the spring, by mounting the spring eccentrically of the member's hinging axis and causing the moment arm of the spring force on the closure member to vary progressively as the latter is moved against gravity between open and closed positions. In its preferred form, the improved balancer also hinges a drop end door to which it is applied to the car body and not only provides a housing for the torsion spring but enables the torque of the spring in the door's closed

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position to be preset during assembly as desired for the particular installation.

With the foregoing its main objectives, other objects and advantages of the invention will appear hereinafter in the detailed description, be particularly pointed out in the appended claims and illustrated in the accompanying drawings, in which:

FIGURE 1 is a fragmentary front elevational view of an end of a railway gondola car showing a drop end door equipped with a preferred embodiment of the load balancer of the present invention;

FIGURE 2 is a vertical sectional view taken along lines 2—2 of FIG. 1;

FIGURE 3 is a fragmentary front elevational view taken along lines 3—3 of FIG. 2;

FIGURE 4 is a fragmentary vertical sectional view on an enlarged scale taken along lines 4—4 of FIG. 3;

FIGURE 5 is a vertical sectional view taken along lines 5—5 of FIG. 4;

FIGURE 6 is a vertical sectional view taken along lines 6—6 of FIG. 5;

FIGURE 7 is a fragmentary vertical sectional view taken along lines 7—7 of FIG. 5;

FIGURE 8 is a fragmentary vertical sectional view taken along lines 8—8 of FIG. 5 but differing from the preceding figures in showing the relative positions of the depicted parts in the open position of the door;

FIGURE 9 is a side elevational view of the torque transmitter removed from the other structure;

FIGURE 10 is a vertical sectional view taken along lines 10—10 of FIG. 9;

FIGURE 11 is a side elevational view shown by itself the end connector for the body-anchorable end of the torsion bar; and

FIGURE 12 is a graph showing the relation between the load curve of the door and the torque derivable from the improved and conventional balancers.

Detailed description

Referring now in detail to the drawings, in which like reference characters designate like parts, the improved compensating load balancer of the present invention, while applicable generally to vertically swingable hinged closure members of railway cars, hereinafter generally termed "doors," is particularly designed for the recently proposed oversize drop end doors for which conventional balancers are not practical.

The improved balancer of this invention resembles conventional balancers in using, for counterbalancing the load of the door, torsion springing which acts over the full range of movement of the door between closed and open positions and is energized on opening and releases its energy on closing of the door. However, while the spring itself may be conventional, the improved balancer differs basically from a conventional balancer in modifying the output or reaction torque of the spring on the door so as to cause it to depart from the usual straight line plot or curve and simulate or approximate, as closely as necessary, the load curve of the particular door. It is this capability that enables the improved balancer to compensate with full range torsion springing for the differences between the characteristic sine load curve of a door and straight line torque curve of a torsion spring, which for oversize doors are of such order as practically to disenable balancing of the door by a conventional balancer.

While of far greater than usual size, the oversize drop end door 1 for which the illustrated embodiment of the improved balancer 2 is particularly designed, will, as usual, be one of a pair of duplicate doors mounted at opposite ends of a body 3 of a railway gondola car, each

between adjoining corner posts 4 for swinging or hinging inwardly from a substantially vertical closed position to a substantially horizontal open position. Following usual practice, each door 1 is bottom hinged and in moving between closed and open positions, swings, hinges or pivots on a horizontal axis extending across its bottom portion laterally of the body 3. As the doors at opposite ends of the car and their balancers ordinarily will be identical, a description of the door and balancer assembly at one end of the car body will suffice for an understanding of the invention.

The hinged mounting of the door 1 on the car body 3 is provided by a pair of hinges 5 at opposite sides of the door, each of which is formed by a bracket fixed to a side of the door and a cooperating bracket fixed to the inside of the adjoining corner post 4. In the illustrated embodiment, in which the preferred torsion springing for counterbalancing the load of the door 1 is a multi-plate or leaf torsion bar 6 extending across the door and connected or anchored at or adjacent opposite ends to the door and car body through the hinges 5, the latter, while suitably identical in their manner of mounting the door, differ with respect to the torsion bar. So differentiated, the car body bracket or butt and cooperating door bracket or butt of the hinge at the end of the torsion bar anchored to the car body are numbered 7 and 8, respectively, while the numbers 9 and 10 designate respectively the body and door brackets or butts of the hinge at the opposite or door-connected end of the torsion bar.

For mounting the door 1, each of the body brackets 7 and 9 has integral or rigid therewith and instanding therefrom toward the adjoining side of the door a hollow cylindrical trunnion or stub shaft or axle 11. The trunnions 11 are concentric or co-axial with each other and each projects or extends into and is rotatably or pivotally received or seated in a concentric or co-axial, at least internally cylindrical, boss or hub 12 integral or rigid with and outstanding laterally from the adjoining or cooperating door bracket 8 or 10.

Were the improved balancer 2 conventional, its torsion springing would extend along or at least cross the door's hinging axis. Such a relation, however, definitely does not obtain between the torsion bar 6 and the door's hinging axis in the improved balancer of this invention. Instead, although preferably extending or disposed horizontally and parallel to the hinging axis, the torsion bar 6 is radially offset from or eccentric to the door's hinging axis, with the radial spacing between the axis and the bar's longitudinal center preferably both fixed and predetermined to suit the particular installation.

For the illustrated application in which the door or closure member is a drop end door, hinged between adjoining corner posts 4, the torsion bar 6 suitably is end-connected to the body 3 and radially or side-connected therebetween to the door 1. Both of the connections are made through the hinges 5, the end connections to the body brackets 7 and 9 and the side connection to one of the door brackets 8 and 10. In the preferred construction only one of the end connections is an anchor and even this connection is initially adjustable for enabling the normal or at rest torque of the bar to be preset, prefixed or predetermined as necessary for the particular installation.

Each of the end connections between the torsion rod 6 and the body brackets 7 and 9 conveniently is made by an end connector or connecting member 13 having in a socketed head or cup 14 an inwardly facing socket 15 of a cross-section suitable for non-rotatively receiving or seating the adjoining end of the torsion bar 6. Outwardly of and centered laterally on and preferably integral with the head 14 of each connector 13 is a cylindrical stem 16 which is rotatively received or seated or journaled in one of a pair of correspondingly cylindrical, coaxial or concentric, seats, apertures or sockets 17, each in and preferably radially within the trunnion 11 of one of the body brackets 7 and 9. While concentric with each other, the connectors 13 and their seats 17 are eccentric or ra-

dially offset relative to the door's hinging axis and the trunnions 11 and bosses 12 by which that axis is fixed, the offset being upwards or vertical with the rotative axis of the connectors and the hinging axis in vertical alignment.

Alike in the above respects, and also in having their heads 14 housed or contained in the door brackets 8 and 10, the connectors 13 differ otherwise as befits the difference in their functions relative to the torsion bar 6. The connector seated in the body bracket 7 through which an end of the torsion bar is anchored to the car body 3, is combined with an adjusting lever or arm 18 to form an adjustable anchor or anchor member 19. Conveniently in the form of a flat socket wrench housed in a cavity 20 in the base 21 and socketing or keyed to a square or other out-of-round extension 22 on the related stem 16 outwardly of or beyond its seat 17, the adjusting lever 18 projects or extends radially of the stem through a side slot 23 in the base which is of sufficient width to accommodate swinging of the lever through an arc covering the range of preset or initial adjustment of the torsion bar 6 required to suit various installations. Once this adjustment is made for a particular installation, the lever arm 18 is welded or otherwise fixed to the body bracket 7, as by welding shut the slot 23 therein, thus transforming the initially adjustable anchor 19 into the fixed body anchor as which it functions during the subsequent service movements of the door 1.

The other of the end connectors 13, while fixing its end of the twisting axis of the torsion bar 6, is never fixed against relative rotation to the related body bracket 9. However, the connector is limited in rotation relative to that body bracket by a torque arm 24 integral or rigid with and projecting radially from its head 14, with which it combines to form a side connector or torque transmitter 25 between the torsion bar 6 and the door. At the door end of the force transmitter 25, the direct donor on opening and recipient on closing of the transmitted forces is the door bracket 10, which for the purpose has a seat or guideway 26 projecting or extending radially from the door's hinging axis outwardly beyond the torsion bar 6 and receiving or seating the outer end portion 27 of the torque arm 24.

Slidable in the guideway 26 rectilinearly thereof and radially of the hinging axis, the end portion 27, over the range of movement of the door, contacts or bears against and slides on a bearing surface 28 facing in the door's opening direction and preferably formed on a hardened, self-lubricated or lubricatable wearplate 29 inset into the door bracket 10 at that side of the guideway. In turn, the preferred outer end portion 27, which, because of the offset of the torsion bar's twisting axis from the hinging axis, can at best have line contact with the bearing surface 28, should be cylindrically bulbous or convex at least on the side facing that surface and may be either the illustrated fixed cylinder struck about an axis parallel to the hinging axis and integral or rigid with the shank 30 of the torque arm, or, for minimum wear, a cylindrical roller mounted on the shank for rotation about such an axis.

For maximum useful life, a load balancer should have its torsion spring and relatively movable parts protected from both weather and any lading transported in the car. The illustrated embodiment meets this desideratum by carrying or extending the main part 31 of the door 1 in the latter's closed position downwardly substantially to the level of the floor 32 of the car body 3 with a rearwardly bent or inclined bottom flange 33 as its downward terminus and welding or otherwise fixing to the rear face 34 of the door a generally V-shaped cover 35, which, with the included bottom portion of the main part 31, forms an open-ended, intermediate housing or casing 36 housing or enclosing the portion of the torsion bar 6 intermediate or between the hinges 5. At the hinges the body brackets 7 and 9 are covered at the back by the corner post 4 and their hollow trunnions or shafts 11 are covered at their

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sides by the hubs or bosses 12 of the door brackets 8 and 10. Inner walls or webs 37, normal to and conveniently integral with the hubs 12, partly close the latter's inner ends but are interrupted by generally oval or arcuate slots 38 each of a size or extent to accommodate the head 14 and stem 16 of the related end connector 13 journaled in the adjoining car body bracket 7 or 9.

The link or filler between the hub 12 of each door bracket 8 or 10 and the adjoining side of the door 1, is an open-ended oval collar or ring 39 surrounding or encircling the related slot 38 and integral or rigid and merging at its outer end with the hub. Conforming at its opposite or inner end generally to the end contour of the intermediate housing 36 on the bottom portion of the door, each collar is fixed as by welding to the adjoining end of that housing, thus to form a continuous housing extending from one to the other of the adjoining car post 4. Each of the door brackets 8 and 10 houses or contains the head 14 of the related connector 13 in its collar 39 and, as indicated, the collar may have on its inner end a stop shoulder or lip 40 partly overlapping the slot 38 and the head of the connector for holding the latter in place. The housing of the moving parts of the balancer 2 is completed by the guideway 26 which conveniently is formed integrally with the collar 39 of the related door bracket 10 and, while opening inwardly onto that collar to receive the torque arm 24, preferably is otherwise closed.

Constructed in the above manner, the improved balancer 2 is designed to be preapplied to and installed as a unit with the door 1. As customary in drop end doors, the illustrated door 1 has its main part 31 ribbed or convoluted for strength and is fixed or stopped in its vertical closed position by engagement at the front with laterally in-
standing flanges 41 on the corner post 4. In assembling the unit, the usual procedure will be to weld the door brackets 8 and 10 to the sides of the door's main part 31, then locate the torque transmitter 25 in its associated door bracket 10 and thereafter apply the torsion bar 6 through the slot 38 in the opposite door bracket 8, until its leading end is socketed in the head 14 of the torque transmitter. After capping the other end of the bar 6 by the head 14 of the adjustable anchor 19, the body brackets 7 and 9 are applied and the unit, thus assembled, is installed in one end of the car body 3 by riveting the body brackets to the corner post 4. With the door and balancer assembly now in place and the adjusting lever 18 of the adjustable anchor 19 readily accessible by its projection through the front opening slot 23 in the base 21 of the body bracket 7, any adjustment desired in the initial or normal torque of the torsion bar 6 is made by swinging that lever and correspondingly twisting the adjoining end of the rod through whatever arc is necessary, after which the adjustable anchor is fixed or locked against turning to the body bracket 7, suitably by welding the slot shut.

Once the adjustable anchor 19 has been fixed in place and the adjoining end of the torsion bar 6 consequently anchored to the car body 3, all twisting torsioning or torquing of the torsion bar is produced by or produces a transfer of force between the torsion bar and the door 1, with the intermediaries or transferors the torque arm 24 and the bearing surface 28 in the guideway 26 of the door bracket 10. Were the torsion bar concentric with the hinging axis, the moment arm of the transferred force would be constant throughout the range of movement of the door. However, because the torsion bar 6 twists on a fixed axis eccentric to the hinging axis, the point or, more precisely, line contact between the torque arm 24 and the bearing surface 28 moves toward or away from the hinging axis and produces a corresponding variation or change in the length of the moment arm of the force with respect to the door as the latter moves between closed and open positions. The torsion bar's eccentricity will also cause the torque arm 24 to swing and the bar to twist through a different arc than the door.

The above effects of the torsion bar's eccentricity, the

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progressive change in the moment arm of the spring force on the door and the difference between the arc of movement of the door and that of twisting of the bar, are combined in the preferred embodiment to approximate closely in the reaction torque of the spring on the door the load or equilibrium curve of the door. Referring to the graph of FIG. 12, the characteristic sine curve of the door load of the particular oversize door is the cross-dashed curve designated as the "door load." A conventional balancer with a torsion bar of like capacity but concentric with the hinging axis would have a straight line plot and best approximate the load curve if given a 5° preset. However, as indicated by the dashed line on the graph, this "best" "conventional balancer" curve, would miss the door's load curve by a wide margin except at the two points of intersection.

In the illustrated balancer the torsion bar 6 not only is eccentric to the hinging axis but is positioned between that axis and the guideway 26 and it and the torque arm 24 are aligned both radially and vertically with each other and the hinging axis in the door's closed position. As a result of the offset of the bar on the guideway or distal side of the hinging axis, the torque arm 24 is swung and the torsion bar twisted through a greater arc than that through which the door moves, some 115° in the illustrated embodiment, as opposed to the movement of about 90° of the door. Disregarding the reaction on the door 1, the effect, relative to a torsion bar 6 of the same capacity centered on the hinging axis, is an increase in both the maximum energy the torsion bar can release and the gradient or the rate of change of the torque applicable at the outer end portion 27 of the torque arm 24. However, the reaction on the door 1 cannot be disregarded since the eccentricity, by causing the sliding or rolling contact between the torque arm 24 and the bearing surface 28 to move relative to the hinging axis as the door moves, progressively decreases and increases the moment arm of the spring force on the door, the former on opening and the latter on closing of the door. It is this progressive change or variation in the moment arm that produces the bending or curving of the reaction torque of the torsion bar 6 on the door and is primarily responsible for the ability of the improved balancer to simulate or approximate to the point of substantial duplication the sine load curve of the door.

Two variants of the reaction torque obtainable from the torsion bar 6 of the improved balancer are shown in solid line on the graph, one, as legended, having no preset, and the other with a preset of 3°. Neither exactly conforms to the load curve of the door but both follow it so closely as to reduce to the order of 20 or so lbs., the lifting force on the distal end of the door required to be exerted by an operator in a closing operation.

From the above detailed description it will be apparent that there has been provided an improved load balancer which is suitable for counterbalancing the load of any vertically swingable hinged door of a freight car. 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 scope of the appended claims.

Having now described my invention, I claim:

1. A load balancer for a hinged door of a railway car swingable between closed and open positions about a substantially horizontal hinging axis, comprising torsion spring means anchored to a body of said car, said spring means extending laterally of said door and having a twisting axis eccentric to said hinging axis, means rigid with, said door, and torque means non-rotatively connected to said spring means and extending normal to said twisting axis thereof, said torque means engaging and on swinging of said door moving along said rigid means normal to said twisting axis for transmitting torsional forces between said door and spring.

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2. A load balancer according to claim 1, wherein the spring means is connected at opposite ends to the car body for fixing the twisting axis thereof and side-connected intermediate its ends to the door by the torque means.

3. A load balancer according to claim 2, including body brackets fixed to the car body at opposite sides of the door and door brackets fixed to opposite sides of the door and each rotatively connected to an adjoining body bracket for hingedly mounting the door on the car body, and wherein the spring means extends between and is connected at its opposite ends to the body brackets.

4. A load balancer according to claim 3, wherein the torque means is connected to the spring means intermediate the body brackets.

5. A load balancer according to claim 4, wherein the spring means is a torsion bar, the twisting axis of the bar is parallel to the door's hinging axis, and in use in service the torsion bar is fixed against turning relative to one and turnable relative to the other of the body brackets.

6. A load balancer according to claim 5, wherein the torque means includes an end connector rotatable in and connecting an adjoining end of the torsion bar to the other body bracket, and a torque arm rigid with and projecting radially from said connector and having a distal end portion, and the rigid means includes a guideway rigid with the adjoining door bracket and engaged by and movably receiving said distal end portion.

7. A load balancer according to claim 6, wherein there is an end connector at each end of the torsion bar, each end connector is initially rotatable in the related body bracket, and an adjusting lever is connected to one of said

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connectors for forming therewith an adjustable anchor for presetting the initial torque of the torsion bar.

8. A load balancer according to claim 6, wherein the outer end portion of the torque arm rides against a bearing surface at a side of the guideway in transferring torque between the door and the torsion bar.

9. A load balancer according to claim 8, wherein in the door's closed position the guideway and the torsion bar are aligned radially of the hinging axis with each other and spaced from each other and the hinging axis toward a distal end of the door.

10. A load balancer according to claim 8, wherein in the door's closed position the center line of the guideway, hinging axis of the door and twisting axis of the spring are substantially vertically aligned.

11. A load balancer according to claim 8, wherein the outer end portion of the torque arm contacting the bearing surface is cylindrically convex for line contact with the surface.

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KENNETH DOWNEY, *Primary Examiner.*

U.S. Cl. X.R.

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