June 29, 1965 F. P. ADLER ETAL 3,191,550

RAILWAY CAR CONSTRUCTION

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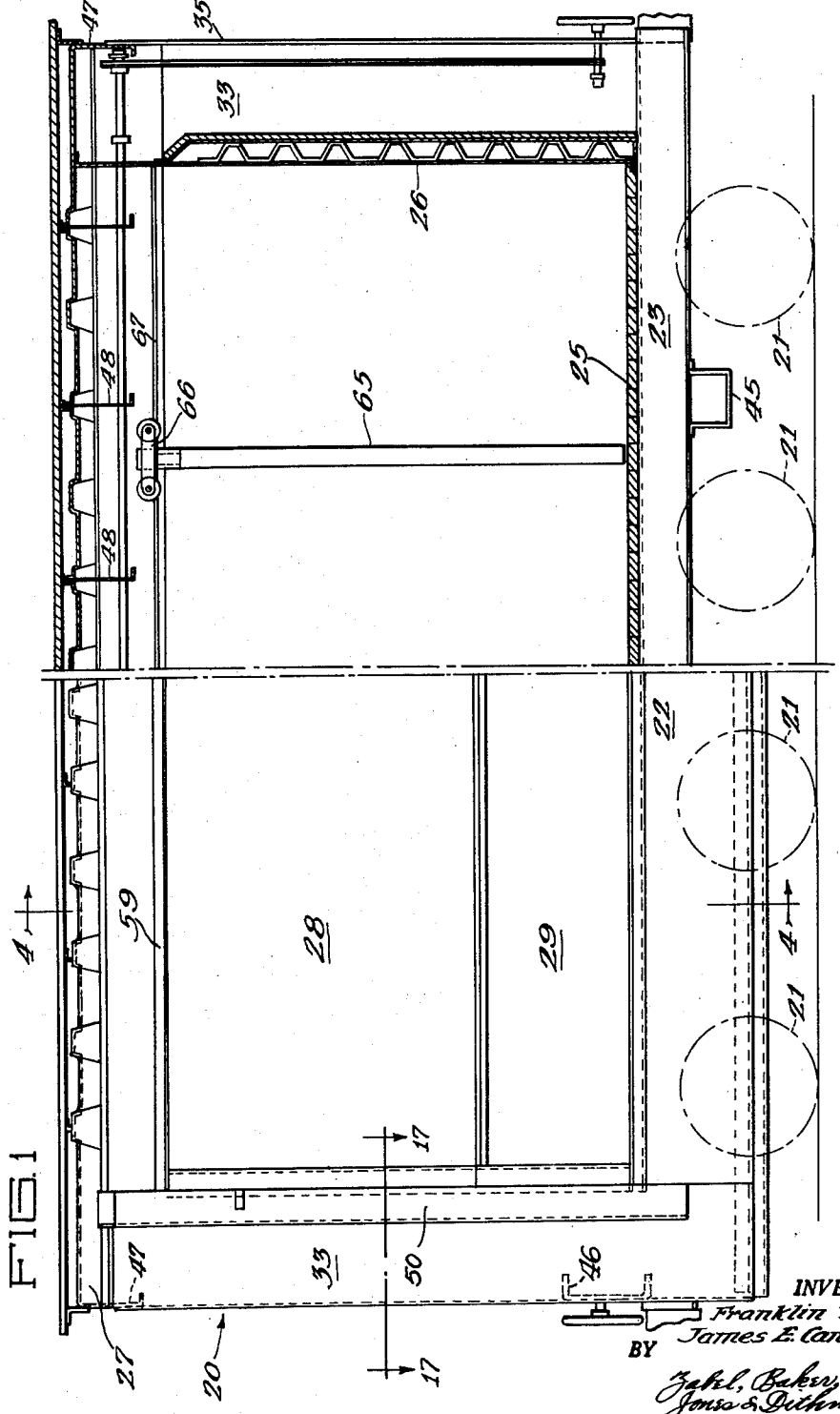


FIG. 1

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RAILWAY CAR CONSTRUCTION

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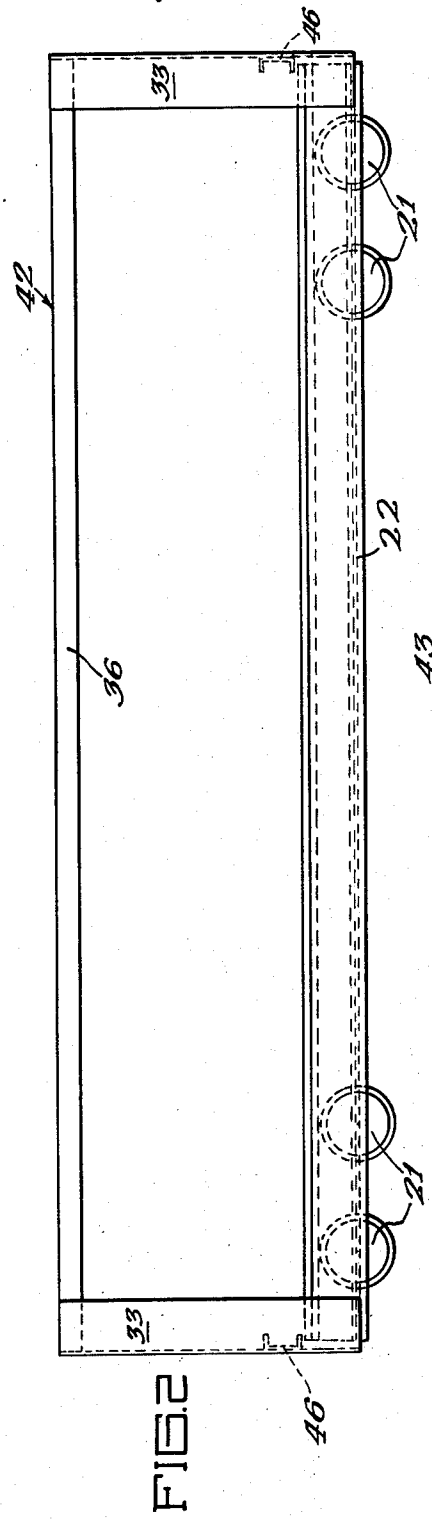


FIG. 2

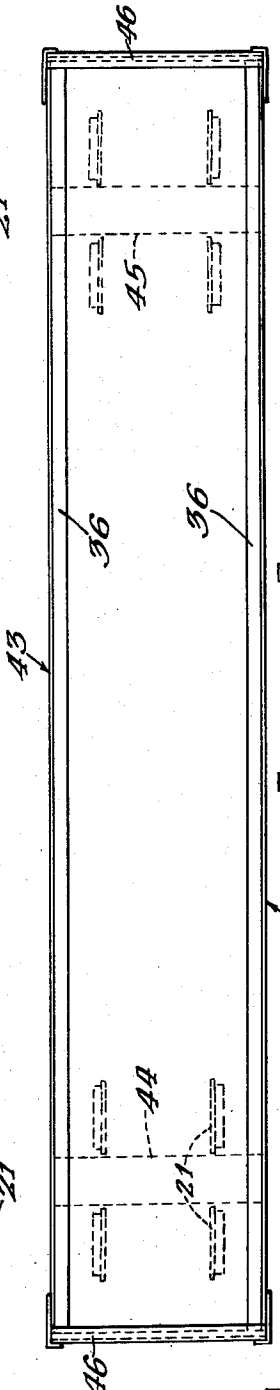


FIG. 3

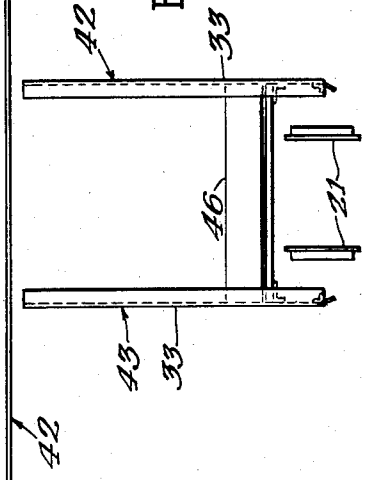


FIG. 4

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June 29, 1965 F. P. ADLER ETAL 3,191,550

RAILWAY CAR CONSTRUCTION

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FIG. 5

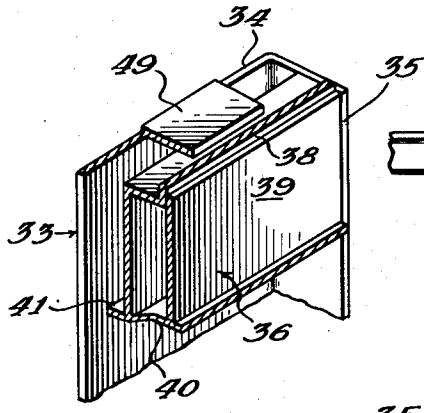
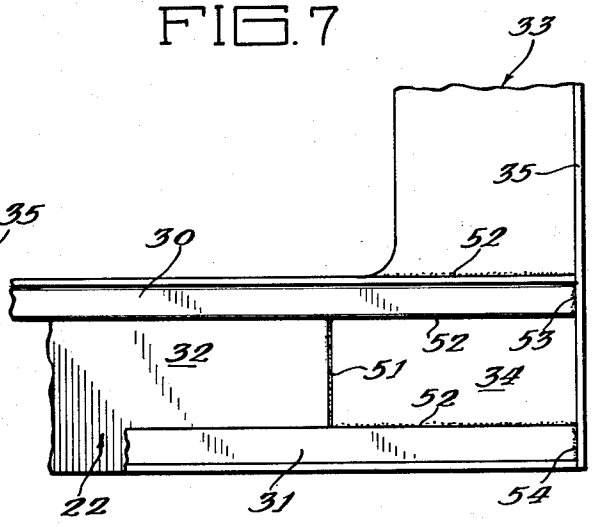


FIG. 7



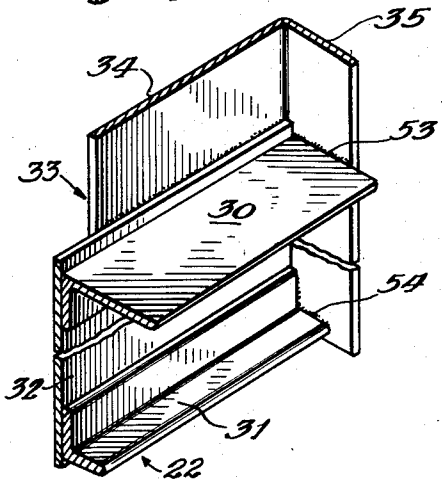
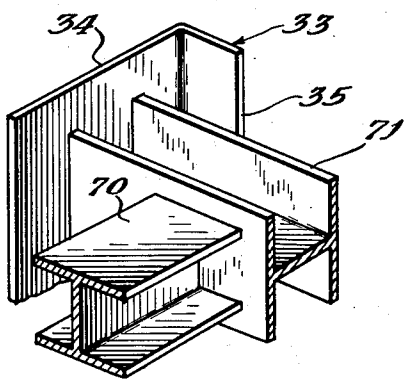


FIG. 6

FIG. 12



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FIG. 8

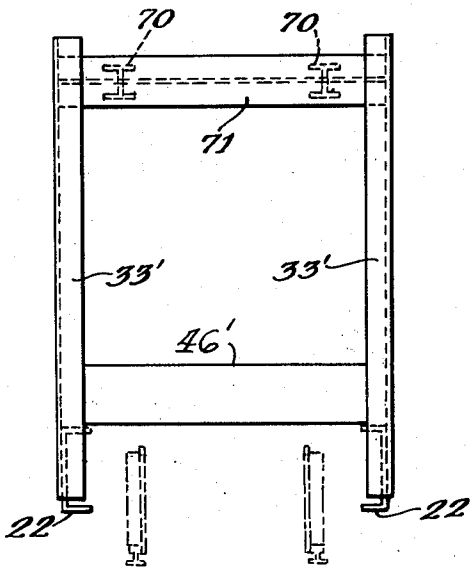


FIG. 9

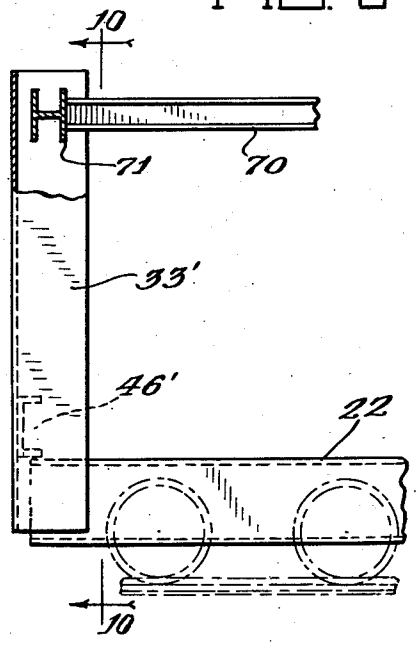


FIG. 10

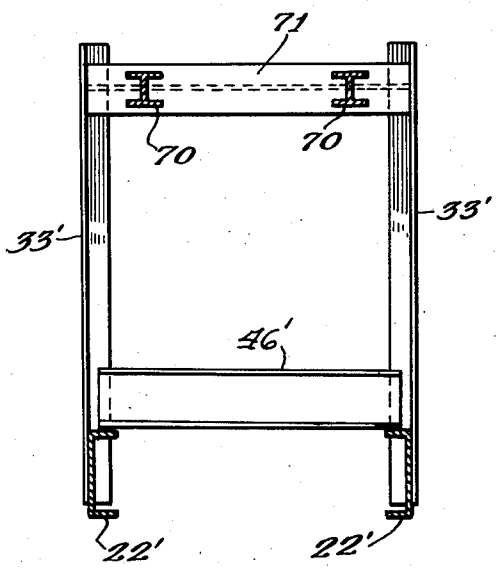
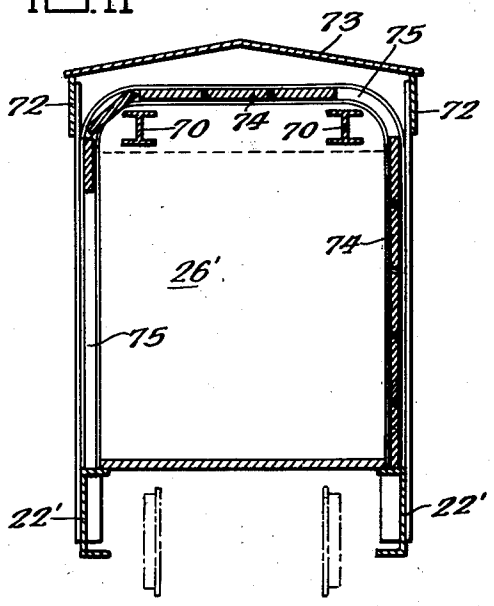


FIG. 11



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FIG 13

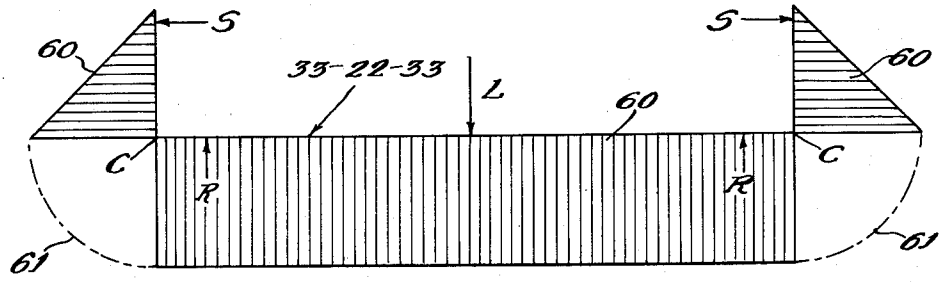


FIG. 14

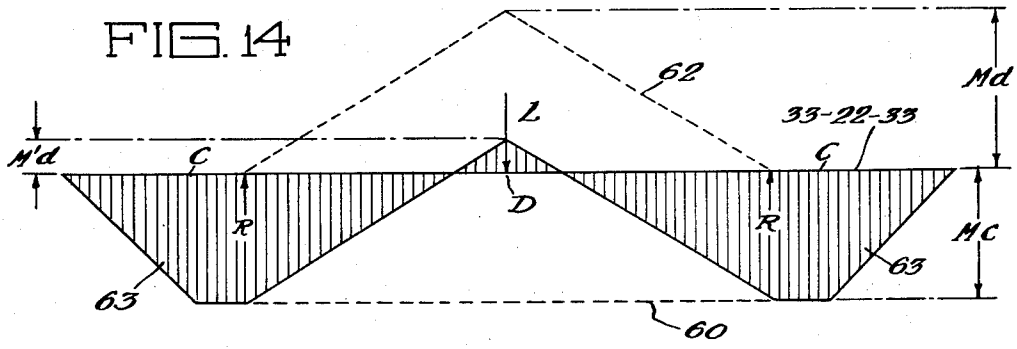


FIG. 15

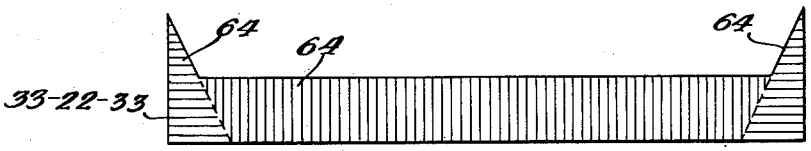


FIG. 16

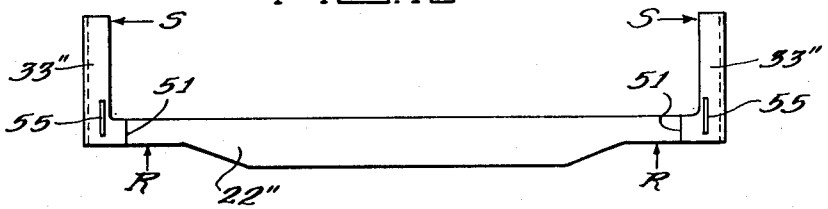
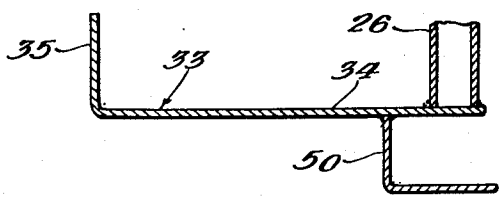


FIG. 17



United States Patent Office 3,191,550 Patented June 29, 1965

3,191,550

RAILWAY CAR CONSTRUCTION

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Filed May 21, 1962, Ser. No. 208,659
(Filed under Rule 47(b) and 35 U.S.C. 118)
16 Claims. (Cl. 105—404)

This application is a continuation in part of Serial No. 89,033 filed February 13, 1961.

This invention relates to an open side railway car suitable for direct loading, and in particular to a car which, due to an extremely rigid structure, can be fitted with vertically sliding doors.

According to this invention, the car may be loaded directly, that is by the transverse movement only of the lading through the open side of the car both at points immediately adjacent the car ends and at intermediate points. According to the usual practice, the lading is moved first transversely through the car door, and then longitudinally toward the car end.

In the usual box car construction the underframe in itself has comparatively little strength with respect to deflection under load. The sides are the main load supporting means, the underframe serving mainly to carry the load to the body bolster and thence to the trucks. This arrangement requires the use of strength members arranged along the side of the car end to which the side sheathing is attached. Therefore, the usual box car construction cannot be adapted for direct loading.

It is an object of this invention to provide a car which is characterized by the absence of all vertical and diagonal strength members at points between the car ends, so that the entire side areas may be utilized for direct loading purposes.

A particular object is to provide a car frame which is resistant to deflection under load, so that the lower edge of a vertically sliding door will be parallel to the floor of the car. If the underframe sags, the parts will not be parallel resulting in a crack between the parts. Also, a sagging underframe will cause binding of the doors in the door guides or door posts.

According to this invention, the load capacity of the car is materially increased by providing as strength members two structural assemblies, which are referred to herein as "unit frames," one for each side of the car. The term "unit frame," as used herein, refers to a structurally rigid U-shaped structure the open end of which is connected by a compression member. The characteristic of this unit frame is that it provides a much greater resistance to flexure in a direction parallel to its plane than is provided by the two horizontal members of an ordinary rectangular frame.

According to this invention, the deflection of the side sill under load is utilized as a means of stressing the unit frame in such a manner that the bending moments of the side sill are reduced.

In the rigid U-shaped structure which comprises the end piers and the side sill of the car, the end piers may be considered as integral extensions of the side sill so that in effect a single continuous beam is provided. According to this theory, the end piers must be very heavy, and the corner connections between the end piers and the side sill must necessarily be able to transmit the bending moment at the immediately adjacent section of the end pier to the immediately adjacent section of the side sill, and vice versa. In other words, the corner connection is no less stiff than the adjacent portions of the continuous beam.

The term "rigid" is used herein in a special sense to denote this characteristic of the corner connection.

Another object is to provide an improved car structure of the type indicated in which the vertical members of the unit frame are located externally of the car ends so that the entire cargo space is accessible for direct loading.

Other objects, features and advantages will become apparent as the description proceeds.

With reference now to the drawings in which like reference numerals designate like parts:

FIG. 1 is a side elevation of a railway car embodying this invention, a portion being shown in section;

FIGS. 2, 3 and 4 are more or less diagrammatic views showing the arrangement of the unit frames in side elevation, plan, and end view respectively;

FIGS. 5 and 6 are perspective views showing the upper and lower corner connection respectively;

FIG. 7 shows a modification of FIG. 6 in elevation;

FIG. 8 is a diagrammatic view similar to FIG. 4, but showing a modified arrangement of the unit frames;

FIG. 9 is a fragmentary side elevation of the arrangement shown in FIG. 8;

FIG. 10 is a diagrammatic section taken along line **10—10** of FIG. 9;

FIG. 11 is a section similar to FIG. 10, but showing the relationship of the car roof and door guides to the horizontal strength members;

FIG. 12 is a perspective view of the upper corner condition of the modified arrangement shown in FIGS. 8 to 11;

FIGS. 13 to 15 are diagrams illustrating the theory of operation;

FIG. 16 shows a modified type of the rigid U-shaped structure, and

FIG. 17 is a sectional detail taken along line **17—17** of FIG. 1.

With reference now to FIG. 1, the car comprises a body **20** which is supported on trucks which are represented by the wheels **21** shown in broken lines. The body **20** includes an underframe which, except for the side sills **22**, is of the usual construction. In other words, the underframe comprises a center sill **23**, the side sills **22**, and bolsters **44** and **45**, all of which are connected to each other by suitable cross bearers and floor beams, not shown. The bolsters **44** and **45** rest on the trucks in the usual manner.

The strength members of the body include the underframe in its entirety, as well as certain end piers and horizontal members as will be pointed out below, but the present invention is concerned with the underframe primarily to the extent that it may be represented by the side sills **22**.

As shown in FIG. 1, the car body **20** also includes a floor **25**, made up of transverse planks resting on the sills **22** and **23**, end walls **26**, and a roof **27**, all of which may be of the usual construction. As previously indicated, the body does not include the usual fixed sides; rather vertically slidable doors are provided as, for instance, the upper and lower doors **28** and **29** shown in FIG. 1.

The side sills **22**, as shown in FIG. 6 are fabricated channels, and comprise upper and lower angles **30** and **31** respectively which are connected by a web **32**, these three elements providing a side sill in the form of a beam which extends the full length of the car. The car ends **26** are spaced inwardly of the ends of the side sills **22**. Disposed longitudinally outwardly of the end walls are end piers **33**, each of which, as shown in FIG. 6 comprises an L-shaped member having a plate portion **34** and a transverse flange **35**.

The L-shaped member is "corner oriented" in the sense that plate portion **34** is inwardly directed in the longitudinal direction, and the flange **35** is inwardly directed in

the transverse direction. The corner orientation permits the end piers 33 to be arranged exteriorly of the side sills 22 so that the welded connection, hereinafter described, will constitute a "rigid" corner connection and will provide a "rigid" U-shaped structure 33–22–33. The car ends 26 are welded to the plate portions 34.

The upper ends of the piers 33 are connected by horizontal compression members 36 which are in the form of box beams. The compression members 36, as shown in FIG. 5 include a bottom plate 40, one edge 41 of which extends outwardly and abuts the longitudinal plate portion 34 of the pier 33.

Each compression member 36 is secured at each end to the piers 33 by welding at various points, such as the point where the edge 41 abuts the plate portion 34 of the pier, and at the points where the end of the box beam 36 abuts the flange 35 of the pier 33 as shown in FIG. 5. Also, the plate portion 34 of the pier 33 terminates at its upper end in a horizontal flange 49 which overlaps and is welded to a portion of the box beam 36 as shown in FIG. 5.

Referring now to FIGS. 2, 3 and 4 which show the strength members of the car divorced from the body, it will be seen that the car structure comprises two transversely spaced unit frames 42 and 43, each of which comprises a rigid U-shaped structure 33–22–33, and a compression member 36 disposed between and secured to the upper ends of the end piers 33. The supporting points for the two frames 42 and 43 are the bolsters 44 and 45 indicated diagrammatically in FIG. 3. The two unit frames 42 and 43 are connected by end sills 46.

In this unit frame type construction, when the car is loaded the members 36 are subjected to compressive stress which results in a greatly diminished flexure of the side sills 22.

In other words, assuming the absence of the compression member 36, flexure of the side sills 22 would result in inward canting of the end piers 33. However, by interposing the compression members 36 between the upper ends of the piers 33, the flexure of the side sills 22 is substantially reduced.

Furthermore, in addition to greatly stiffening the car structure against flexure, the present arrangement maintains the end piers 33 in parallelism with each other so that they can be used as a part of the door mounting means.

The roof 27 includes end transoms 47 and inside transoms 48. The roof structure 27 and the end sills 46 provide lateral stability for the two unit frames 42 and 43, and additional cross bracing may be provided between the compression members 36, if necessary.

Vertically extending door guides 50 are mounted on each of the end piers 33, only one being shown in FIG. 1, which provide channels for receiving both the upper and lower doors 28 and 29. The upper and lower doors 28 and 29 may be actuated by suitable mechanism which includes a door actuating wheel 61.

Since the unit frames 42 and 43 are subject to much less deflection under load than the side sills of the usual car construction, the end piers 33, which are rigidly mounted at right angles to the side sills 22, are therefore maintained in substantial parallelism with the result that the door guides 50 which are mounted on the end piers also will be maintained in substantial parallelism which permits the use of vertically sliding doors without encountering any binding.

The compression members 36 and side sills 22 are preferably abutted up against and welded to the end pier flange 35 as shown in FIGS. 5 and 6. The web 32 overlaps and is welded to the plate portion 34, and the angles 30 and 31 abut and are welded to the flange 35. A modification is shown in FIG. 7 in which the web 32 is butt welded to the side edge of the end pier 33 at 51 so that the overlapping welded connection 52 is between the angles 30–31 and the plate portion 34. The angles 30 and 31 are abutted and welded to the flange 35 at points 53 and 54.

This abutting and welded relationship of the angles 30–31 and the flange 35, in combination with the welding of the overlapping parts, affords a much more rigid corner connection than that which can be obtained by the welding of only the overlapping parts 34 and 32, or 34 and 30–31, as the case may be.

In some instances, it is desirable to prestress in tension the unit frames 42 and 43 prior to final assembly. After the underframe has been assembled and the end piers 33 secured to the side sills 22, as shown in FIG. 6, the underframe is loaded up to a certain proportion of its rated load. Then the compression members 36 are welded to the piers 33 to complete the unit frames. In the alternative, the upper ends of the end piers 33 may be pushed toward each other.

A modified unit frame is shown in FIGS. 8 to 12 in which the rigid U-shaped structure 33'–22'–33' is identical to that of FIGS. 1 to 4, but the compression members 70 are offset inwardly toward the center of the car. Thus, each unit frame is not coplanar, but the arrangement shown is found to be substantially as effective as the arrangement shown in FIGS. 1 to 4.

As shown in FIGS. 8 and 9, a transverse anchor 71 in the form of a cross beam connects the upper ends of the two end piers 33' at each end of the car, and the compression members 70 bear against the anchors 71 and are secured thereto. Here the compression members may be in the form of an I-beam, and the manner of association is shown in FIG. 12.

According to this arrangement, side plates 72 are provided for supporting the car roof 73, and the assembly comprising the car roof and side plates is supported from the compression members 70 by means of the transoms, not shown.

In the arrangement of FIGS. 1 to 4, the compression member 36 serves as the side plate and supports the roof structure directly. However, an advantage of the modified arrangement of FIGS. 8 to 12 is that the offsetting of the compression members 70 from the separate side plates 72 permits the use of roll up doors 74 which, as shown in FIG. 11, may be accommodated in the space between the side plates 72 and the compression members 70. The door guides 75 may be mounted on the car end 26', and may comprise a continuous pathway for both doors, or a separate pathway for each door may be provided.

The roll up door 74 may be in the form of a single door extending the full width of the car, or a plurality of doors, in which case a separate set of door posts is provided at various intermediate points. However, due to the rigidity of the car structure it is not necessary to provide intermediate strength members, with the result that the door posts may be removably secured with respect to car frame, and curved door guides may be provided at the intermediate points without danger of getting out of alignment due to deflection under load.

As shown in FIGS. 8 to 12, the offsetting of the compression members 70 is comparatively small with respect to the length of the transverse anchor 71 so that practically all of the force transmitted by each compression member will be transmitted to the closest adjacent end pier 33'. As a result the bending moment of the transverse anchor in a horizontal plane is comparatively small; it may be arranged either with the flanges vertical, as shown, or with the flanges horizontal.

In operation, the lower corner connection shown in FIG. 6 is extremely rigid with the result that all three members 33, 22, 33 can be considered as a single U-shaped beam 33–22–33 exhibiting continuity of bending moment transmitting properties, just like a continuous beam. As a result of the unit frame construction, the end piers 33 and the car ends 26 are maintained in substantial parallelism, which permits the use of vertically

sliding doors which fit tightly against the floor, and the elimination of all supplementary strength members permits direct loading. For instance, 50-foot lengths of lumber can be loaded into a car constructed in accordance with this invention.

For use with lading of smaller dimensions, one or more movable bulkheads **65** may be provided as shown in FIG. 1. The bulkhead **65** may be supported by a trolley **66** which rides on flanges **67** which are provided by extending inwardly the bottom plates **40** of the box beam compression members **36**, and suitable means, not shown, may be provided for locking the bulkheads **65** in a given position.

In connection with the prestressing operation during assembly, the side sills **22** preferably are given a slight camber to offset the deflection under the prestressing load so that in the finally assembled unit frame the end piers **33** will be parallel to each other. Thus, the desired parallelism and rectangular relationship of the various frame elements for door fitting purposes may be maintained even though such elements are prestressed in a direction which opposes the load stress.

In FIG. 13, the shaded areas show the bending moments **60** due to the frame stress S, exerted by the compression member. The frame stress S is developed only when the structure **33–22–33** is loaded. The curved dotted lines **61** indicate that there is no discontinuity at the corners C.

In FIG. 14, the load is assumed for purposes of illustration to be a concentrated load stress L, and the reactions R are indicated at the bolster points. The load stress bending moments are indicated by the dotted line triangle **62**. This FIG. 14 illustrates the manner in which the frame stress bending moments **60** offset the load stress bending moments **62**; the shaded areas show the net bending moments **63**. The FIG. 13 diagram has been unfolded in FIG. 14 for the purpose of illustrating the continuity of the bending moments.

By virtue of the offsetting, the bending moment at the center point D has been very substantially reduced, from M*d* to M'*d*.

The corner connection C requires special attention due to danger of overstressing; it is analogous to a dangerous section. End pier sections must be selected which are quite heavy with respect to the side sill section at the center point D, and the corner connection should be as stiff as at least one of the adjacent sections in order to transmit the corner bending moment Mc.

As a general parameter, it has been found that the effective moment of inertia (I_{33}) of the end pier should be between 25% and 75% of the moment of inertia (I_{22}) of the side sill at the center point D. A design is preferred which calls for an I ratio (I_{33}/I_{22}) at the lower end of this range, in order to avoid overstressing of the corner connection C, although higher values can be utilized if the rigid U-shaped structure **33–22–33** is prestressed in tension.

FIG. 15 shows the frame stress bending moments **64** of an unloaded unit frame which is prestressed in tension. Due to the prestress, which is positive, the frame stress under load, which is negative, will be correspondingly reduced, thus providing a means for reducing the corner bending moment, Mc, of FIG. 14. Therefore, prestressing provides latitude of design while still maintaining low values of Mc with respect to M*d*.

The unit frame construction distributes the impact stress to the corner connections at both ends of the car; when the unit frame is prestressed, not only are the corner bending moments reduced at the forward end of the car, but the impact stress is shared approximately equally by both ends of the car.

Two practical examples are given below of the magnitudes involved in the design of a rigid U-shaped structure according to this invention for a 50-foot 70 ton car with 42 foot bolster spacing. In the first, the I ratio is substantially 40%, and in the second, it is about 30%.

In the embodiment of FIGS. 1–4, the side sill **22** is 28 inches deep and has a moment of inertia of about 3000 in.^{4}. The end pier **33** has a depth dimension of 27 inches (half inch plate, 6½ inch flange) and a moment of inertia of 1200 in.^{4}. Since the plate portion **34** is welded to the car end **26**, the effective moment of inertia of the end pier **33** at points above the side sill is somewhat greater, but the value for the section immediately adjacent the corner connection is substantially 1200 in.^{4}.

FIG. 16 shows the invention as applied to a fishbelly type of side sill. The rigid U-shaped structure **33''–22''–33''** was designed for roll up doors (FIGS. 8–11) and had a corner connection as shown in FIG. 7. Here, the moment of inertia at the middle portion (29 inches deep) of the side sill **22''** was about 3600 in.^{4}, and at the reduced end portions (18½ inches deep) about 1100 in.^{4}. The L-shaped end pier **33''** had a depth dimension of 24 in. (⅜ inch plate, 6 inch flange) and a moment of inertia of about 670 in.^{4}. The lower portion of the end pier **33''** was stiffened by a heavy gusset strip **55** welded to the external surface of the plate portion **34**, and a lighter gusset strip (not shown) was applied externally to the flange **35**, bringing the total moment of inertia up to about 1240 in.^{4}. These gusset strips extended for about one-third of the height (12 feet) of the end pier **33''**, so as to overlap the car end. Above the gusset strips, the welded connection between the end pier and the car end was utilized to increase the effective moment of intertia up to about 1200 in.^{4}.

In effect, therefore, the end pier **33** is a channel with one flange cut away at its lower end to provide a corner oriented L-shaped section which cooperates with the side sill to provide the rigid corner connection. If the moment of inertia of the L-shaped portion at the immediately adjacent section is insufficient, additional stiffening means may be provided, either in the form of a gusset strip **55** as shown in FIG. 16, or by extending the door guide **50** downwardly below the bottom of the car end **26** as shown in FIG. 1.

The compression members **36** and **70** in both instances were much lighter than the end piers **33**, the moment of inertia ranging from 250 in.^{4}, up to 426 in.^{4}.

Although only preferred embodiments of this invention have been shown and described herein, it will be understood that various modifications and changes may be made in the constructions shown without departing from the spirit of this invention as pointed out in the appended claims.

We claim:

1. An open side railway car characterized by the absence of intermediate roof supporting members comprising an underframe, load receiving means mounted on said underframe, an upright rigid U-shaped structure located at either side of said car, and a horizontal compression member connecting the open end of each of said U-shaped structures in order to provide two transversely spaced substantially vertical unit frame, each U-shaped structure comprising a side sill which forms a part of said underframe, and a vertically arranged end pier at each end of said side sill, the effective moment of inertia of the lower portion of said end pier being between one-fourth and three-fourths of the moment of inertia of the central portion of said side sill, said side sills being initially cambered and said unit frames being initially prestressed so that said compression members are under tension when the car is not loaded.

2. An open side railway car as claimed in claim **1** which includes car ends supported by said underframe, said end piers being located longitudinally externally of said car ends so that the lading space immediately adjacent said car ends is unobstructed in the transverse direction, said unit frames outlining side openings for said car which are

available for direct loading, and door means for closing said side openings.

3. An open side railway car as claimed in claim 1 which includes door guides located at the ends of said car, and a vertically sliding door mounted for engagement with one of said door guides.

4. An open side railway car as claimed in claim 3 in which said door guides comprise a pair of oppositely disposed angles mounted on said end piers, and in which said vertically sliding door extends for substantially the full length of said car and engages both of said door guides.

5. A railway car structure as claimed in claim 3 in which said vertically sliding door is an articulated door of the roll up type, and in which said door guides comprise curved tracks mounted on said car ends.

6. An open side railway car as claimed in claim 1 in which said end piers each comprise a corner oriented angle having a flange and a plate portion, said plate portions being disposed externally of said side sills, and the ends of said side sills abutting and being welded to said flanges.

7. An open side railway car as claimed in claim 6 in which said compression members comprise beams disposed inwardly of said plate portions, the ends of said beams abutting and being welded to said flanges.

8. An open side railway car as claimed in claim 1 which includes a transverse anchor for said compression members, said transverse anchor comprising a horizontally disposed structural member connecting the upper ends of the end piers at each end of the car, said compression members being secured at their ends to said transverse anchors and each being offset transversely inwardly from the plane of its associated U-shaped structure.

9. An open side railway car as claimed in claim 1 in which said end piers each terminate at its lower end in a corner oriented L-shaped portion having a flange and a plate portion which is disposed externally of a side sill, and in which each side sill is a fabricated channel comprising a plate and upper and lower angles, the ends of said angles abutting and being welded to said flanges at the lower ends of said end piers.

10. An open side railway car as claimed in claim 1 in which said rigid U-shaped frame structure includes means providing rigid lower corner connections between said side sill and said end piers, each rigid lower corner connection being constructed and arranged to transmit the bending moment at the immediately adjacent section of said end pier to the immediately adjacent section of said side sill.

11. An open side railway car as claimed in claim 1 which includes car ends supported by said underframe, and in which said end piers each comprise a vertically disposed corner oriented angle having a flange and a plate portion, said flanges being disposed externally of said car ends and said plate portions being disposed externally of said side sills, said plate portions being welded at their inner edges to said car ends in order to stiffen said end piers, and the ends of said side sills abutting said flanges and being welded thereto.

12. An open side railway car as claimed in claim 11 which includes vertically arranged stiffening means secured to the lower external surfaces of the plate portions of said end piers at points opposite said car ends, and extending downwardly below the bottom of said car ends to compensate for the lack of the flange effect provided by the welding of said car ends to said plate portions.

13. An open side railway car as claimed in claim 1 in which the ratio of said moments of inertia is substantially one to three.

14. An open side railway car as claimed in claim 1 which includes a roof structure supported by said horizontal compression members, and end sills connecting the end piers at each end of the car, said unit frames being reinforced laterally by said roof structure and said end sills.

15. An open side railway car comprising a floor structure, car ends, a roof structure, and a structural unit for supporting said floor structure, car ends, and roof structure, said structural unit comprising a rectangular unit frame, said unit frame comprising upper and lower horizontal members and two vertical members, of which said lower horizonal member is a side sill of the railway car, and of which said vertical members are end piers rigidly secured to the ends of said side sill in perpendicular relationship to provide a rigid U-shaped structure, said side sill being initially cambered so that prior to assembly with said upper horizontal member said end piers are upwardly diverging, said rigid U-shaped structure having been loaded during the said assembly operation to provide a prestressed unit frame having parallel end piers, and in which said upper horizontal member is under tension when said car is empty, the rated loading of said car tending to offset the prestressing of said unit frame to reduce the bending moments at the corner connections between said end piers and said side sill.

16. An open side railway car comprising a floor structure, car ends, a roof structure, and a structural unit for supporting said floor structure, car ends, and roof structure, said structural unit comprising a rectangular unit frame, said unit frame comprising upper and lower horizontal members and two vertical members, of which said lower horizontal member is a side sill of the railway car, and of which said vertical members are end piers, and means providing a rigid lower corner connection constructed and arranged to transmit the bending moment at the immediately adjacent section of each end pier to the immediately adjacent section of said side sill to provide a rigid U-shaped structure, whereby the deflection of said side sill under load will stress said upper horizontal member in compression so that the bending moments of said side sill due to load stress will be reduced, said unit frame having been prestressed so that said upper horizontal member is under tension when said car is empty, the rated loading of said car tending to offset the prestressing of said unit frame to reduce the bending moments at said rigid lower corner connections.

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