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Bembridge et al.

[11] **3,713,399**

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[54] TANK CAR

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[52] **U.S. Cl.** **105/358,** 105/248, 105/362, 105/410, 105/413

[51] **Int. Cl.**.....**B61d 5/02,** B61d 5/06

[58] **Field of Search**.....105/358–362, 404, 105/410, 413, 425, 248

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[57] **ABSTRACT**

A hopper-type railroad tank car having a longitudinally extending tank shell supported upon a pair of shortened stub center sill assemblies, one at each end, and a plurality of hopper compartments spaced at intervals along the length of the car. Each hopper compartment communicates with a bottom outlet, cut-out of the tank shell. The inboard edges of the center sills are positioned outboard of the respective end-most hopper outlets. An end reinforcing structure is provided to transmit horizontal and vertical loads from the center sills to the tank shell and to transmit bending moments applied to the end of the car to the tank shell.

18 Claims, 4 Drawing Figures

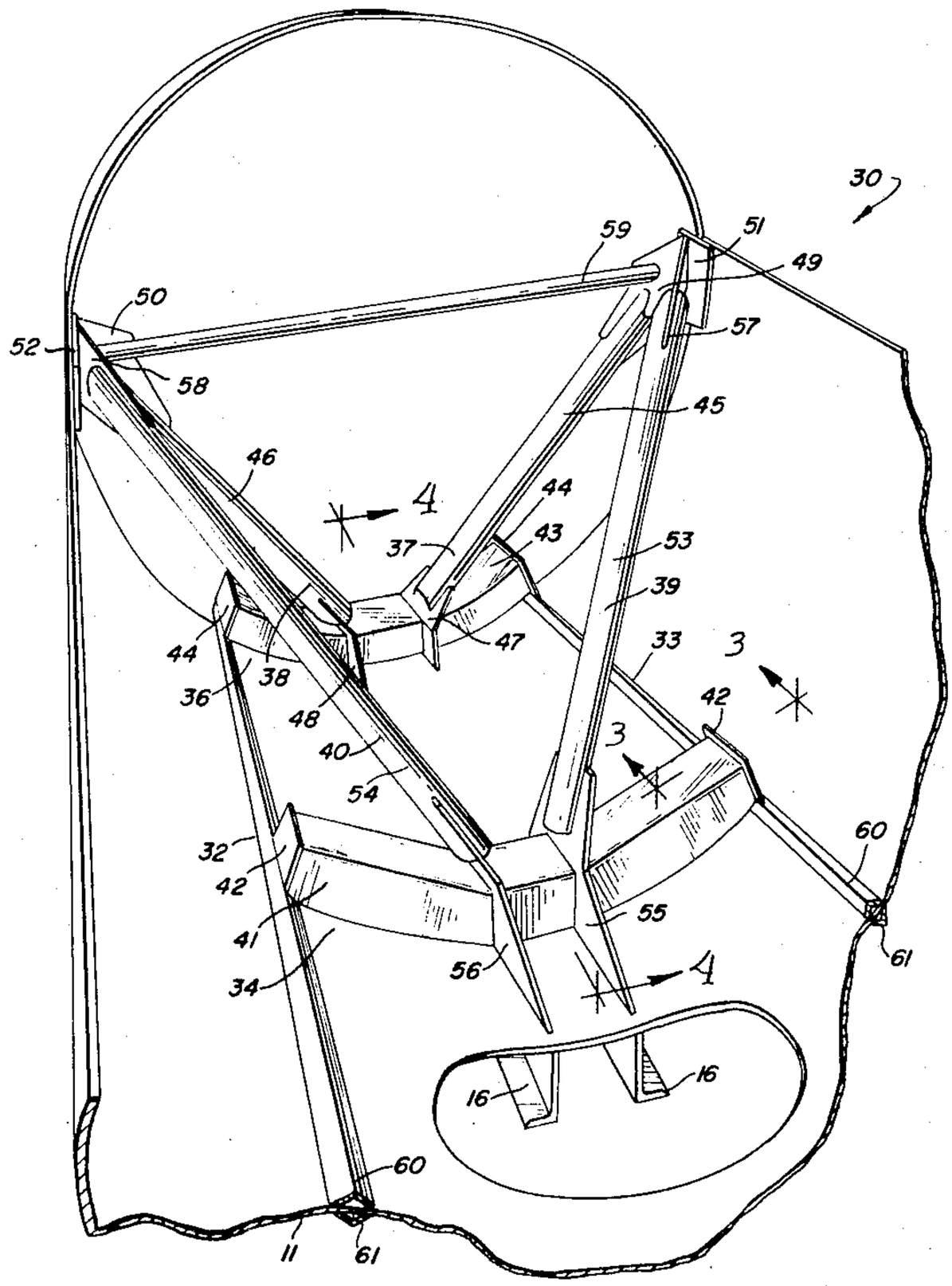

FIG. 1

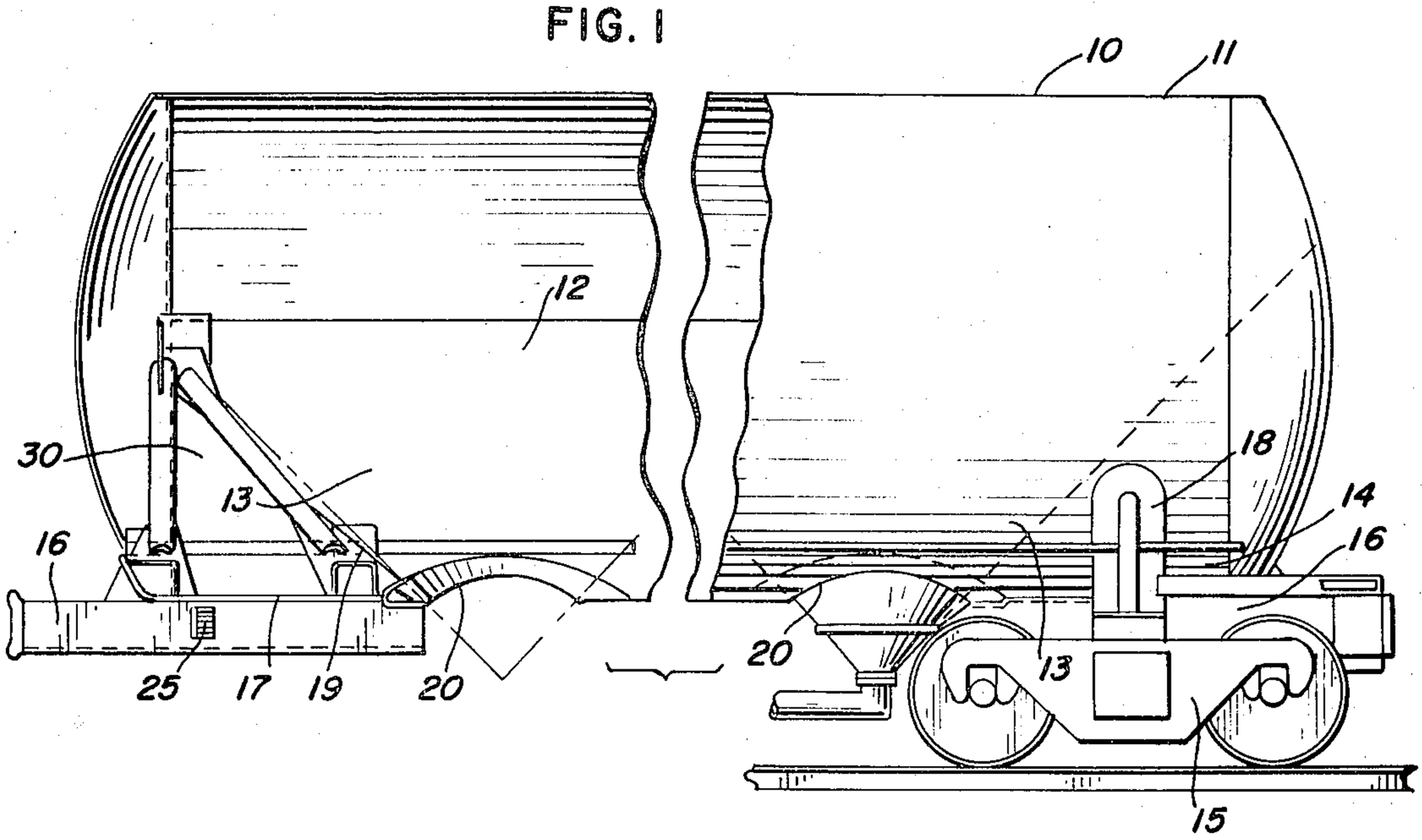

FIG. 3

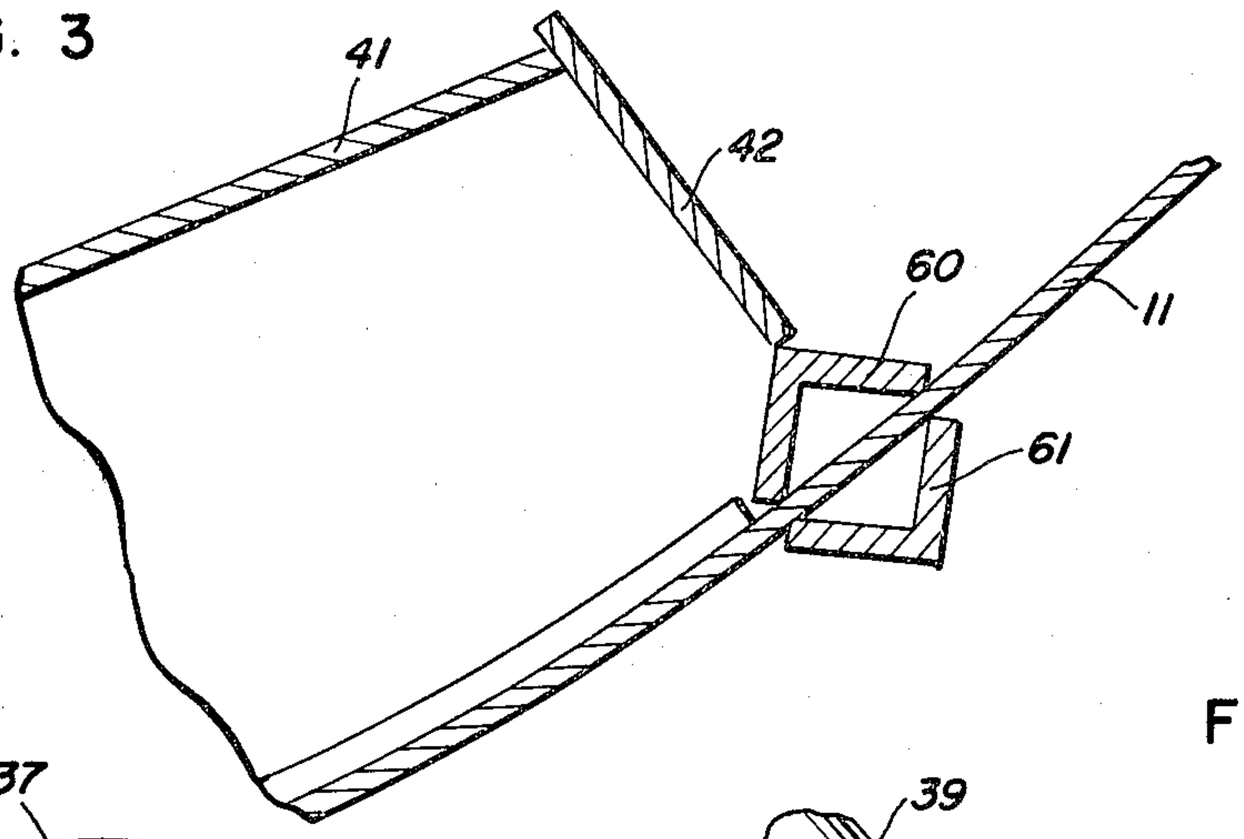

FIG. 4

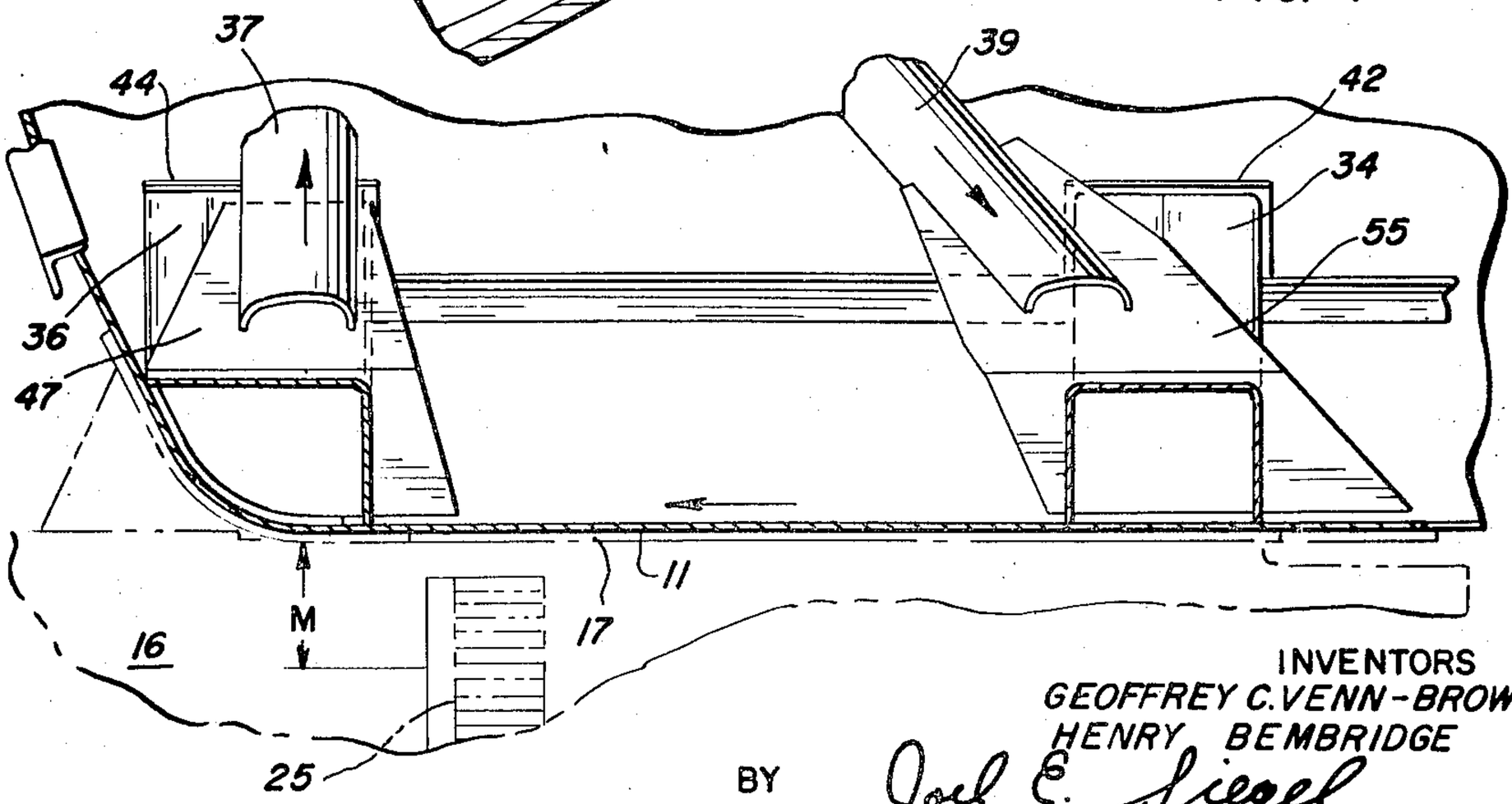

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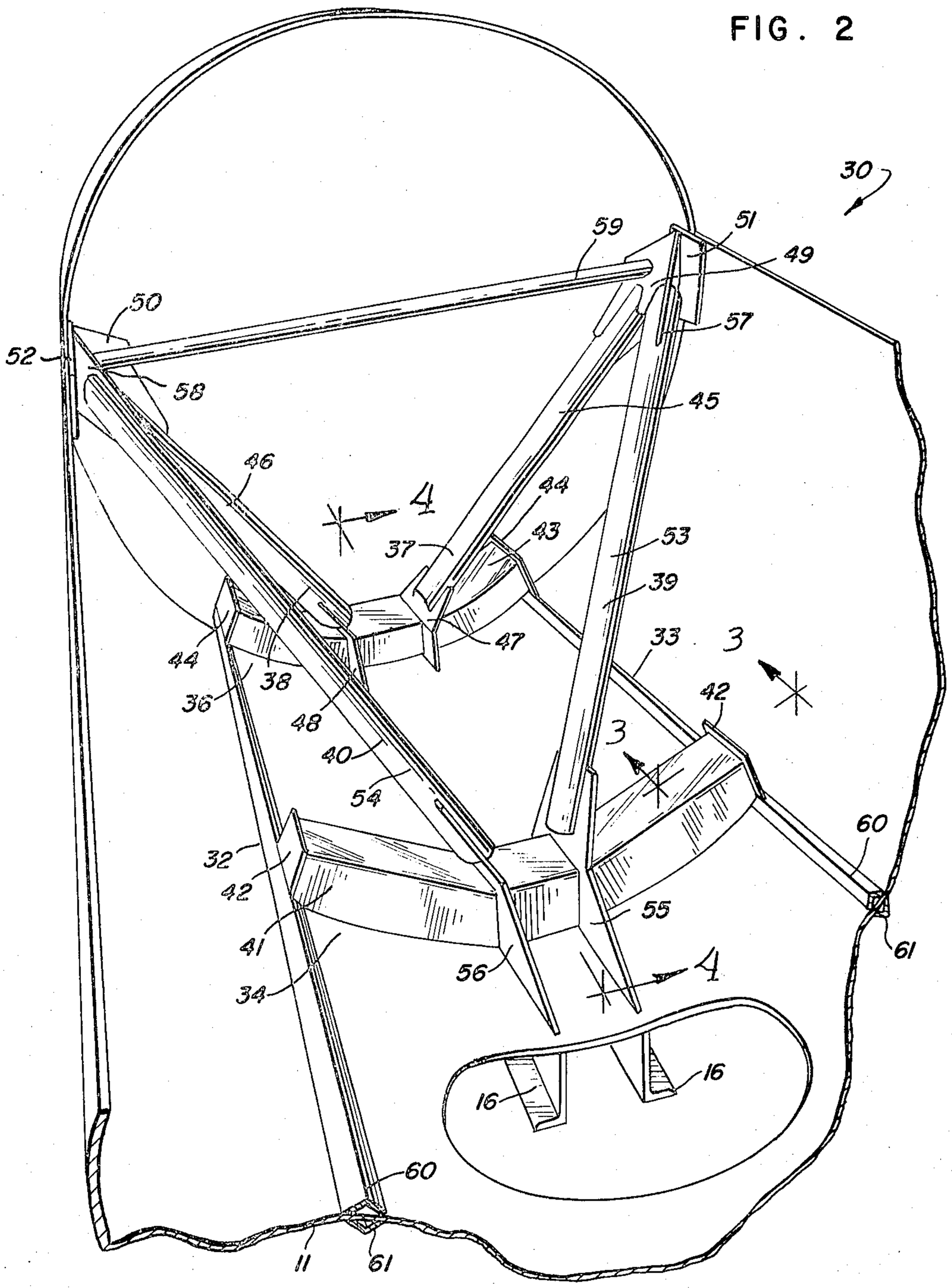
FIG. 2



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TANK CAR

BACKGROUND OF THE INVENTION

This invention relates to railroad tank cars and more particularly to an improved end reinforcing structure for use in railroad tank cars generally of the hopper-type.

Hopper-type railroad tank cars have heretofore included a pair of stub center sill assemblies, associated with the respective ends of the tank shell, which have extended inboard beyond the two end hopper compartments. This structural arrangement has been necessary to permit the car to handle the A. A. R. coupler loads, side bearing loads and jacking loads. Since the center sills have extended inboard beyond the end hopper compartments it has been necessary to raise the two end compartments to a level above the intermediate compartments to prevent interference with the center sills. This has resulted in the following problems: reduced product capacity; precludes the utilization of removable aeration equipment; and causes inaccessibility to the end hopper compartments, which results in assembly, clean-out, maintenance and operation difficulties. It further requires the use of a bent discharge pipe which causes clean-out difficulties and other problems when handling abrasive products.

It has been found from experience, that on railroad tank cars the introduction of horizontal forces at the joint between the draft sills and the tank shell causes considerable creep in the shell at the inboard tip of the sills and that the amount of creep depends on the length of the joint. In order to permit the two end compartments to be positioned at the same level as the intermediate compartments it is necessary to reduce the length of the center sills and thus considerably reduce the length of the center sill/shell joint. This reduction joint length causes severe problems in and around the end-most compartments and their reinforcing plates. The reinforcing structure of the present invention is specifically designed to solve these problems.

SUMMARY OF THE INVENTION

It is the principle object of the present invention to provide a hopper-type railroad tank car which permits easy access to the end hopper compartments.

Another object is to provide a hopper-type railroad tank car having its end-most hopper compartments at the same level as its intermediate hopper compartments to facilitate assembly, clean-out, maintenance and operation.

A further object is to provide a hopper-type railroad tank car which permits the utilization of removable aeration equipment at the end-most hopper compartments.

A still further object of the present invention is to provide a railroad tank car, having shortened draft sills, that is capable of carrying A. A. R. coupler loads, side-bearing loads and jacking loads.

Another object is to provide a railroad tank car that includes an end reinforcing structure which transmits horizontal and vertical loads from the center sill to the tank shell and which transmits bending moments applied to the end of the car to the tank shell.

The present invention provides a railroad tank car having a longitudinally extending tank shell supported upon a pair of stub center sill assemblies, one at each

end, and a plurality of hopper compartments spaced at intervals along the length of the car. Each hopper compartment communicates with a bottom hopper outlet, cutout of the tank shell. The inboard edges of the center sills are positioned outboard of the respective endmost hopper outlets to permit easy access thereto. A unique end reinforcing structure is provided to transmit horizontal and vertical loads from the draft sill to the tank shell and to transmit bending moments applied to the end of the car to the tank shell. The end reinforcing structure comprises: a pair of longitudinally extending stiffener assemblies attached to the tank shell, one on each side of the center sill assembly; a transversely extending outboard box-section attached to the tank shell adjacent the end portion thereof and a transversely extending inboard box-section attached to the tank shell positioned inboard of the first box-section and outboard of the end hopper outlet; a pair of outboard load carrying members, having opposite slopes, diagonally extending upward and outwaRdly from the tank shell portion adjacent the center sill to a pair of opposing points on the tank shell, such that a vertical plane passes through the outboard members and the outboard box-section; and a pair of inboard load carrying members extending upward and outwardly from the tank shell portion adjacent the center sill and the inboard box-section to the pair of opposing points on the tank shell. The outboard and inboard box-sections and the tank shell therebetween form a curved shear girder to receive a horizontal load and distribute it to the tank shell via the longitudinally extending stiffener assemblies. The outboard load carrying members and the inboard load carrying members act as a torsion box to transmit bending moments to the tank shell.

DESCRIPTION OF THE DRAWINGS

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following description of a preferred embodiment of the invention, as illustrated in the accompanying sheets of drawings, in which:

FIG. **1** is a side elevational view of a hopper-type railroad tank car illustrating an end portion embodying features of the present invention;

FIG. **2** is a perspective view of the end portion of the tank car of FIG. **1** showing the unique end reinforcing structure of the present invention;

FIG. **3** is a vertical sectional view taken along line **3—3** in FIG. **2** illustrating one of the longitudinally extending stiffeners and a portion of the inboard box-section; and

FIG. **4** is a vertical sectional view taken along line **4—4** in FIG. **2** illustrating the structural connections between the inboard and outboard load carrying members and the inboard and outboard box-sections.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. **1**, there is shown a hopper-type railroad tank car generally designated by the numeral **10**. The tank car **10** is preferably comprised of a reinforced, relatively thin shelled tank **11** that serves as the confining enclosure for a conventional hopper structure **12**. Hopper structure **12** includes a plurality of generally conically shaped hopper compartments **13**. The structural details are substantially identical for cars

having from three to seven hopper compartments, except for the number of hoppers. The reinforced tank **11** is supported at its opposite ends by a combined draft rigging and body bolster assembly **14**. Assembly **14** functions both as the supporting means for the ends of the tank **11** and as the means for linking the tank to conventional truck assemblies **15**.

Each of the assemblies **14** includes a pair of spaced apart support channels or center sills **16**. The center sills **16** provided at each end of the tank **11**, are secured to a tank reinforcing plate **17** which is welded or other wise secured to the underside of the tank adjacent the corresponding end thereof. Aligned peripheral side portions at each end of the tank **11** are reinforced by suitable saddle plates **18** that are preferably integrally secured to the tank. These saddle plates **18** extend from adjacent the reinforcing plates **17** to a location approximately midway up the sides of the tank, and the plates **18** cover a sufficient area so that local stress concentration in the tank shell is minimized. It will be appreciated that the draft gears, truck assemblies, and other conventional components typically employed in railroad tank cars would be suitably joined to the aforedescribed tank supporting structure to complete the car for operation. A rear draft stop **25** secured to the inner surfaces of center sills **16** abuts the rear end of the draft gear and coupler structure (not shown) and transmits forces to the center sills **16** from the draft gear and coupler structure upon buff and impact loads exerted against the coupler.

Each of the hoppers **13**, which are defined by plate members **19** that are welded or otherwise suitably secured to the internal surface of tank **11**, communicates with a lower discharge outlet port **20** cutout of the bottom of shell **11**. All of the outlet ports **20** are substantially at the same level to maximize commodity capacity and facilitate assembly, clean-out, maintenance and operation. As seen in FIG. **1**, the center sills **16** at each end of tank shell **11** are shortened such that their inboard edges are positioned outboard of the adjacent end-most hopper outlets **20**. This reduction in center sill length, and the consequential reduction in center sill/shell joint, tends to cause considerable creep in the shell at the inboard tip of the sill, which results in severe problems in the welds in and around the end-most hopper outlets **20**.

In accordance with the present invention, an end reinforcing structure **30** is provided at each end of tank car **10** which transmits horizontal and vertical loads from the center sill assemblies **16** to the tank shell **11** and which transmits bending moments applied to the end of the car to the tank shell **11**. As shown in FIGS. **2–4** reinforcing structure **30** includes: a pair of longitudinally extending stiffener assemblies **32** and **33**; inboard and outboard transversely extending box-sections **34** and **36** respectively; a pair of outboard load carrying members **37** and **38**; and a pair of inboard load carrying members **39** and **40**. Referring to FIGS. **2** and **3**, stiffener assemblies **32** and **33** each include longitudinally extending internal and external angle stiffeners **60** and **61** respectively, secured to and sandwiching shell **11** therebetween in a suitable manner, as by welding. Stiffeners **60** and **61** preferably extend from approximately the tank line to a point inboard of the end-most outlets **20**. Stiffener assemblies **32** and **33** are parallel to center sill assemblies **16**, one on each side thereof, and are spaced apart by a distance greater than the outer dimension of the end-most hoppers **20**.

Referring to FIGS. **2** and **4**, inboard box-section **34** includes a transverse channel shaped member **41**, which is positioned on the bottom surface of shell **11** and extends between stiffener assemblies **32** and **33** and is slightly outboard of the end-most outlets **20**. End plates **42** close off the open ends of member **41** and are suitably secured to internal stiffeners **41**. Outboard box-section **36** includes a transverse angle member **43** which is positioned on the bottom surface of shell **11** and extends between stiffener assemblies **32** and **33**, and is positioned approximately at the tan line of tank car **10**. The tank head and tank shell close off member **43** to form a box-section **36** similar to box-section **34**. End plates **44** close off the open ends of member **43** and are sutiably secured to internal stiffeners **41**. Back-up bars **35** may be provided to reinforce the structural connection between the bottom surfaces of box-sections **34** and **36** and the inner surface of shell **11**.

Outboard load carrying members **37** and **38** each include a tubular pipe section **45** and **46** respectively, extending upward and outward from the tank shell portion adjacent center sills **16**. Pipes **45** and **46** have opposite slopes and are spaced a greater distance apart at their upper ends than at their lower ends, as seen in FIG. **2**. The lower ends of pipes **45** and **46** are respectively secured to gusset plate **47** and **48** which in turn pass through box-section **36** and are secured to tank shell **11**, one immediately above each of the center sills **16**. A substantially vertical plane passes through members **37** and **38** and box-section **36**. The upper ends of pipes **45** and **46** are respectively secured to gusset plates **49** and **50** which in turn are respectively secured to a pair of opposing points on tank shell **11**. Reinforcing plates **51** and **52** are provided at the points where plates **49** and **50** are attached to shell **11**, which are approximately midway up the tank sidewalls. A transverse pipe **59**, attached at its respective ends to gussets **49** and **50**, extends between the upper ends of members **37** and **38**.

Inboard load carrying members **39** and **40** each include a tubular pipe section **53** and **54** respectively, extending upward and outward from a portion of the tank shell adjacent center sills **16** and the box-section **34**, to plates **51** and **52** respectively. The lower ends of pipes **53** and **54** are respectively secured to gusset plates **55** and **56** which in turn pass through box-section **34** and are secured to tank shell **11**, one immediately above each of the center sills **16**. The upper ends of pipes **53** and **54** are respectively secured to gusset plates **57** and **58** which are in turn respectively secured to reinforcing plates **51** and **52**.

Referring to FIG. **4**, the load paths of the forces upon impact loads are illustrated by appropriate arrows. A moment arm M exists between the center line of the rear draft stop **25** and the weld between the shell **11** and sills **16** upon the introduction of longitudinal loads at stop **25**. The reaction to the longitudinal load occurs at the weld between shell **11** and sills **16**. This moment causes a tensile force in outboard load carrying members **37** and **38** transmitted from center sills **16** via plates **47** and **48**. Resulting reaction forces appear in inboard load carrying members **39** and **40** and pass to

the sills **16** via plates **55** and **56**. Because the inboard load carrying members and the outboard load carrying members are positioned so that their center line intersect at plates **51** and **52**, both the vertical and transverse components of the forces cancel each other out at this point. The remaining component is longitudinal, and is transmitted to shell **11** via plates **57** and **58** and plates **51** and **52**. Transverse pipe **59** theoretically carries no structural loads, but is included for stiffening purposes and to carry any structural loads resulting from construction eccentricities. Outboard load carrying members **37** and **38** and inboard load carrying members **39** and **40** act as a torsion box so as to transmit bending moments to tank shell **11**.

Horizontal longitudinal loads that are applied to car **10** at the joint between sills **16** and shell **11** are distributed to the tank shell **11** by a resulting shear girder made up of box-sections **34** and **36** and the portion of shell **11** therebetween. Most of the load is removed from the portion of shell **11** between box-sections **34** and **36** and distributed to a larger portion of shell **11** by stiffener assemblies **32** and **33**. As seen in FIG. **3** stiffener assemblies **32** and **33** each include angle stiffeners **61** and **62** sandwiching shell **11** therebetween. In this arrangement, the neutral axis of the stiffeners **32** and **33** in the plane of shell **11** coincides with shell **11**, where the load is applied and removed by the stiffeners **32** and **33**. Thus, there will be no major bending moments applied to stiffeners **32** and **33**.

Although the preferred embodiment is disclosed in conjunction with a hopper-type railroad tank car it is contemplated that end reinforcing structure **30** of the present invention is equally applicable for use in conventional railroad tank cars to transmit horizontal and vertical loads from the center sill to the tank shell and to transmit bending moments applied to the end of the car to the shell. Various modifications are contemplated and may obviously be resorted to by those skilled in the art without departing from the spirit and scope of the invention, as hereinafter defined by the appended claims, as only a preferred embodiment thereof has been disclosed.

What is claimed is:

1. In a railroad tank car having a longitudinally extending tank shell supported upon a pair of stub center sills, one at each end; an improved end reinforcing structure to transmit horizontal and vertical loads from the center sill to the tank shell, comprising:

a. a pair of longitudinally extending stiffener assemblies attached to said tank shell, one on each side of said center sill;

b. a first transversely extending structural member attached to said shell adjacent the end portion thereof and a second transversely extending structural member attached to said tank shell positioned inboard of said first structural member;

c. a pair of outboard load carrying members, having opposite slopes extending upward and outward from said tank shell portion adjacent said center sill to a pair of opposing points on said tank shell, such that a substantially vertical plane passes through said outboard members and said first structural member; and

d. a pair of inboard load carrying members extending upward and outward from said tank shell portion adjacent said center sill and said second structural member to said pair of opposing points on said tank shell;

e. said first and second structural members and the tank shell portion therebetween forming a curved shear girder to receive a horizontal load and distribute it to said tank shell via said longitudinally extending stiffener assemblies;

f. said outboard load carrying members and said inboard load carrying members acting as a torsion box so as to transmit bending moments to said tank shell.

2. The invention of claim **1** further including a transverse structural member attached at its ends to said opposing points of said tank shell.

3. The invention of claim **1** wherein said outboard load carrying members and said inboard load carrying members each have connector plates associated with their respective ends, said connector plates associated with the bottom ends of said outboard load carrying members pass through said second structural member and are secured to said tank shell immediately above said center sill, and said connector plates associated with the bottom ends of said inboard load carrying members pass through said first structural member and are secured to said tank shell immediately above said center sill.

4. The invention of claim **3** wherein said connector plates associated with the tops ends of said outboard load carrying members and said inboard load carrying members are secured to said tank shell at said opposing points.

5. The invention of claim **4** wherein a wear plate is secured to said tank shell at said opposing points to receive said connector plates secured to said tank shell at said opposing points.

6. The invention of claim **1** wherein each of said stiffener assemblies includes an internal angle stiffener member secured to the internal surface of said shell and external angle stiffener member secured to the external surface of said shell, said internal stiffener member and said external stiffener member sandwich a portion of said shell therebetween.

7. In a hopper-type railroad tank car including a longitudinally extending tank shell supported upon a pair of stub center sills, one at each end; a plurality of hopper compartments spaced at intervals along the length of said tank shell, each communicating with a bottom hopper outlet cut-out of said tank shell, the inboard edges of said center sills being positioned outboard of the respective endmost hopper outlets to permit said hopper outlets to be positioned all at substantially the same level; and end reinforcing structure means associated with each end of said tank shell to transmit horizontal and vertical loads from said center sill to said tank shell; said end reinforcing structure comprising:

a. a pair of longitudinally extending stiffener assemblies attached to said tank shell; one on each side of said center sill;

b. a first transversely extending box-section attached to said tank shell adjacent the end portion thereof and a second transversely extending box-section attached to said tank shell positioned inboard of said first box-section and outboard of said end hopper outlet;

c. a pair of outboard load carrying members, having opposite slopes, extending upward and outward from said tank shell portion adjacent said center sill to a pair of opposing points on said tank shell, such that a substantially vertical plane passes through said outboard members and said first box-section; and

d. a pair of inboard load carrying members extending upward and outward from said tank shell portion adjacent said center sill and said second box-section to said pair of opposing points on said tank shell;

e. said first and second box-sections and the tank shell therebetween forming a curved shear girder to receive a horizontal load and distribute it to said tank shell via said longitudinally extending stiffener assemblies;

f. said outboard load carrying members and said inboard load carrying members acting as a torsion box so as to transmit bending moments to said tank shell.

8. The invention of claim **7** further including a transverse structural member attached at its ends to said opposing points of said tank shell.

9. The invention of claim **7** wherein said outboard load carrying members and said inboard load carrying members each have connector plates associated with their respective ends, said connector plates associated with the bottom ends of said outboard load carrying members pass through said second box-section and are secured to said tank shell immediately above said center sill, and said connector plates associated with the bottom ends of said inboard load carrying members pass through said first box-section and are secured to said tank shell immediately above said center sill.

10. The invention of claim **9** wherein said connector plates associated with the tops ends of said outboard load carrying members and said inboard load carrying members are secured to said tank shell at said opposing points.

11. The invention of claim **10** wherein a wear plate is secured to said tank shell at said opposing points to receive said connector plates secured to said tank shell at said opposing points.

12. The invention of claim **7** wherein each of said stiffener assemblies includes an internal angle stiffener member secured to the internal surface of said shell and an external angle stiffener member secured to the external surface of said shell, said internal stiffener member and said external stiffener member sandwich a portion of said shell therebetween.

13. In a hopper-type railroad tank car having a longitudinally extending tank shell supported upon a pair of stub center sills, one at each end, and a plurality of hopper compartments spaced at intervals along the length of said tank shell each communicating with a bottom hopper outlet cut-out of said tank shell, the inboard edges of said center sills being positioned outboard of the respective end-most hopper outlets; an improved and reinforcing structure, to transmit horizontal and vertical loads from the center sill to the tank shell, comprising:

a. a pair of longitudinally extending stiffener assemblies attached to said tank shell, one on each side of said center sill;

b. a first transversely extending structural member attached to said tank shell adjacent the end portion thereof and a second transversely extending structural member attached to said tank shell positioned inboard of said first structural member and outboard of said end hopper outlet;

c. a pair of outboard load carrying members, having opposite slopes extending upward and outward from said tank shell portion adjacent said center sill to a pair of opposing points on said tank shell, such that a substantially vertical plane passes through said outboard members and said first structural member; and

d. a pair of inboard load carrying members extending upward and outward from said tank shell portion adjacent said center sill and said second structural member to said pair of opposing points on said tank shell;

e. said first and second structural members and the tank shell portion therebetween forming a curved shear girder to receive a horizontal load and distribute it to said tank shell via said longitudinally extending stiffener assemblies;

f. said outboard load carrying members and said inboard load carrying members acting as a torsion box so as to transmit bending moments to said tank shell.

14. The invention of claim **13** further including a transverse structural member attached at its ends to said opposing points of said tank shell.

15. The invention of claim **13** wherein said outboard load carrying members and said inboard load carrying members each have connector plates associated with their respective ends, said connector plates associated with the bottom ends of said outboard load carrying members pass through said second structural member and are secured to said tank shell immediately above said center sill, and said connector plates associated with the bottom ends of said inboard load carrying members pass through said first structural member and are secured to said tank shell immediately above said center sill.

16. The invention of claim **15** wherein said connector plates associated with the tops ends of said outboard load carrying members and said inboard load carrying members are secured to said tank shell at said opposing points.

17. The invention of claim **16** wherein a wear plate is secured to said tank shell at said opposing points to receive said connector plates secured to said tank shell at said opposing points.

18. The invention of claim **13** wherein each of said stiffener assemblies includes an internal angle stiffener member secured to the internal surface of said shell and an external angle stiffener member secured to the external surface of said shell, said internal stiffener member and said external stiffener member sandwich a portion of said shell therebetween.

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