

Exhibit 1

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

FREIGHTCAR AMERICA, INC.,

Petitioner,

v.

NATIONAL STEEL CAR LIMITED,

Patent Owner

IPR2025-01046 (Patent 8,166,892)

IPR2025-01047 (Patent 8,132,515)

**PATENT OWNER'S NOTICE OF DEPOSITION OF
DR. MEHDI AHMADIAN**

On behalf of National Steel Car Limited

By: Safet Metjahic (Reg. No. 58,677)

Robert Keeler (Reg. No. 70,546)

ICE MILLER LLP

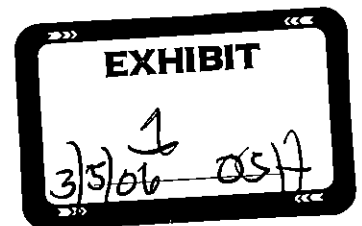
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Pursuant to 37 C.F.R. § 42.53, counsel for Patent Owner will conduct examination by deposition of Dr. Mehdi Ahmadian on March 5, 2026 at 9am ET. The deposition will be taken at the law offices of Knobbe Martens Olson & Bear LLP, 1717 Pennsylvania Ave NW #900, Washington, DC 20006, and will continue day to day until completed with adjournments as to time and place that may be necessary. The deposition may be recorded by audio, audiovisual, and/or stenographic means and will be taken before a notary public or other officer authorized to administer oaths.

Respectfully Submitted,

Date: February 6, 2026

/Safet Metjahic/

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*Attorneys for Patent Owner,
National Steel Car Limited*

CERTIFICATE OF SERVICE

The undersigned hereby certifies that the foregoing **PATENT OWNER'S NOTICE OF DEPOSITION OF DR. MEHDI AHMADIAN** was served electronically in its entirety on the date noted below via electronic mail to the following attorneys of record:

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Exhibit 2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FREIGHTCAR AMERICA, INC.,
Petitioner,

v.

NATIONAL STEEL CAR LIMITED,
Patent Owner.

Case IPR2025-01046
Patent 8,166,892

**DECLARATION OF MEHDI AHMADIAN
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,166,892**

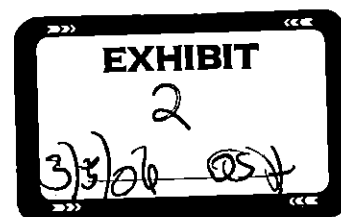


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c.	[1d] “said rail road car having a side sill and a top chord; said first upstanding sidewall extending from said side sill to said top chord;”	26
d.	[1e] “said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;”	28
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b.	[2g] “said draft sill having a striker longitudinally outboard of said first truck center;”	35
c.	[2h] “said first end section having a shear plate mounted overtop of said first draft sill and said main bolster; said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet; said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;”	38

d.	[2i] “said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;”	42
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2.	Dependent Claim 6:	61
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C.	Ground 1c: Claim 9 – obviousness over the 1946 Cyclopedia in view of Lindström and Wong.	69
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1.	Independent Claim 1	80
a.	[1d] “said rail road car having a side sill and a top chord; said first upstanding sidewall extending from said side sill to said top chord;”	80
b.	[1e] “said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;”	81

c.	[1g] “said sidewall stiffener having a first portion, said first portion being a lower portion thereof, said first portion being mounted to said first region of said first upstanding sidewall;.....	83
	said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;”	83
d.	[1j] “said sidewall stiffener having web continuity between said first and second portions thereof.”	86
F.	Ground 2b: Claims 2-14 – obviousness over Lindström in view of Wong, and optionally the 1946 Cyclopedia.....	88
1.	Independent Claim 2	88
a.	[2f] “said first end section having a first draft sill and a main bolster extending cross-wise to said first draft sill, said first draft sill and said main bolster intersecting at a first truck center, said first truck being located centrally under said first truck center;	88
b.	[2h] “said first end section having a shear plate mounted overtop of said first draft sill and said main bolster; said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet; said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;”	90
c.	[2i] “said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;”	93

d.	[2j] said lower, longitudinally inboard end of said first end slope sheet being reinforced by a second cross-wise extending beam;.....	97
e.	[2m] “said first end section being free of longitudinally oriented elephant ears extending between said draft sill and said first end slope sheet;”	99
2.	Dependent Claim 3: “The rail road hopper car of claim 2 wherein said first and second portions of said sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.”	101
3.	Dependent Claim 5: “The rail road hopper car of claim 4 wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said transition portion is located a distance above said first side sill that is in the range of $\frac{1}{4}$ to $\frac{2}{3}$ L.”	102
4.	Dependent Claim 6:	104
a.	[6a] “The rail road hopper car of claim 2 wherein said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof;”	104
b.	[6b] “said hopper includes first and second sloped side sheets; and said first sloped side sheet meets said first sidewall at said transition portion.”	104
c.	[8b] “and an end post extends from said draft sill to said end top chord, said end post being mounted above said draft sill between said truck center and said striker.”	107

5.	Dependent Claim 9:	109
a.	[9a] “The rail road hopper car of claim 8 wherein said hopper has an end wall extending downward of said end top chord;	109
b.	[9b] “said upper, longitudinally outboard end of said first end slope sheet meets said downwardly extending end wall;.....	110
	and said first cross-wise extending beam is located where said downwardly extending end wall meets said first end slope sheet; and.....	110
	said first cross-wise extending beam is of hollow cross-section.”.....	110
6.	Dependent Claim 11: “The rail road hopper car of claim 10 wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.”	112
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I, Mehdi Ahmadian, Ph.D., declare as follows:

1. I am making this declaration at the request of FreightCar America, Inc. (“FCA”). I have been retained by FCA as a technical expert in this matter.

2. I am being compensated for my work on this matter and I am being reimbursed at cost for my expenses. My compensation in no way depends upon the outcome of this proceeding. I do not own any stock in FCA and, to my knowledge, I have no financial interest in FCA.

3. In preparation for this declaration, I have considered the following materials:

Exhibit No.	Description
1001	U.S. Patent No. 8,166,892 (“the ’892 patent”)
1002	File History of the ’892 patent
1004	Excerpts from <i>1946 Car Builders’ Cyclopedia</i> , 17th ed. (“1946 Cyclopedia”)
1005	U.S. Patent No. 1,321,928 (“Lindström”)
1006	U.S. Patent No. 4,941,411 (“Wong”)
1007	Excerpts from <i>Lancashire & Yorkshire, Vol. 2</i> , Noel Coates, copyright 2006 (“Coates”)
1023	U.S. Patent No. 2,030,748 (“Gilpin”)

4. I have also relied on my education, training, and experience, and my knowledge of pertinent literature in the field of the ’892 patent.

I. EXPERIENCE AND QUALIFICATIONS

5. My experience and qualifications are summarized in my *curriculum vitae*, a copy of which is attached hereto as Appendix A.

6. I am currently employed as J. Bernard Jones Chair of Mechanical Engineering at Virginia Polytechnic Institute and State University ("Virginia Tech"). I am also the Director of the Center for Vehicle Systems and Safety (CVeSS) and the Railway Technologies Laboratory (RTL) at Virginia Tech. I am the founding director of CVeSS, RTL, Virginia Institute for Performance Engineering and Research (VIPER), and the Advanced Vehicle Dynamics Laboratory (AVDL).

7. I hold four degrees, three of which are in the field of Mechanical Engineering. I obtained my Doctor of Philosophy degree in Mechanical Engineering from the State University of New York at Buffalo in 1984. I obtained my Master of Business Administration (MBA) from Pennsylvania State University – Behrend College in 1994. I obtained my Master of Science (MS) in Mechanical Engineering from the State University of New York at Buffalo in 1982. I obtained my Bachelor of Science (BS) in Mechanical Engineering from the State University of New York at Buffalo in 1980. I worked at General Electric Transportation Systems from 1993-1995 before joining Virginia Tech as an assistant professor in 1995. Since joining Virginia Tech, a substantial portion of my research has been directed to the railroad

industry and railroad systems. This research is evident in the hundreds of publications, books, book chapters, and presentations listed in my CV.

8. I have over 25 years of experience as an independent consultant on matters related to product liability and patent litigation cases involving a broad spectrum of passenger cars, commercial vehicles, and railway systems. I have also assisted clients on issues related to vehicle dynamics and handling, electromechanical systems, braking, rollover stability, and active safety systems. I have broad technical experience in advanced vehicular systems for railway and heavy vehicles, including railway control and safety systems.

9. I have authored more than 500 publications and hold 12 U.S. and international patents. Additionally, I have edited eight technical volumes on various engineering topics. I have served as Editor of the International Journal of *Vehicle System Dynamics* (2008 to 2022) and Editor-in-chief of the *Journal of Vibration and Control* (2014 to 2023). I have also served as the Editor-in-Chief of *Shock and Vibration* (2011-2016), the Editor-in-Chief of *Advances in Automotive Engineering* (2012-2014), and Editor for *Smart Materials Research* (2010-2014), *Advances in Mechanical Engineering* (2008-2014), and *Mechanical Engineering* (2010-2014). I have also served as an Associate Editor for the *ASME Journal of Vibration and Acoustics* (1989-1996), the *AIAA Journal* (2000-2008), and *Shock and Vibration* (2003-2011). I have served on the editorial boards of *Advances in Theoretical and*

Applied Mechanics (2012 to present), *Nonlinear Analysis and Differential Equations* (2013 to present), and the *Journal of Theoretical and Applied Vibration and Acoustics* (2018 to present).

10. I am a Fellow of the Society of Automotive Engineers (SAE International) (2001 to present), a Fellow of the American Society of Mechanical Engineers (“ASME”) (1984 to present), a Fellow of the International Society for Condition Monitoring (“ISCM”) (2021 to present), a Fellow of the International Institute of Acoustics and Vibration (“IIAV”) (2021 to present), and an Associate Fellow of the American Institute for Aeronautics and Astronautics (“AIAA”) (1984 to present). I have also been a Member of the American Railway Engineering and Maintenance-of-Way Association (“AREMA”) (2011 to present), American Society of Education for Engineers (1984-2001), and Tau Beta Pi National Engineering Honorary Society (1979 to present)

11. I have received several professional awards throughout my career, including most recently being awarded the 2024 Society of Automotive Engineers (SAE) Medal of Honor (the highest recognition of lifetime achievement, bestowed on one SAE member per year) and the 2023 Virginia Tech Alumni Award for Research Excellence (regarded as the most prestigious Virginia Tech award for significant life-long research) for my research contributions.

12. I am an inventor on the following issued patents:

- Kinetic Energy-Harvesting Device for Powering and Charging Railway and Other Applications, U.S. Patent 12,088,180, September 10, 2024.
- Dual-action rotary dynamic load stabilization pneumatic valve system, U.S. Patent 9,975,392, May 22, 2018.
- A Compact Lightweight Double-piston Magnetorheological (MR) Damper with large adjustable dynamics force, Chinese Patent # ZL 201110420869.8, December 25, 2013.
- A Compact Lightweight Double-piston Magnetorheological (MR) Damper, Chinese Patent # ZL 201110418073.9, January 9, 2014.
- Doppler Sensor for the Derivation of Torsional Slip, Friction, and Related Parameters, U.S. Patent 8,294,883, October 23, 2012.
- Doppler Sensor for the Derivation of Torsional Slip, Friction and Related Parameters, U.S. Patent 7,705,972, April 27, 2010.
- No Jerk Semiactive Suspension System, U.S. Patent 6,115,658, September 5, 2000.
- No Jerk Semi-active Skyhook Control Methods and Apparatus, Canadian Patent Application, No. 09/225,147, December 17, 1999.
- Self-Steering Locomotive Truck, U.S. Patent 6,006,674, December 28, 1999.
- Self-Steering Locomotive Truck, U.S. Patent 5,746,135, May 5, 1998.
- Self-Steering Locomotive Truck, U.S. Patent 5,613,444, March 25, 1997.
- Electromagnetically Operated Pneumatic Valve Assembly for an Electrical Contactor Actuator, U.S. Patent 5,409,036, April 25, 1995.

II. APPLICABLE LEGAL STANDARDS

13. I have been asked to provide my opinions related to whether claims of U.S. Patent. No. 8,166,892 (“the ’892 patent”) are anticipated and/or would have

been obvious to a person of ordinary skill in the art at the time of the alleged invention, in view of the prior art.

14. I am an engineer by training and profession. The opinions I am expressing in this report involve the application of my training and technical knowledge and experience to the evaluation of certain prior art with respect to the '892 patent.

15. Although I have been involved as a technical expert in patent matters before, I am not an expert in patent law. Therefore, attorneys from Knobbe, Martens, Olson & Bear have provided me with guidance as to the applicable patent law in this matter. The paragraphs below express my understanding of how I must apply current principles related to patent validity in my analysis.

16. It is my understanding that a claim is "anticipated" if a person of ordinary skill in the art (POSITA), reading a prior art reference at the time of the invention, would have understood the reference to disclose each limitation of the claim.

17. It is my understanding that a claim is "obvious" if the claimed subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time of the alleged invention. I understand that the following factors must be evaluated to determine whether a claim would have been obvious: (i) the scope and content of the prior art; (ii) the differences, if any, between each claim of the '892

patent and the prior art; (iii) the level of ordinary skill in the art at the time of the claimed invention; and (iv) additional considerations, if any, that indicate that the invention was obvious. I understand that these “additional considerations” are often referred to as “secondary considerations” or “objective indicia” of non-obviousness.

18. I also understand that the frame of reference when evaluating obviousness is what a hypothetical person of ordinary skill in the pertinent art would have known at the time of the claimed invention. I understand that the hypothetical person of ordinary skill is presumed to have knowledge of all pertinent prior art references.

19. I understand that a prior art reference may be a pertinent prior art reference (or “analogous art”) if (i) it is in the same field of endeavor as the patent, or (ii) if it is pertinent to the problem that the inventors were trying to solve. I understand that a reference is reasonably pertinent if it logically would have commended itself to an inventor’s attention in considering the problem at hand. If a reference relates to the same problem as the claimed invention, I understand that supports use of the reference as prior art in an obviousness analysis.

20. It is my understanding that the law recognizes several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include:

- combining prior art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- a predictable use of prior art elements according to their established functions;
- using known techniques to improve similar devices (methods, or products) in the same way;
- using a feature that was commonly used on similar devices and well-known in the field;
- applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success (in which case a claim would have been obvious to try);
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and

- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

21. I understand that a prior art reference may also suggest a combination with another prior art reference or a modification in view of another reference. In that case, even if the prior art reference does not explicitly or inherently disclose the limitation, the motivation to modify the prior art reference to include the limitation may exist within the prior art reference itself. Thus, the limitation would have been obvious over that prior art reference alone.

22. I understand that “secondary considerations” must be considered as part of the obviousness analysis when present. I further understand that the secondary considerations may include: (1) a long-felt but unmet need in the prior art that was satisfied by the claimed invention; (2) the failure of others; (3) skepticism by experts; (4) commercial success of a product covered by the patent; (5) unexpected results achieved by the claimed invention; (6) industry praise of the claimed invention; (7) deliberate copying of the invention; and (8) teaching away by others. I am not aware of any evidence of secondary considerations that would suggest that the claims of the ’892 patent would have been nonobvious at the time of the claimed invention.

23. I understand that when assessing obviousness, using hindsight is impermissible; that is, what is known today or what was learned from reading the asserted patent should not be considered. The asserted patent should not be used as a road map for selecting and combining items of prior art. Rather, obviousness must be considered from the perspective of a person of ordinary skill at the time the alleged invention was made. (See paragraph 26 for discussion of invention date.)

24. I also understand that an obviousness analysis must consider the invention as a whole, as opposed to just a part or element of the invention. I understand this “as a whole” assessment to require showing that one of ordinary skill in the art at the time of invention, confronted by the same problems as the inventor and with no knowledge of the claimed invention, would have selected the elements from the prior art and combined them in the claimed manner.

III. THE '892 PATENT

A. Overview of the '892 Patent

25. Each claim of the '892 patent requires sidewall stiffeners with “web continuity.” The '892 patent uses the term “web continuity” to refer to alignment in a vertical plane. EX1001 at Fig. 2c & 15:44-46 (“Portions 104 and 106 are co-planar, or substantially co-planar, such that stiffener 102 has web continuity through member 94.”). I discuss web continuity in greater detail below.

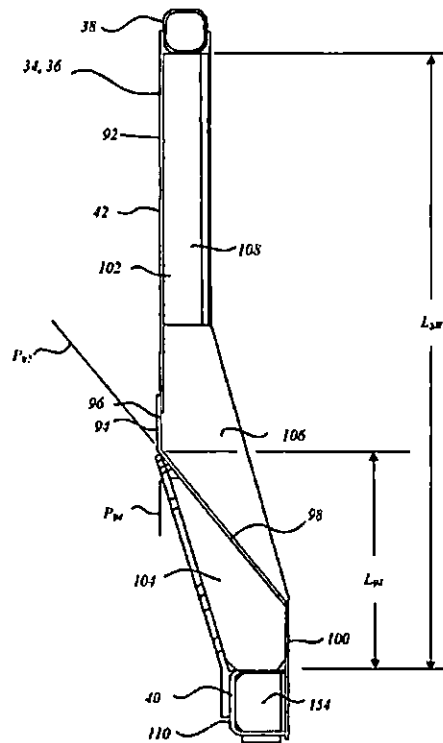


Figure 2c

EX1001 at Fig. 2c.

B. Priority Date of the '892 Patent

26. The '892 patent was filed as U.S. Application No. 12/559,065 on September 14, 2009 and claims priority to Canadian Patent Application No. 2,678,605, also filed on September 14, 2009, as well as to Canadian Patent Application No. 2,678,447, filed on September 11, 2009. EX1001 at cover; EX1002 at 120. I understand that the earliest claimed priority date of the '892 patent is September 11, 2009, and I have been instructed to assume for the purposes of my opinions that this is the invention date for the '892 patent.

C. Prosecution History of the '892 Patent

27. Based on my review of the file history for the '892 patent, I understand that, on January 3, 2012, the Examiner allowed the pending claims and offered the following Reasons for Allowance:

The following is an examiner's statement of reasons for allowance: The sidewall stiffener having web continuity between the first and second portions along with the first portion of the sidewall stiffener being laterally outboard of the first region and the second portion of the sidewall stiffener being laterally inboard of the second region is seen as an unobvious improvement over the art of record.

EX1002 at 416. I understand that the Examiner never discussed any prior art reference during the prosecution of the '892 patent.

D. Level of Ordinary Skill in the Art of the '892 Patent

28. It is my understanding that, when interpreting the claims of the '892 patent and evaluating whether a claim would have been obvious, I must do so based on the perspective of a person of ordinary skill in the art at the time of invention (POSITA). (See paragraph 26 for discussion of invention date.)

29. I understand that, in determining the level of ordinary skill in the art, several factors are considered. Those factors may include: (i) the type of problems encountered in the art; (ii) prior art solutions to those problems; (iii) the rapidity with which innovations are made; (iv) the sophistication of the technology; and (v) the educational level of active workers in the field. A person of ordinary skill in the art

must have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

30. The claims of the '892 patent are directed to reinforcing and assuring the structural integrity of the side wall of a railway hopper car. A person of ordinary skill in the art to which the '892 patent pertains would have had at least a bachelor's degree in a discipline related to mechanical engineering, physics, structural design, or an equivalent discipline, and at least two years of experience designing or analyzing rail cars or similar vehicles. However, my opinions do not turn on this specific definition of the level of ordinary skill. The claims would be obvious from the perspective of a skilled artisan under any reasonable definition.

31. My opinions herein would remain the same even if the invention date, field of endeavor, or level of ordinary skill were slightly different.

32. I qualify as a POSTIA based on my education and experience described herein and in my CV. *Supra* § I. ; App'x A.

E. Claim Construction

33. It is my understanding that in determining whether a patent claim is anticipated by or obvious in view of the prior art, the Patent and Trademark Office construes the claim by giving the claim terms their plain and ordinary meaning, as they would have been understood by a POSITA at the time of the invention in view of the intrinsic record (patent claims, patent specification, and file history). I

understand that a patent and its prosecution history are considered “intrinsic evidence” and are the most important sources for determining how a POSITA would understand claim language. I also understand that an interpretation of a claim term that prevents the claim from covering any embodiment in the patent is rarely, if ever, correct.

34. In general, unless the intrinsic evidence indicates that the inventors adopted a special definition of a claim term, I have interpreted each claim term in accordance with its plain and ordinary meaning as it would have been understood by a person of ordinary skill in the art at the time of the invention.

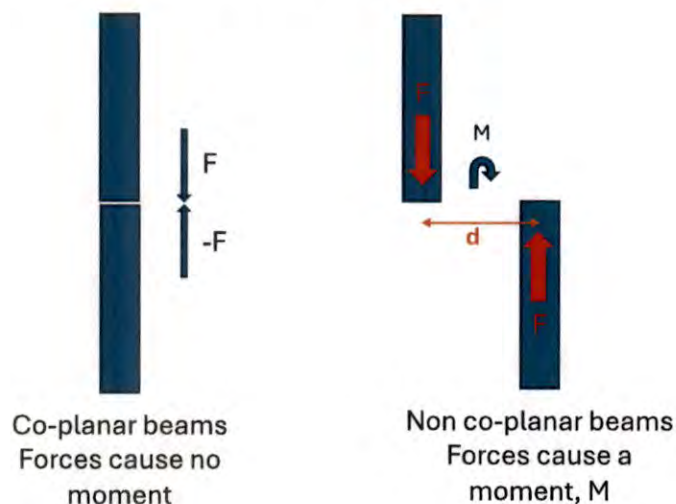
IV. CONCEPTS RELATED TO THE '892 PATENT

A. Transmitting Loads Through Co-Planar Reinforcing Elements

35. The use of elements that allow transferring loads and forces from one part of a structure to another part is not novel. It has been practiced in various embodiments for decades in various structures, including railcars, dating back to before the priority dates of the subject patents.

36. Aligning those load-transferring elements, i.e., making them co-planar in a plane through the axis of load transfer, offers benefits related to simplicity and efficiency in design and analysis, particularly in situations where the structure is two-dimensional or can be reasonably approximated as such. It also allows for a more efficient transfer of forces without causing an out-of-plane bending.

37. As shown below, the action and reaction forces are aligned in a co-planar structure, and no bending moment is generated. When they are not co-planar, a bending moment (M) is generated, directly proportional to the magnitude of the forces and their misalignment, known as the moment arm, d . The simplicity and efficiency of co-planar structures such as the beams shown below and in many hopper car structures are known to a POSITA.



B. Stiffening a Flat Structure by Adding Ribs Was Not Novel

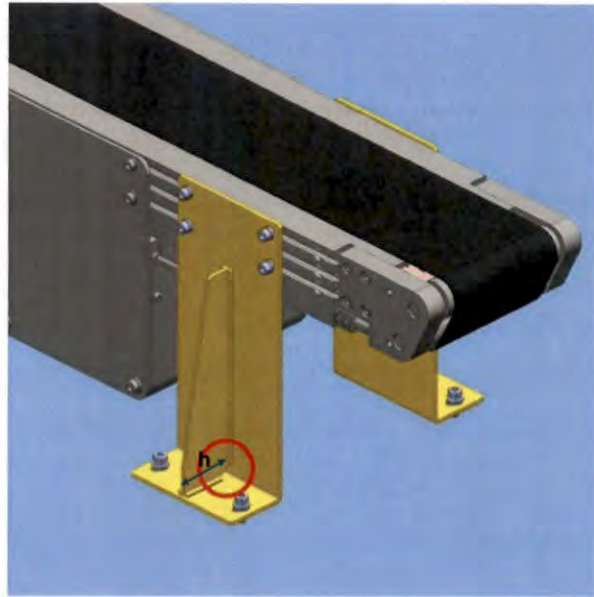
38. It was known to a POSITA long before 2009 that ribs are frequently used to improve the strength of sheet metal parts and reduce their deformation when subjected to heavy loading. It was known that a structure made of sections with sheet metals tends not to be strong and lacks stiffness and resistance to bending. When subjected to large forces, such sheet metals can bow or bend in response to forces they are subjected to, such as those occurring in sidewall elements of a hopper car filled with heavy cargo like minerals. Adding stiffening elements such as ribs,

flanges, hems, flat elements, C-channels, L-brackets, or tubing to sheet metal parts increases their resistance to deformation when subjected to pressures caused by heavy loads. They do so by increasing the effective thickness of the sheet metal in the direction for which bending is to be prevented.

C. Making Reinforcing Elements from Flat Bar Was Not Novel

39. It was known to a POSITA long before the priority date that elements used for stiffening a sheet metal are often applied in the form of a rib made from flat bar. Flat bars have superior weight efficiency and cost-effectiveness to resist bending in the plane of the flat bar. A flat-bar rib, such as the one shown below, resists bending deformation in direct proportion to its height, h . Flat bars used in this fashion can be connected to supported material by separate L-brackets, incorporated flanges, welding (as shown below), or through other means. The plane (or “web”) of such flat bars can also take any of a multitude of cross-sectional shapes; for example, as shown below, a flat bar can be in a trapezoid form.

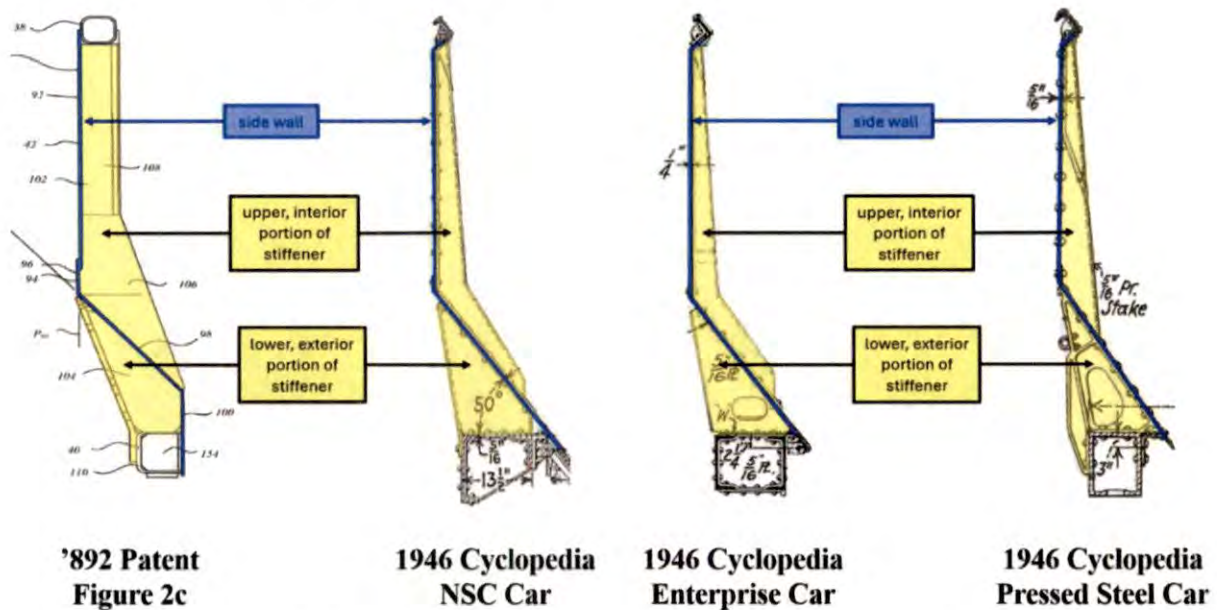
40. The stiffening effect of flat-bar ribs was known to persons of ordinary skill in the art long before the priority date. Equally known was the spacing of such flat bars. It was known to a POSITA that flat-bar ribs are uniformly spaced along the length of a structure, such as the sidewalls of a hopper railcar, to reduce warping and offer deformation resistance when the hopper is loaded. This spacing can be seen in the railcars discussed in the following section.



D. Web Continuity Was Not Novel in 2009

Side-wall stiffeners with two parts (e.g., 104 and 106 in '892 patent Fig. 2c above) having web continuity were common in hopper cars used to transport minerals such as coal and iron ore long before the priority date. For example, the 1946 Cyclopedia has a section regarding hopper ore cars. EX1004 at 290-95. In that ore-car section of the 1946 Cyclopedia, three of the four schematics in the section disclose two-part side-wall stiffeners with web continuity. *Id.* at 290, 292, 294. Those three schematics have rear section views that show both the interior and exterior portions of the stiffener in relation to the side wall. *Id.* The arrangement of those stiffeners with respect to the sidewall is very similar—almost identical—to the arrangement thereof shown in Figure 2c of the '892 patent, as shown below. *Id.* For example, in each, the side wall has an upper vertical, outside aspect, below which

the side wall angles laterally inward and downward between the two portions of the stiffener; the upper portion of the stiffener is attached to the interior side of the vertical and angled aspects of the side wall; the lower portion of the stiffener is attached to the exterior side of the angled aspect of the side wall; this setup is over, and transfers load to, the side sill. *Id.*



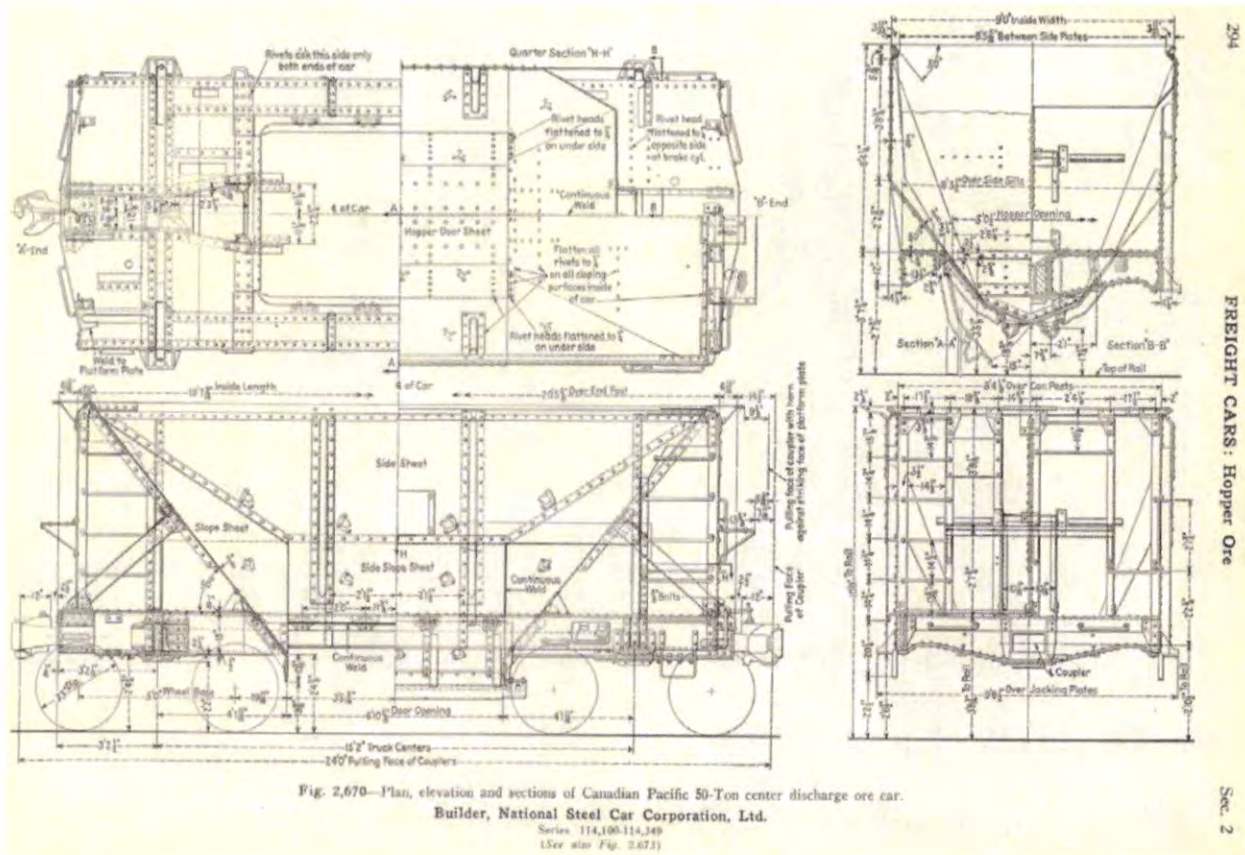
EX1001 at Fig. 2c; EX1004 at 294 (NSC Car); 292 (Enterprise Car); 290 (Pressed Steel Car).

E. Interpreting Technical Schematics from the 1940s

41. 1946 Cyclopedia contains four drawings of the NSC ore car, shown below. EX1004 at 294. These drawings are arranged in accordance with conventions that were common in the twentieth century, but that are less common today in the era of CAD-generated drawings. In three of those drawings, different

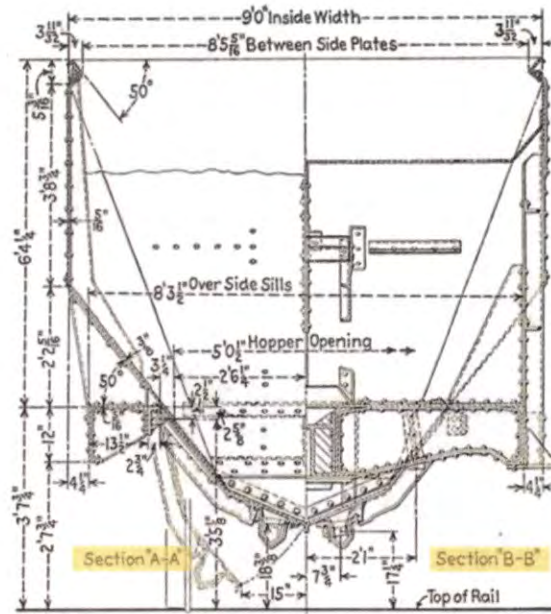
sections views are shown on left and right sides and/or the top and bottom portions.

I will therefore briefly explain what is being shown in each of the four drawings.

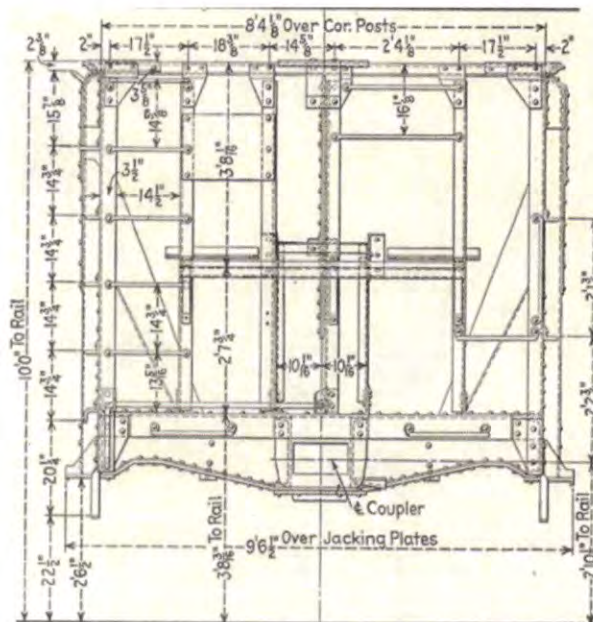


42. Top Left Drawing. In the top view (below), the left half is a sectional view that shows the structure of the lower frame or undercarriage; the upper-right quadrant shows a section along the line H-H, which the side view identifies as sectioning the ore car approximately midway between the undercarriage and the top of the car; and the lower-right quadrant shows a top view from outside the car. Thus, for example, the lower-right quadrant shows half of one of the two end slope sheets.

44. Top Right Drawing. The bottom right drawing In the end section views (below), the left half shows a section along the line A-A and the right half shows a section along the line B-B, both of which are identified in the top view.



45. Bottom Right Drawing. The final drawing is a simple rear view, though with certain hidden features shown in dashed lines.



V. SPECIFIC PROPOSED GROUNDS FOR UNPATENTABILITY

A. Ground 1a: Claim 1 – anticipation by, or obviousness over, the 1946 Cyclopedia.

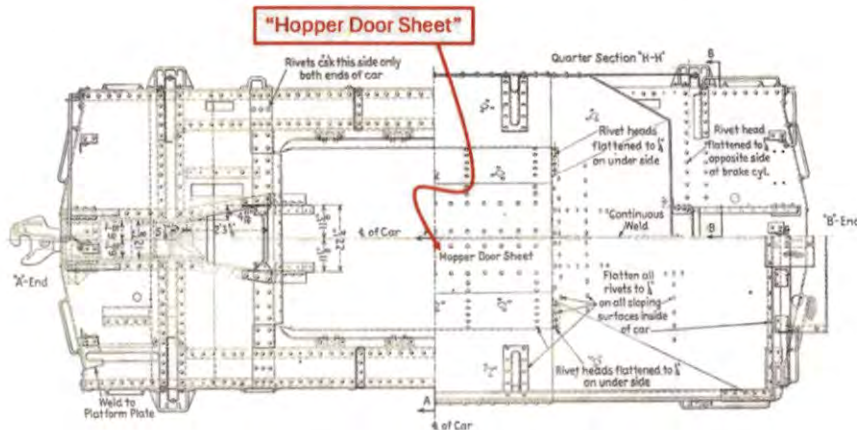
a. [1a] “A rail road hopper car comprising: a hopper carried between a pair of trucks”

Technical drawing of a hopper car, showing side and end views with dimensions and labels. The drawing includes the following elements:

- Labels:**
 - hopper** (red box)
 - truck** (green box)
 - distance between "Truck Centers"** (green box)
- Dimensions:**
 - Inside Length: 19' 7"
 - 4' of Car
 - 20' 5" Over End Post
 - 14' 9"
 - 12' 1"
 - 32' 1"
 - 15' 2" Truck Centers
 - 24' 0" Pulling Face of Couplers
 - 37' 1"
 - 35' 4"
 - 6' 10"
 - 41' 8"
- Structural Components:**
 - Side Sheet
 - Slope Sheet
 - Side Slope Sheet
 - Continuous Weld
 - Continuous Weld
 - Boards
 - Wheel Base
 - Door Opening
- Other Labels:**
 - Pulling face of coupler with train line
 - Pulling Face

22

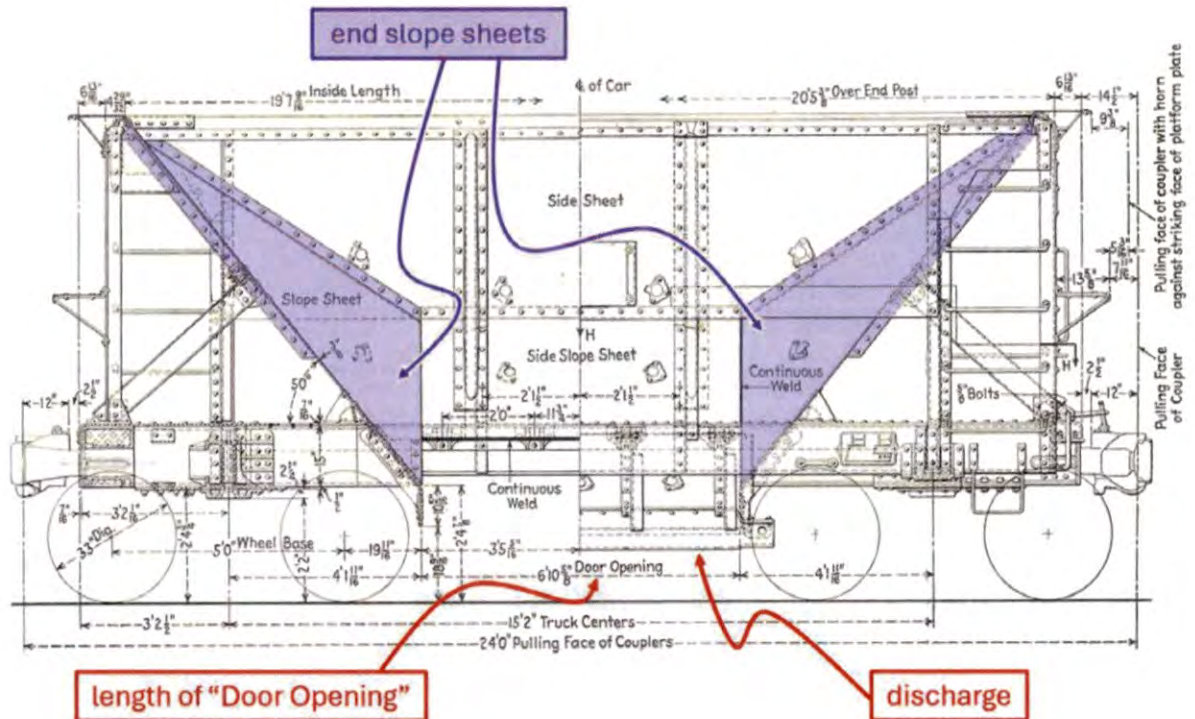
In addition, the drawing below expressly refers to the hopper door.



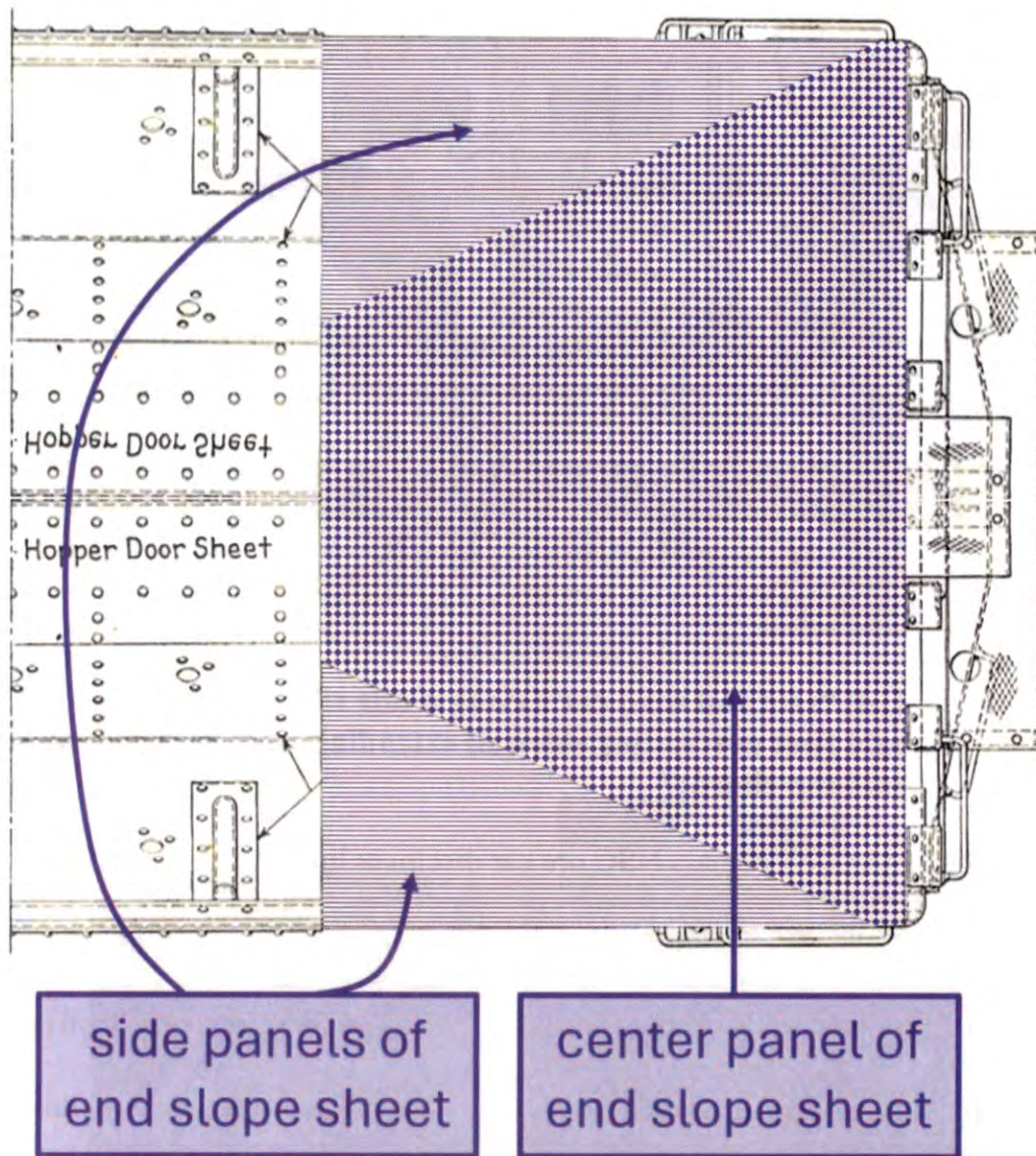
Id. Regarding the trucks, the 1946 Cyclopedia defines “truck” as “the assembly of parts comprising the structures which support a car body at each end ... and also provide for the attachment of wheels and axels.” *Id.* at 66. A POSITA would be familiar with the term “truck,” as trucks are standard features of rail cars. In the NSC drawing, each end of the car is supported by a truck with four wheels.

b. [1c] “said hopper having a lower discharge and convergent slope sheets giving onto said discharge;”

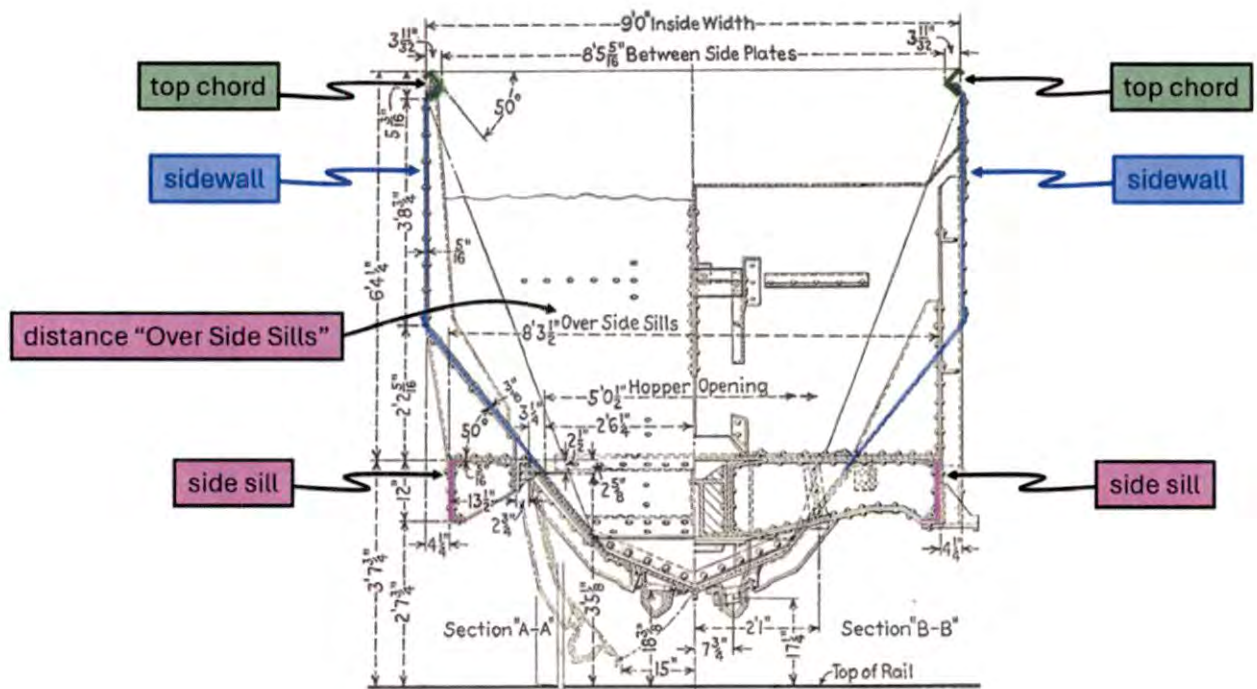
48. The NSC ore car has a lower discharge. This can be seen in the side-view drawing of the car, which calls out a measurement for the length of the “door opening” at the bottom of the rail car. The same side-view drawing shows end slope sheets that are angled to move lading toward the discharge at the center of the car, as shown below.



EX1004 at 294. Each end slope sheet comprises a central portion perpendicular to the plane of the page, designated by two angled purple lines in the image above, as well as two corner portions that are angled with respect to the central portion. I have created the image below to show what all three portions would look like in a top view. I designated the center portion with a purple diamond pattern and the corner portions of the end slope sheet with a purple striped pattern.



Id. (modified). Finally, the image below shows all portions of the end slope sheets that are visible in the side-view drawing of the NSC ore car.



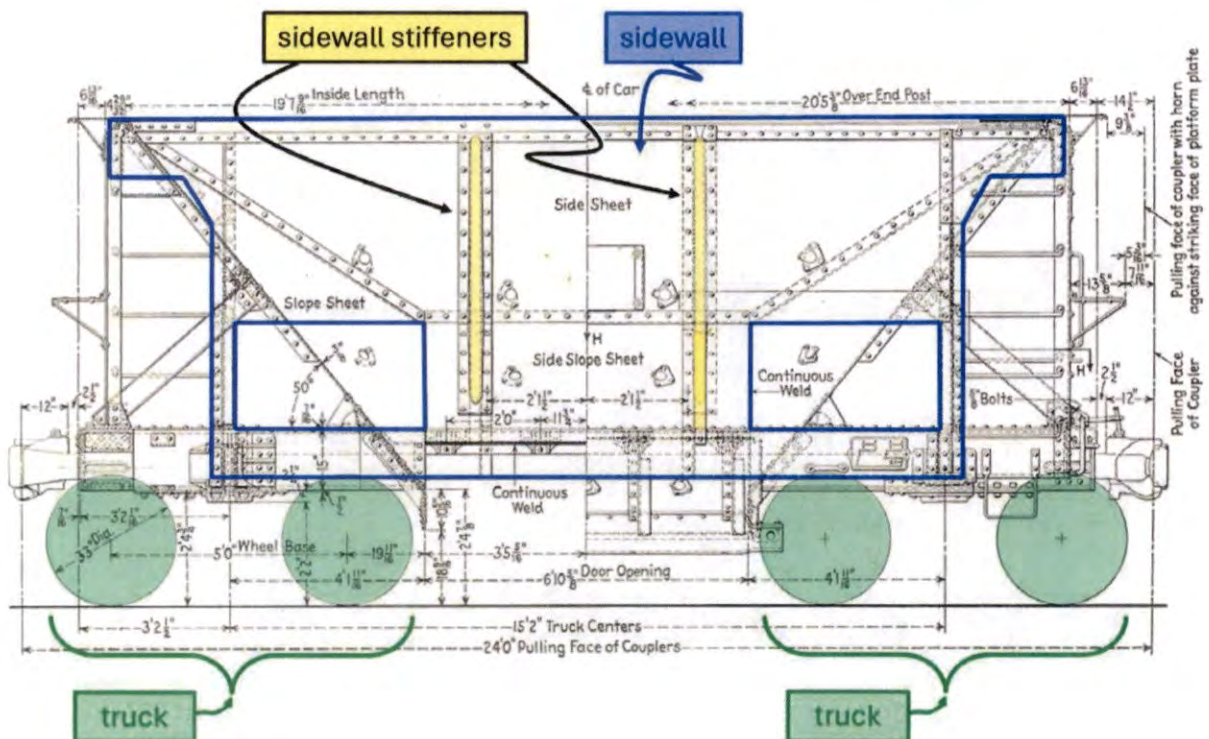
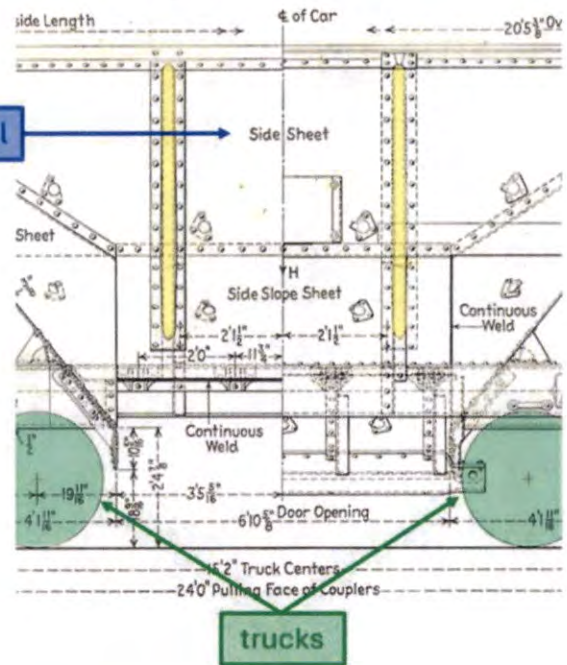
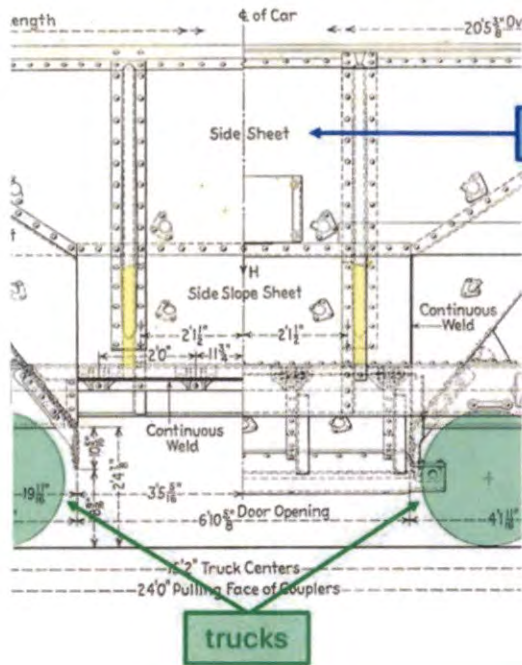
EX1004 at 294-95.

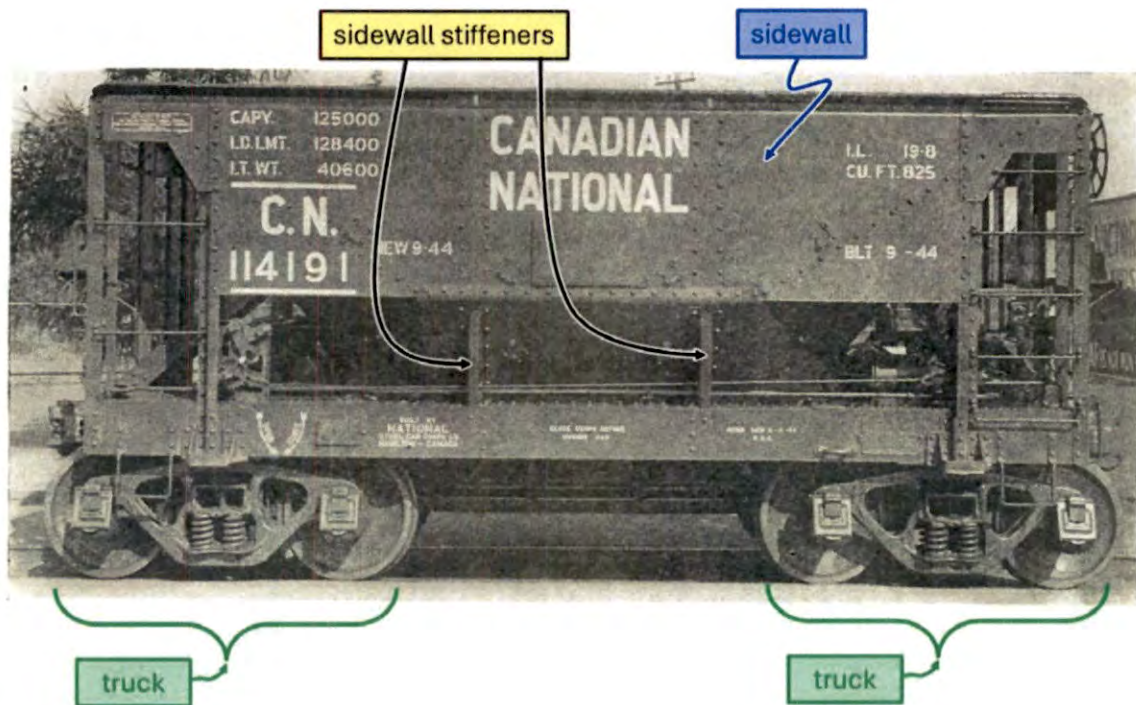
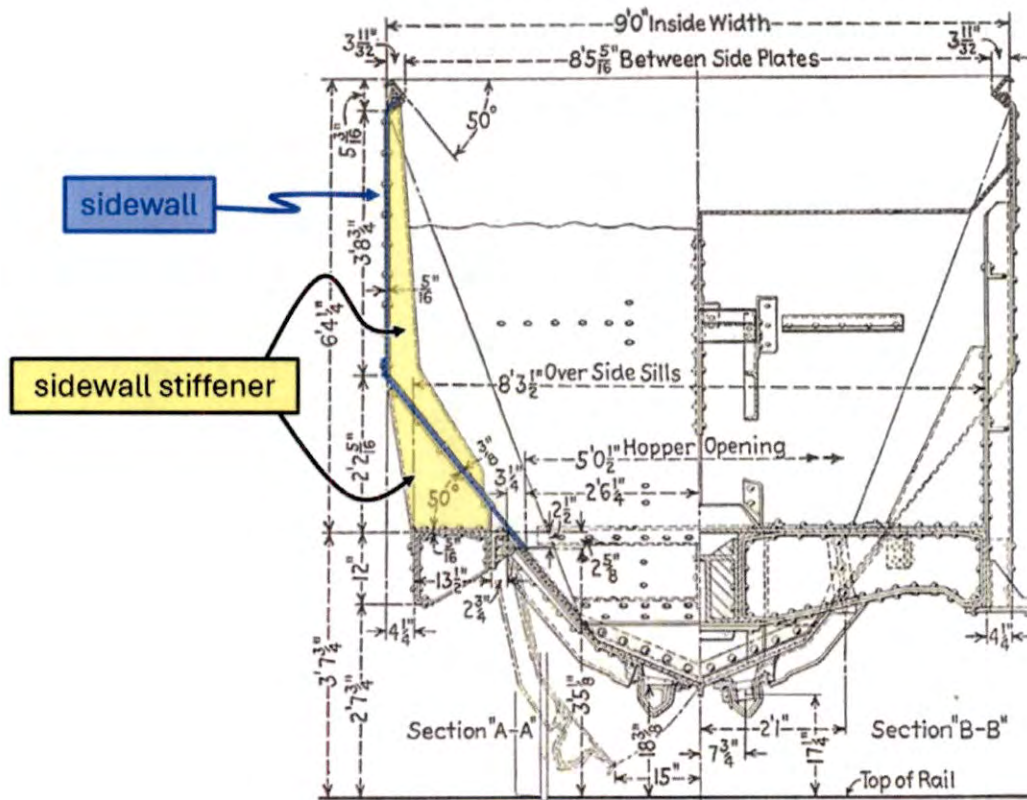
- d. [1e] “said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;”

50. The 1946 Cyclopedia’s NSC ore car discloses limitation [1e], as shown below. EX1004 at 294-95. The sidewall has predominantly upwardly running sidewall stiffeners (shown in yellow). *Id.* A POSITA would recognize these as conventional stiffeners providing support to prevent bending in the lateral dimension. Those stiffeners are mounted to the sidewall (shown in blue), as claimed, with rivets and flanges shown in the drawings and photograph. *Id.* The sidewall stiffener is located at a longitudinal station intermediate the trucks, as claimed, as shown in the side view and photograph. *Id.*

lower, exterior (first) portions
of sidewall stiffeners

upper, interior (second)
portions of sidewall stiffeners





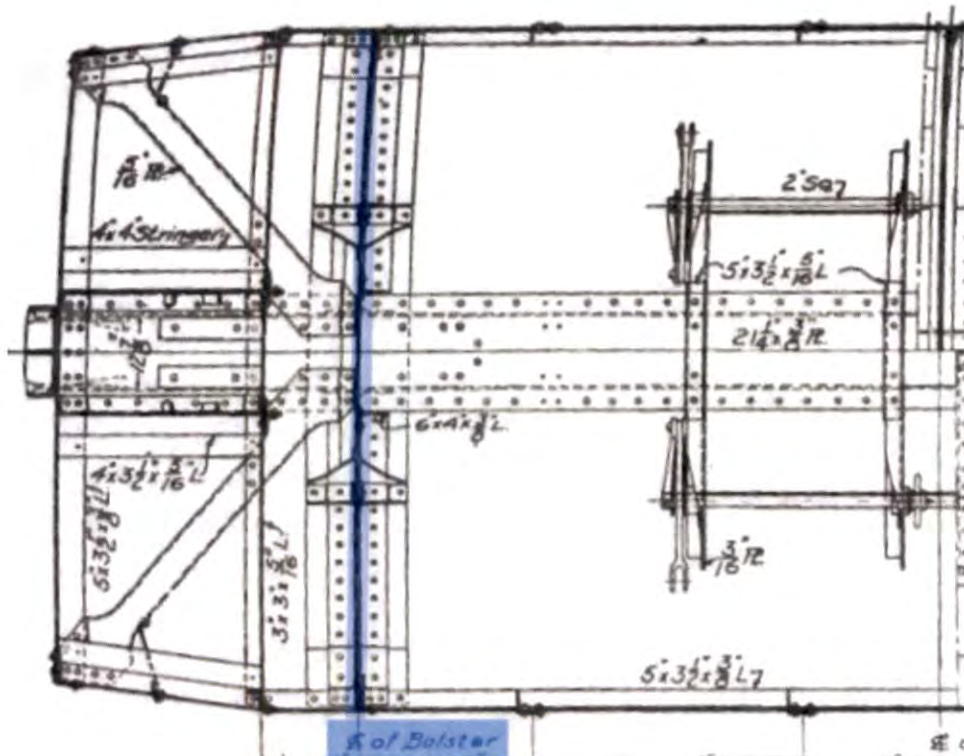
Id.

B. Ground 1b: Claims 2–8 and 10–14 – obviousness over the 1946 Cyclopedia in view of Lindström, and optionally in view of Wong.

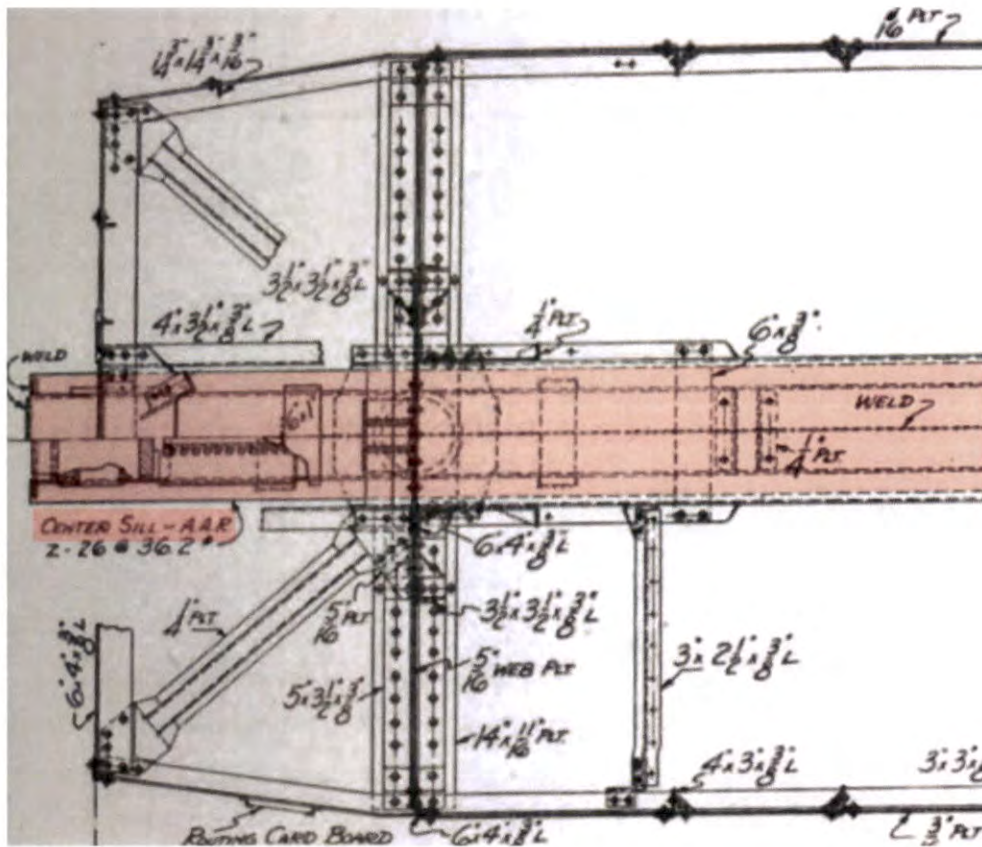
1. Independent Claim 2

- a. [2f] “said first end section having a first draft sill and a main bolster extending cross-wise to said first draft sill, said first draft sill and said main bolster intersecting at a first truck center, said first truck being located centrally under said first truck center;**

51. A POSITA would understand what is meant by the claim terms “bolster” and “draft sills.” These are standard features on rail cars, and have been since long before the priority date in 2009. For example, the 1946 Cyclopedia defines “bolster” as “a cross member on the underside of a car body and in the center of a truck, through which the weight is transmitted.” EX1004 at 16. It also discloses examples of bolsters, including by calling out the centerline of a bolster (“ $\mathbb{L}$ of Bolster”) in the following diagram:



Id. at 293 (color added). Regarding the claimed “draft sill,” the ’892 patent states: “In the terminology of the industry, the portion of the center sill 44 (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center ... may also be referred to as the draft sill.” EX1001 at 14:31-34. The 1946 Cyclopedia defines “center sill” as: “The central longitudinal member of the underframe of a car, which forms, as it were, the backbone of the underframe and transmits most of the buffing shocks, from one end of the car to the other.” EX1004 at 22. The 1946 Cyclopedia identifies the center sills in certain drawings, including the following:



Id. at 404 (color added). As shown below, the 1946 Cyclopedia's NSC ore car discloses the first draft sill and the main bolster recited in limitation [2f], including the intersection of the two components at truck center.

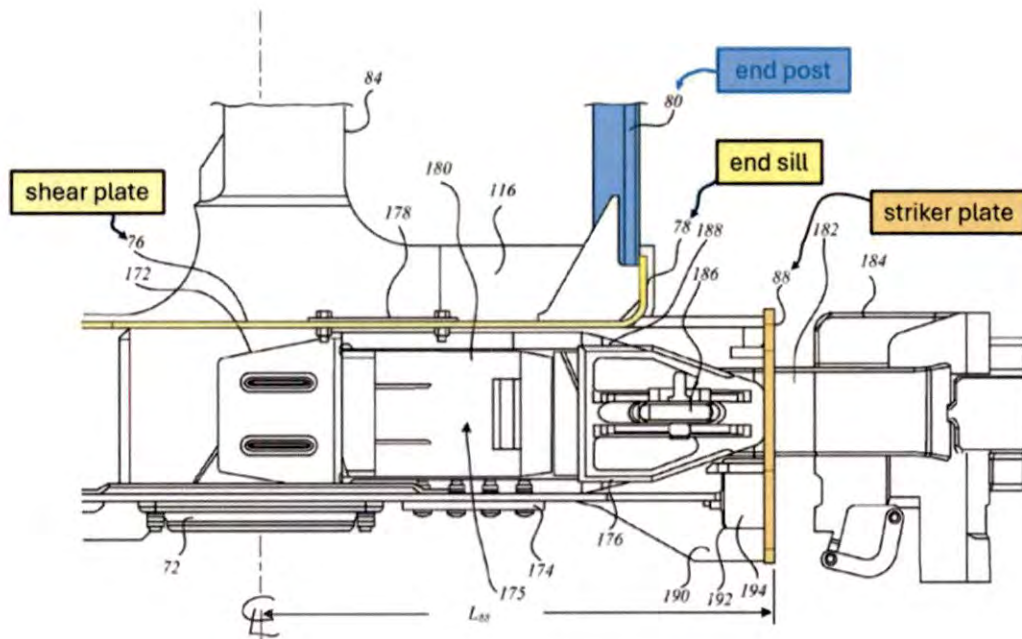
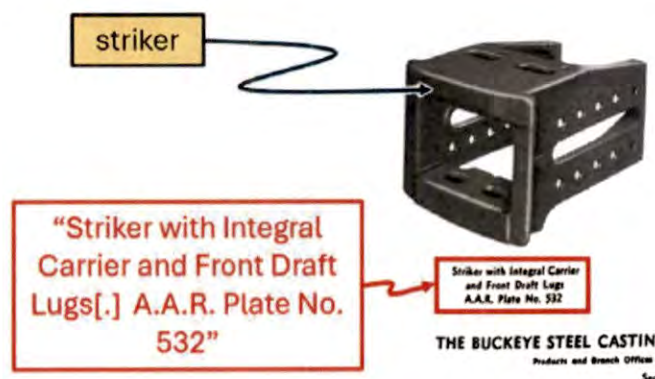


Figure 3c

EX1001 at Fig. 3a, 3c.

54. The 1946 Cyclopedia defines “striker” and “striking plate” to mean: “A member placed on the ends of the center sills of freight cars against which the horn of the coupler strikes, preventing damage to the draft gear and center sills.” EX1004 at 62. The reference shows many examples of strikers, including the following:



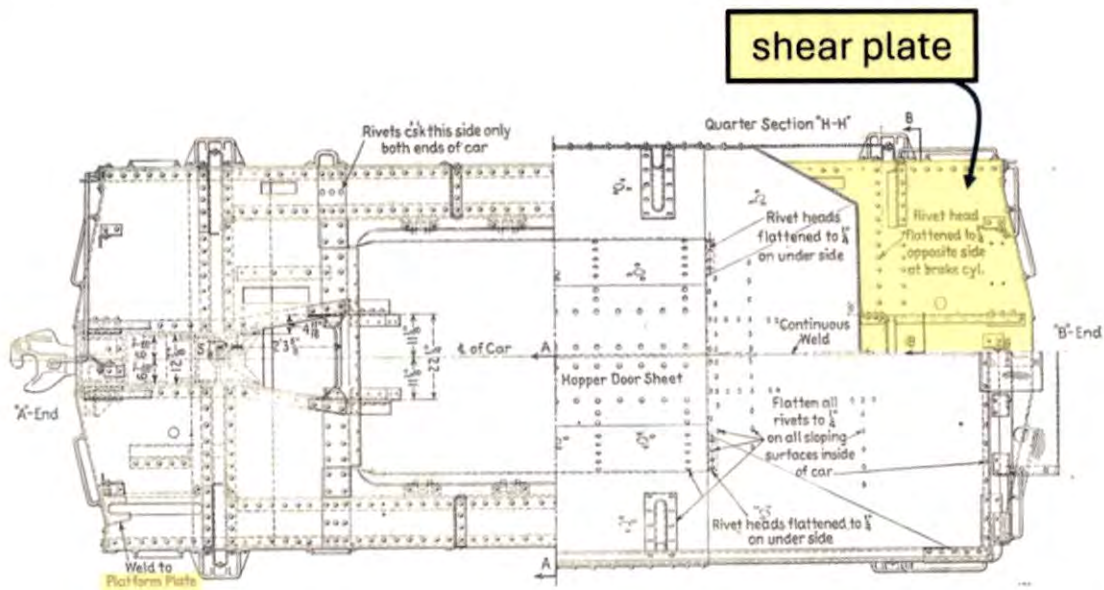
[illegible]

FreightCar America, Ex. 1003
IPR Petition - USP 8,166,892

- c. [2h] “said first end section having a shear plate mounted otop of said first draft sill and said main bolster; said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet; said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;”

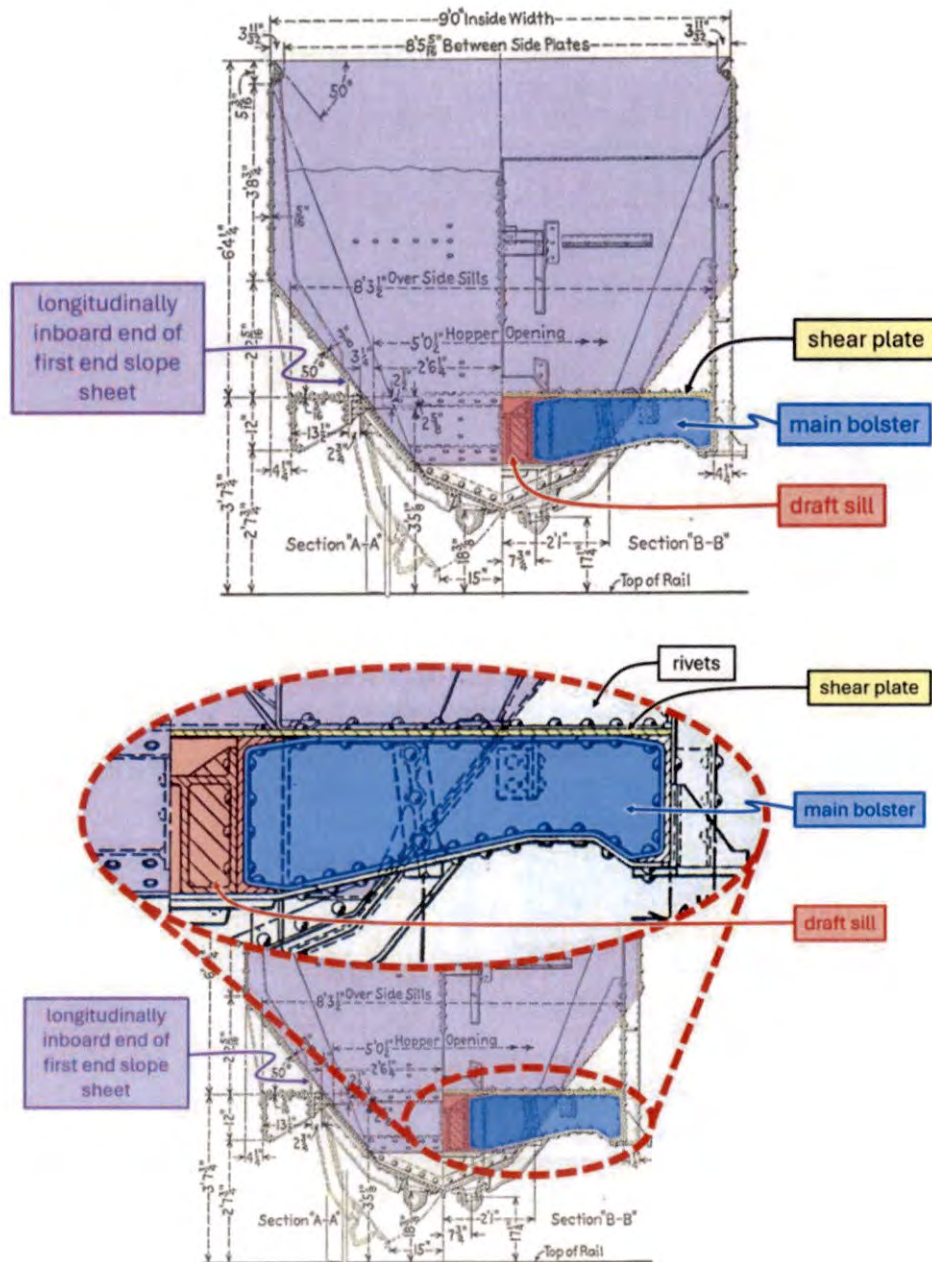
55. The 1946 Cyclopedia’s NSC ore car discloses the claimed shear plate.

The upper-right quadrant of the top view (below) shows the shear plate in the H-H, quarter section.

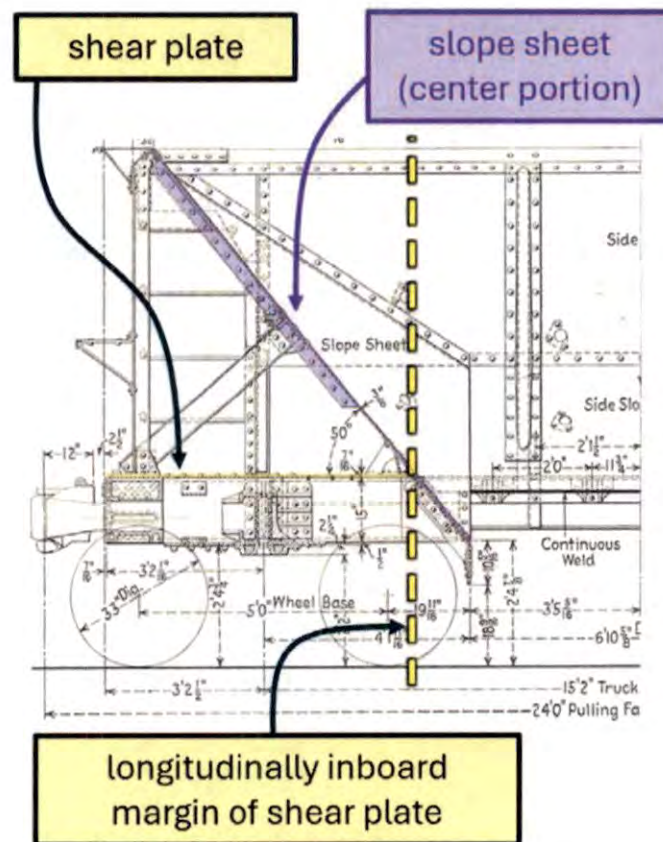


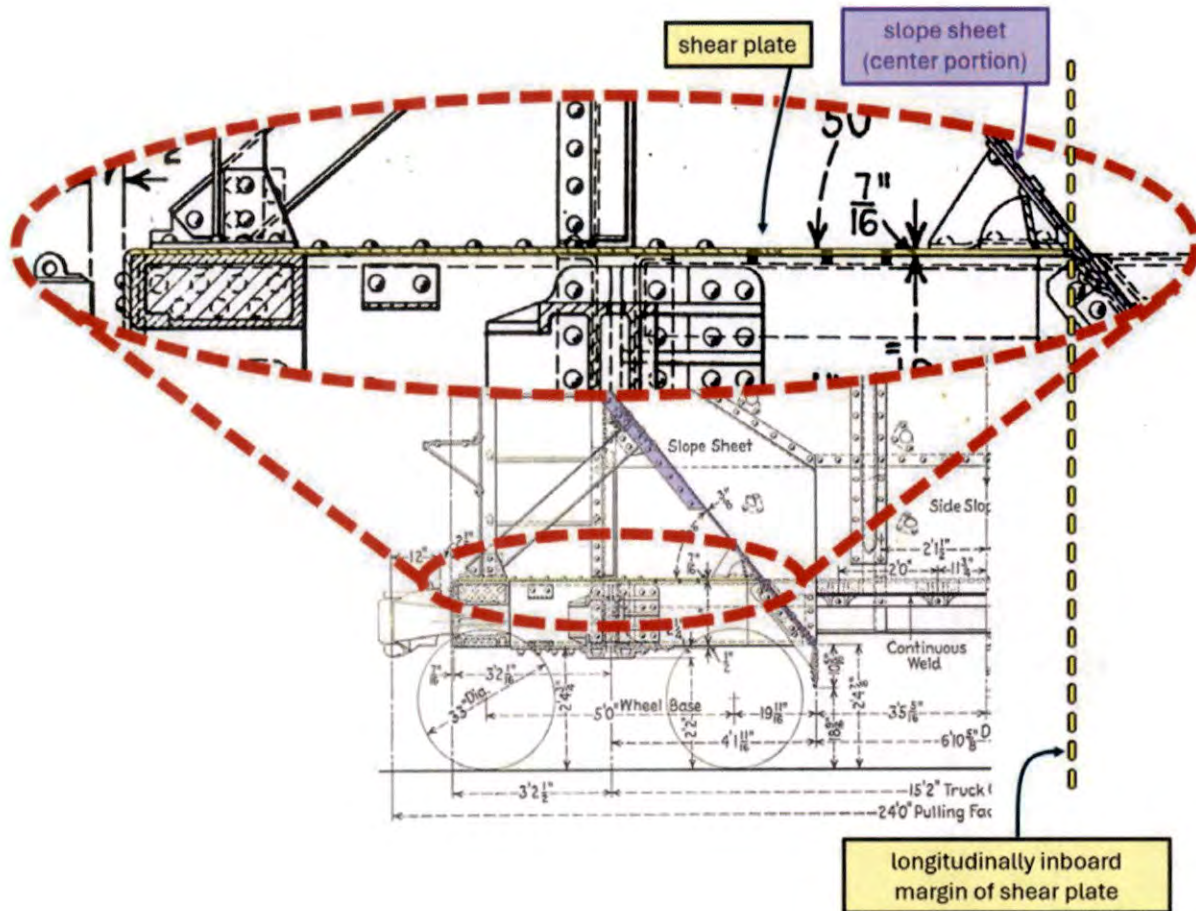
EX1004 at 294. This quarter section top view along the line H-H shows only one half of the “B end” of the car, symmetrically. *Id.* As discussed above, the NSC ore car can be accurately depicted in this quarter view because a POSITA would understand that the depicted structure is symmetrical about its longitudinal and lateral axes. Thus, the H-H quarter section shows that the shear plate extends laterally from one side of the car to the other side. *Id.* This is confirmed by sectional

end view along the line B-B, which appears below. *Id.* The B-B view confirms that the shear plate is a distinct layer directly on top of the main bolster and the draft sill, that the shear plate is riveted to the bolster, and that the shear plate extends from one side of the car to the other. *Id.*

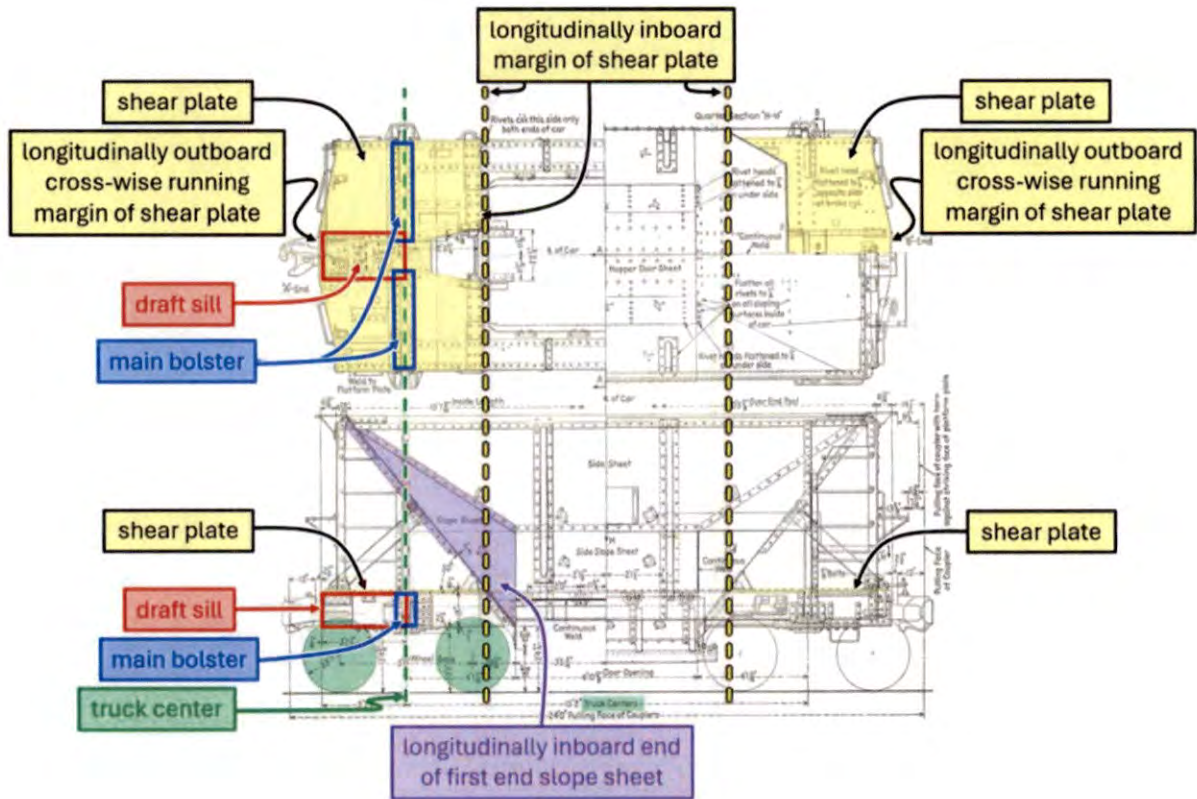


EX1004 at 294. The left half of the side view (below), which is a vertical-longitudinal sectional cut that shows inside the hopper, shows the longitudinal extent of the shear plate. *Id.* It shows that the shear plate extends inward from the end of the draft sill (at the left of the image) to the point where it meets the downwardly extending slope sheet. *Id.* The hatched portion indicates areas where the section cuts through the shear plate, whereas non-hatched portions indicate areas where the shear plate appears farther back into the page. *Id.* This hatching of the side section view enables a POSITA to understand the horizontal coverage of the shear plate shown in the left half of the top view (further below). *Id.*





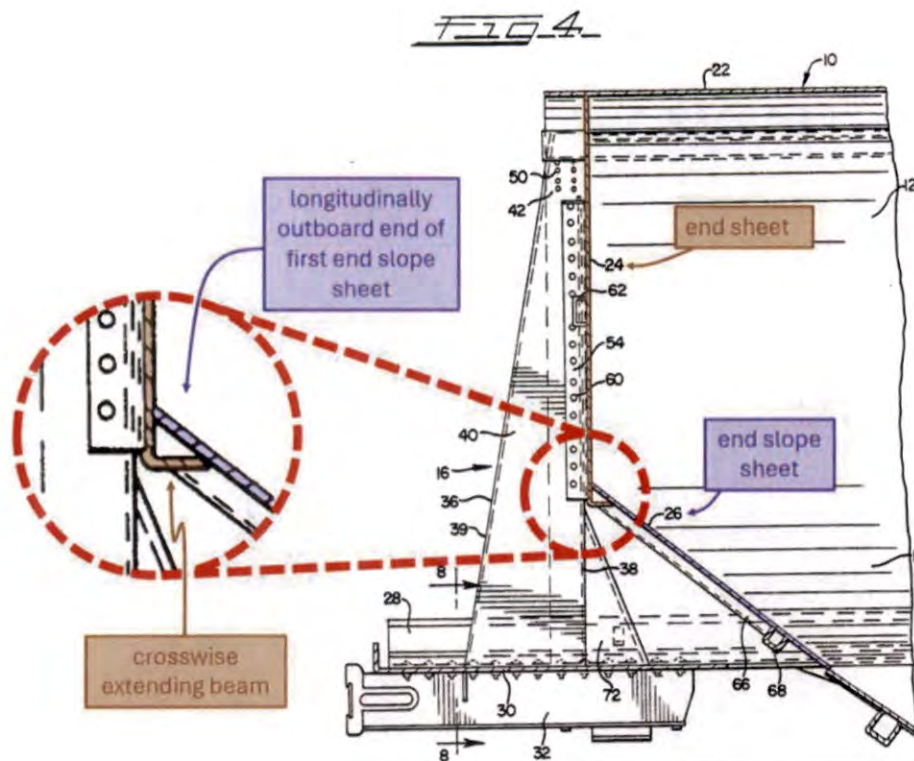
EX1004 at 294. Once the lateral and longitudinal margins of the shear plate are determined, it is apparent that the 1946 Cyclopedia's NSC ore car discloses limitation [2h], as shown below.



Id.

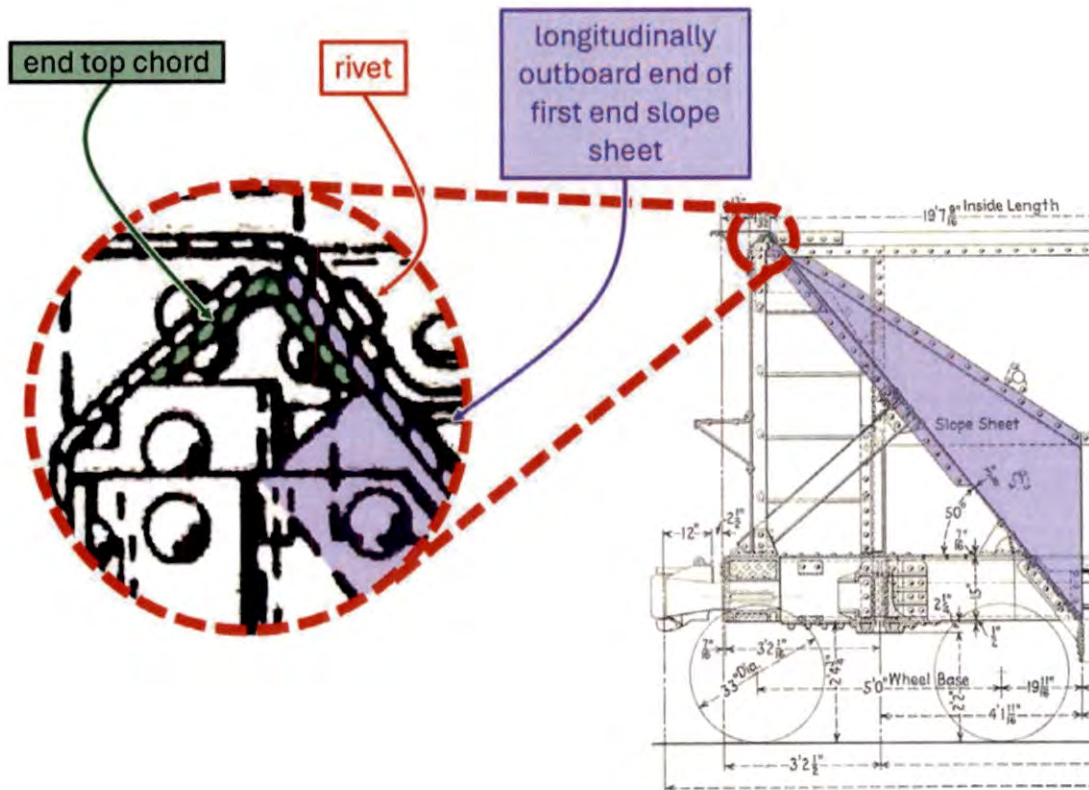
- d. [2i] “said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;”

56. The 1946 Cyclopedia’s NSC ore car, as modified in view of Wong, would satisfy limitation [2i]. As shown below, Wong discloses a first end slope sheet (“end slope sheet” 26). The upper, outboard end of the sheet is reinforced by a cross-wise, L-shaped beam positioned under the slope sheet.

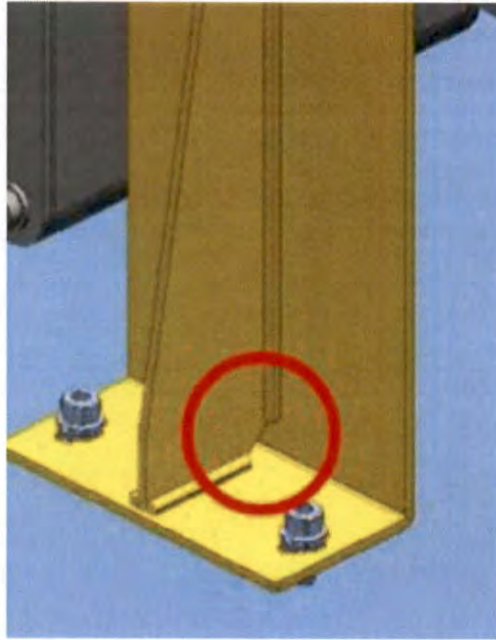


EX1006, Fig. 4. It would have been obvious to modify the 1946 Cyclopedia's NSC ore car to further support the upper, outboard end of the slope sheet with a crosswise, L-shaped beam as in Wong. A POSITA would have been motivated to make the modification. For example, Wong and the 1946 Cyclopedia are in the same field of hopper railcars. EX1004 at 294-95 ("ore car" with a hopper); EX1006, Abstract ("hopper railcar"). That is the same field to which every claim of the '892 patent is directed. EX1001, Cl. 1-2 preambles (each independent claim is directed to a "rail road hopper car"). As another example, a POSITA would have understood the benefits of further reinforcing the slope sheet at its upper end. A POSITA would have understood that, at that upper end, a load in the hopper creates a stress concentration at the intersection of the end slope sheet and the end top chord, which

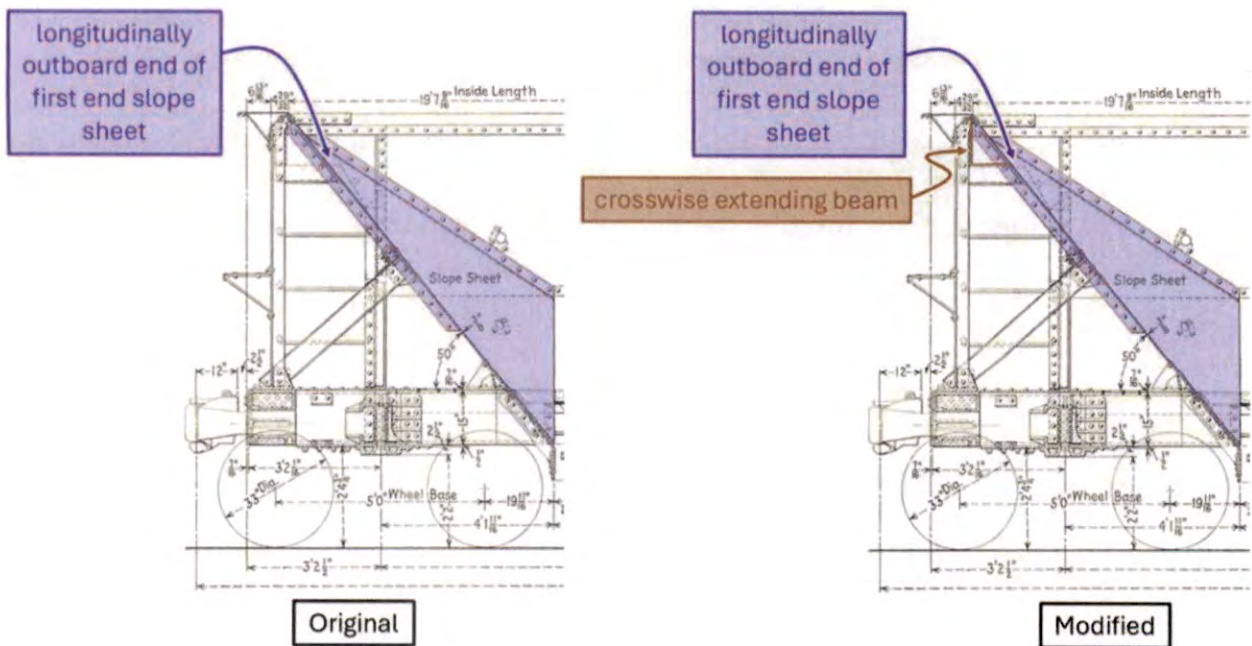
is shown below. A POSITA would have understood that the stress concentration could be ameliorated by spreading the load over a larger area. A common way to accomplish that was (and is) to support the upper, outboard end of the slope sheet with a cross-wise beam as in Wong.

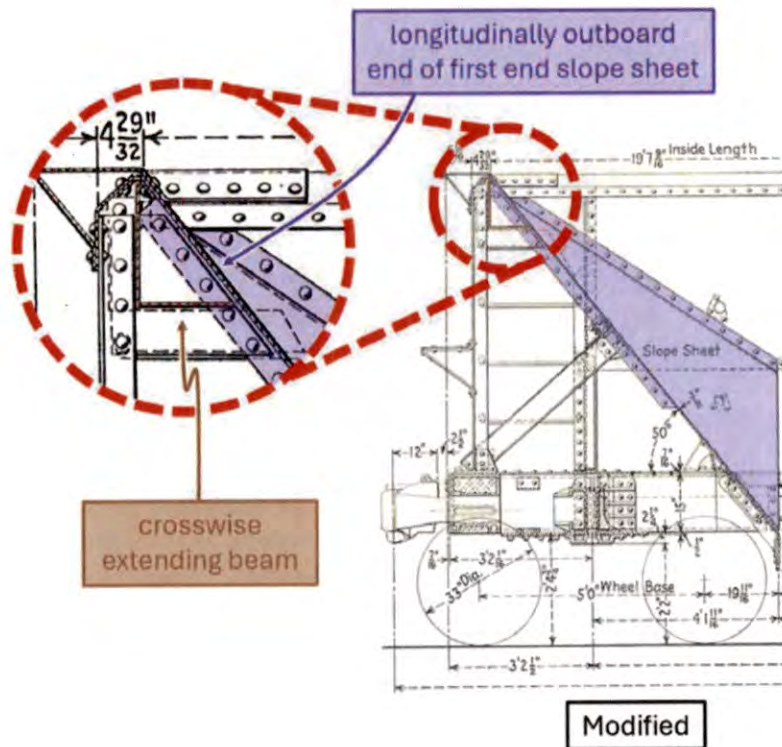


EX1004 at 294. Another such stress concentration relief is shown in the figure below, where the bracket's corner is rounded with a “relief hole”. Both Wang’s teaching (above) and what is shown below are common engineering methods for relieving stress concentrations.



A POSITA would have had a reasonable expectation of success in making this modification because it would be a straightforward addition of a simple structure, as shown below.

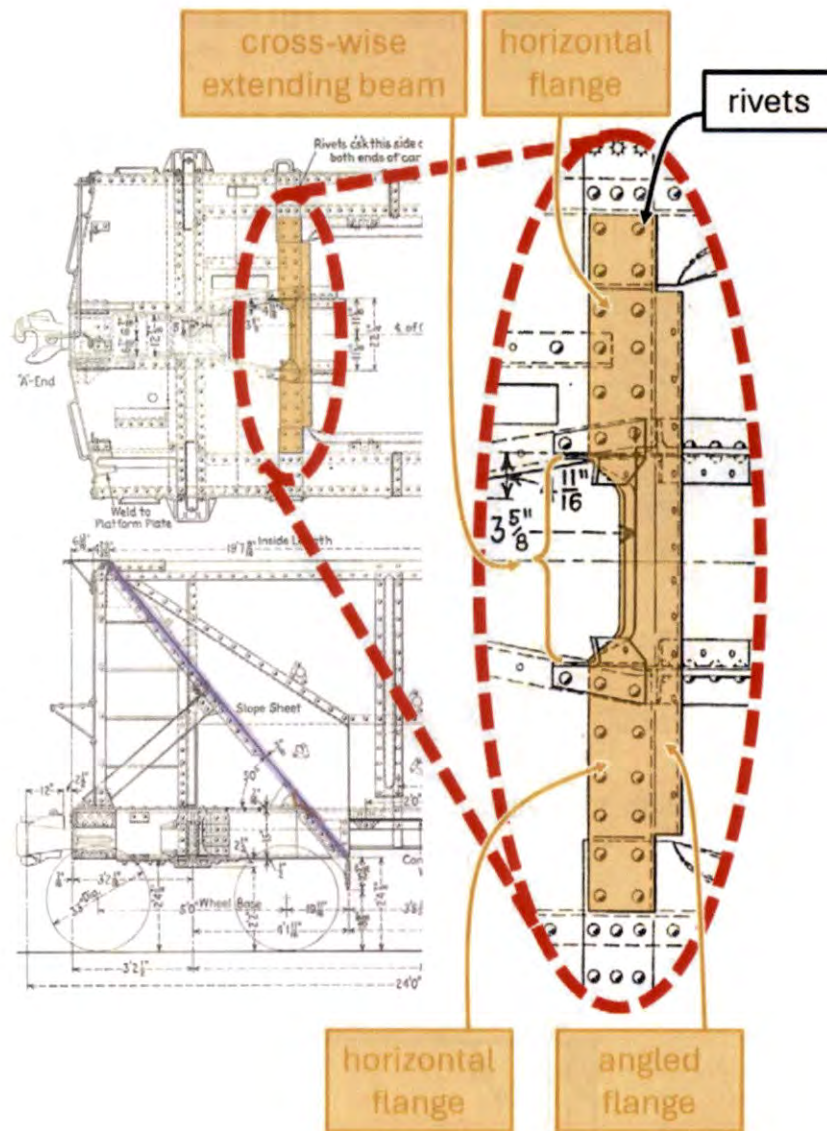




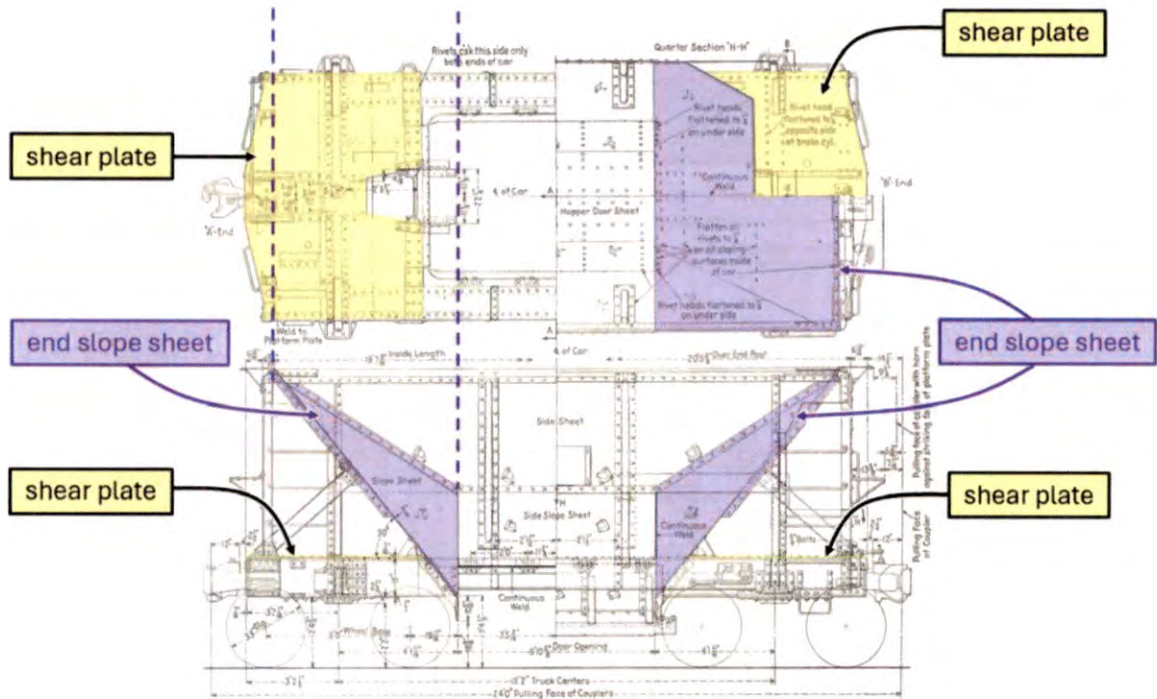
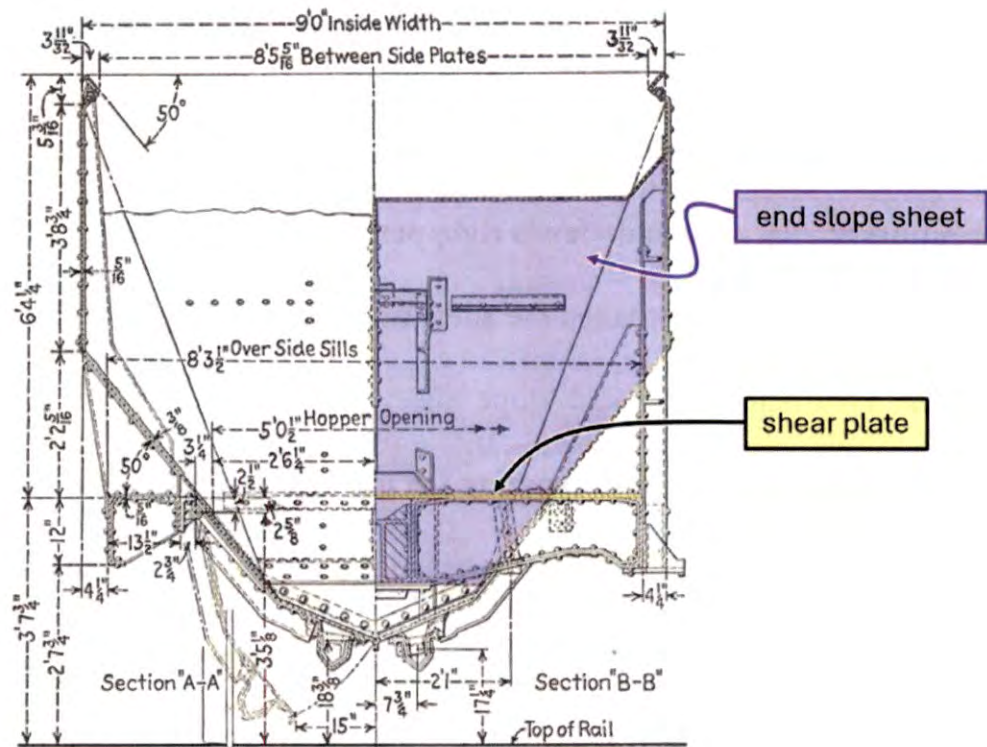
Id. (modified).

- e. [2j] “said lower, longitudinally inboard end of said first end slope sheet being reinforced by a second cross-wise extending beam;”

57. The 1946 Cyclopedia’s NSC ore car discloses this limitation. As shown below, a support plate for the slope sheet (orange) is on top of the shear plate. EX1004 at 294. The support plate has horizontal flanges riveted to the shear plate. *Id.* Those rivets are seen most clearly on the left side of the top view (enlarged below). *Id.* The support plate also has an angled flange connected to the slope sheet below the plane of the shear plate. *Id.*



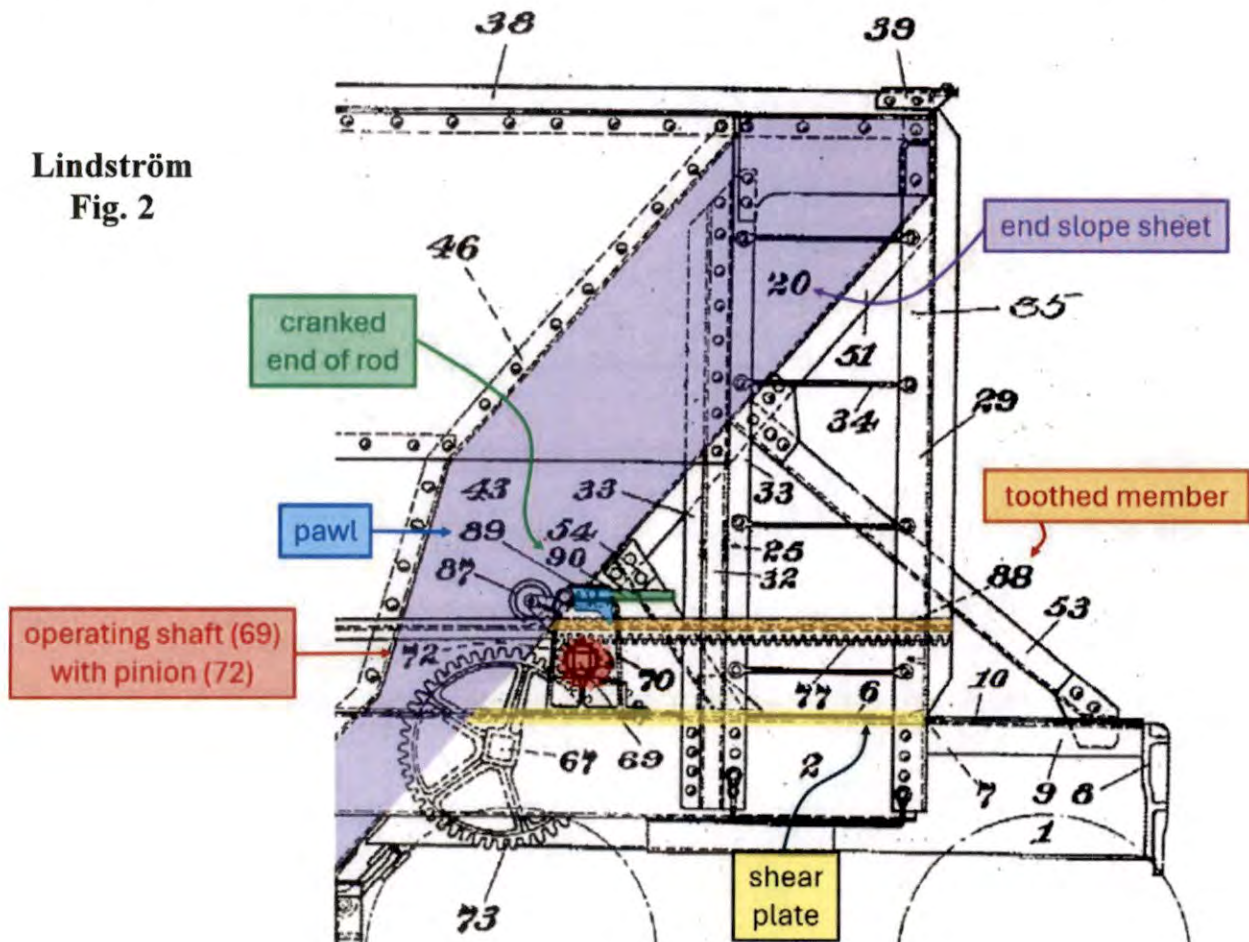
Id. In its transverse center, between the horizontal flanges transition, the support plate's longitudinally outboard edge is bent upwards to make reinforcing contact with the bottom surface of the slope sheet. *Id.* This forms a beam which runs crosswise underneath the slope sheet, at the inboard end of the slope sheet. *Id.*



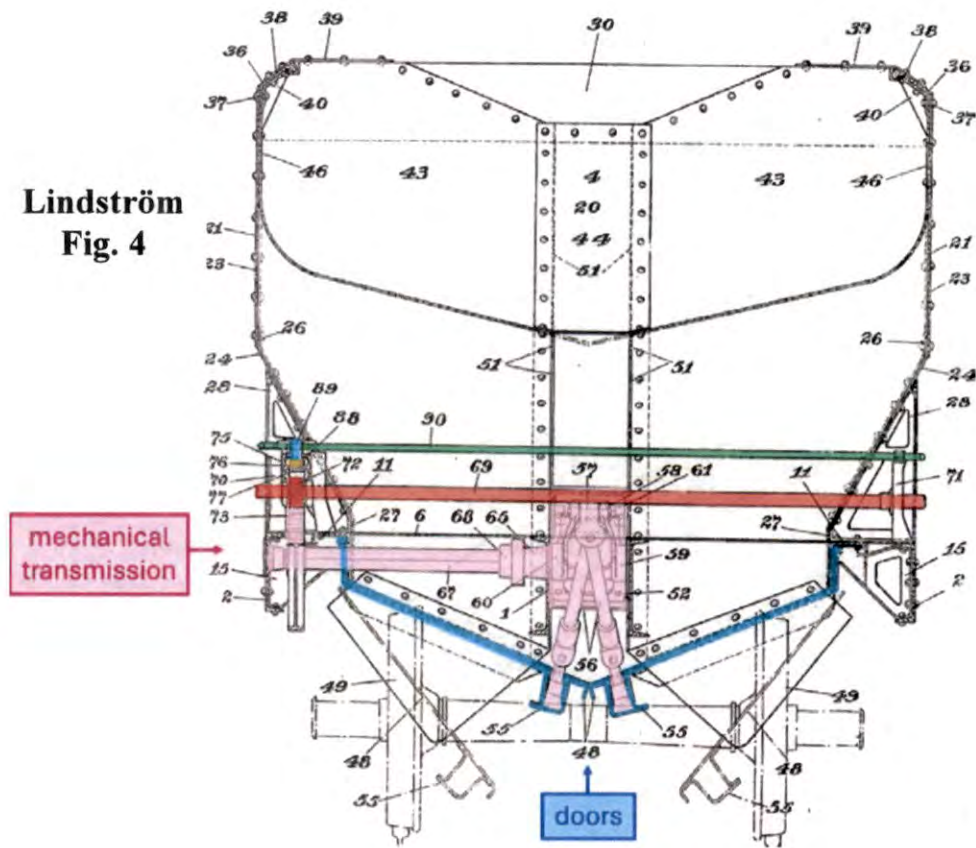
Id.

- g. [21] “a door actuator mounted above said shear plate, said door actuator being at least partially overhung by said first end slope sheet; said door actuator being connected to said door by a mechanical transmission;”

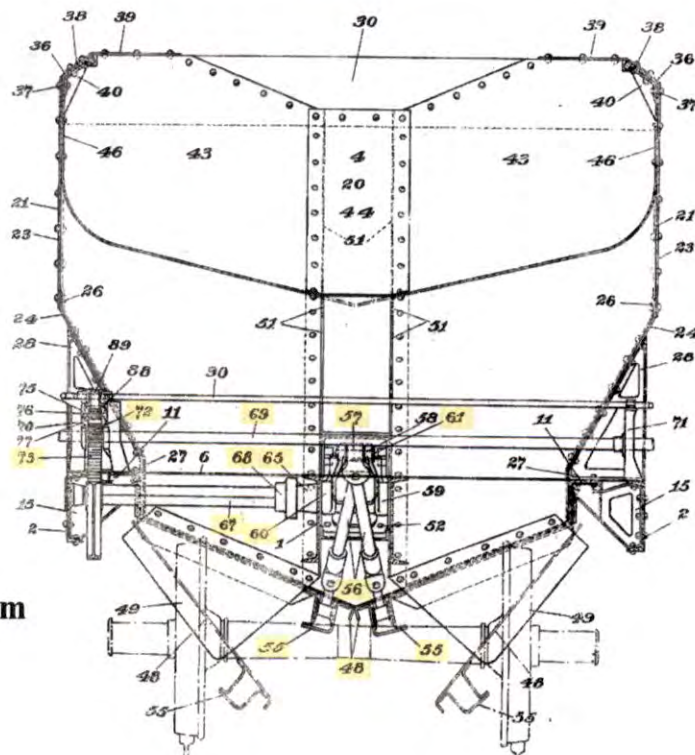
59. The 1946 Cyclopedia’s NSC ore car, as modified by Lindström, satisfies this claim limitation. As shown below, Lindström discloses a hopper car with a shear plate comprising plate 6 and an end slope sheet (“sloping end floor” 20). For opening hopper doors 48, Lindström discloses a door actuator comprising an operating shaft 69, a pinion 72, a toothed member 88, a pawl 89 and a rod 90.



Lindström
Fig. 4



Lindström
Fig. 4



sections extending along and under its free edge and projecting slightly on each end of the door. The ends of beams 55, 55 are connected through the medium of universally jointed links 56 to yokes 57, 57 pivotally mounted in crank frames 58, 58, which are preferably located between the sills 1, 1, and at each end of the doors. That is to say, *there is a pair of links 56 at each end of the discharge doors, one end of each of said links being connected to the end of its respective beam 55, the other end of each pair of links being brought together and pivotally mounted in the yoke 57.* Each of the crank frames which are oppositely disposed consists of a pair of crank arms 59, 60 connected together through the medium of a web 62. *At the free ends of the crank arm there is carried the crank pins 61 upon which the yokes 57 are directly mounted.* Each of the crank frames 58 is journaled, as later described, in the draft sills 1, 1 in such a position that when the discharge doors 48, 48 are closed, the links 56 and yoke 57 are on the dead center of the crank frame 58, or slightly beyond the same toward the sloping floor, so that the load on the doors tends to force the crank frame in the closing direction and thus the doors are automatically locked against opening from jars or shocks during transit. It will be noted from the drawings that the crank frames 58 are oppositely disposed so that through the medium of the yokes 57 and the links 56 they oppose each other, which arrangement is a further safeguard against accidental opening of the doors during transit.

The arms 59 of the crank frames 58 are journaled on trunnions 63, while the *arms 60 are provided with trunnions 64 having cylindrical outer bearing portions which are suitably journaled in bearing members 65* preferably integral with the members 52 secured between the sills 1, 1. Each of these trunnions is provided with a squared inner end which fits in a square perforation in the crank arm 60 and may form a member of the safety clutch hereinafter referred to. Trunnions 63 are each provided with a flange 66 which is preferably secured to the outer face of the sill 1.

For operating the crank frames 58, *shafts 67 are provided which are secured in the outer portions of the clutches hereinafter described* by any suitable means. The shafts 67 extend transversely from the clutches to the side of the car, and are supported at their outer ends by suitable bearings. Near the outer ends of the shafts 67, segments of gears are

secured thereto, connected with rack operating mechanism hereinafter described.

Safety clutches are introduced for the purpose of permitting the dropping of the doors quickly without danger to the operator. The clutch members 68 and the trunnions 64 are provided with projecting lugs, such lugs being in the same rotary plane so that *the lug in the clutch member 68 when rotating will strike the lug on the trunnion 64 and transmit motion to such trunnion 64* and, conversely, either the clutch member or the trunnion is capable of limited non-transmitting movement relative to the other. These clutches are of the same general character as described in United States Letters Patent Nos. 865,714, 865,920 and 865,921 granted to Charles A. Lindstrom. It will be noted that the crank frames 58, in dropping the doors will make about one half revolution, and this being the case, because of the interposition of the clutches, such movement will not be transmitted to the shafts 67, and hence will be independent of shafts 67 and the balance of the mechanism.

It is necessary that the two crank frames 58 operate simultaneously to prevent undue strain on either side of a door due to one crank frame operating before the other, also that the two crank frames move away from the end sloping floors when the doors are being opened and toward the floors when the doors are being closed, which enables the placing of the crank frames closer to the floors and also allows the use of straight connections to the beams 55; further, as the load on the doors is naturally great, on account of the size of the doors as well as the nature of the lading, a power increasing mechanism is necessary. For this purpose the two shafts 67 are operatively connected to a common operating shaft 69, preferably extending transversely of the car and journaled in bearings 70 and 71. *The shaft 69 is connected to one of the shafts 67 through the medium of a pinion 72 secured on the shaft 69, meshing with a segment gear 73 on the shaft 67*, such segment gear projecting upwardly between the side sill 2 and the member 11, and shaft 69 being preferably located above the horizontal plane of the upper surfaces of the side and draft sills. The operating shaft 69 is connected with the other shaft 67 by means of a segment gear 74 on the shaft 67, the pinion 72 on the shaft 69 and toothed racks 75 meshing with and operatively connecting said segment gear 74 and pinion 72.

The rack 75 comprises a member 76 which is preferably of I form having toothed members 77 and 78 attached to its horizontally disposed web in such position as to mesh with the pinion 72 and the segment gear 74 respectively. The toothed member 78 is attached to the web of the member 76 through the medium of bolts 79 which pass through perforations in the member 78 and through slotted perforations 80 in the member 76, such bolts being held in position by nuts or other suitable means. To the member 76, intermediate the members 77 and 78, a bracket 81 is secured. Held within this bracket and extending outwardly therefrom is a threaded member 82 which is adapted to pass through a perforation in the lug 83 of the member 78. This member 82 is provided with nuts 84 and 85 which are adapted to engage the opposite faces of the lug 83 and hold the member 78 in any desired position. When for any reason it is desired to lengthen or shorten the distance between the members 77 and 78 the nuts 84 and 85 are turned to affect such adjustment.

The rack 75 is supported in operative position by means of brackets 86 and 70, projections being provided on the inner sides of the vertical portion of the sides of the brackets, on which slide the side extensions or flanges of the rack. The rack is retained in such a position, that the teeth shall be in mesh with the teeth of the pinion 72 and segment gear 74, by means of rollers 87 which contact with the upper portions of the rack, and which are held in such position by means of pins which are passed through the upward extensions of the brackets 86 and 70. Intermediate the brackets 86 and 70 the rack is retained in position by a roller journaled between the lugs 28a which are preferably integral with one of the members 28.

Id. at 4:43-5:96. As shown in the figures above, Lindström's door actuator is mounted above the shear plate and is at least partially overhung by the end slope sheet.

60. It would have been obvious to modify the 1946 Cyclopedia's NSC ore car to add a door opening mechanism like Lindström's, including the door actuator. A POSITA would have been motivated to make that modification. For example,

Lindström and the 1946 Cyclopedia are in the same field of hopper railcars. EX1004 at 294-95 (“ore car” with a hopper); EX1005 at 1:11-13 & Figs 1-2 (“dumping car” with a hopper). That is the same field to which every claim of the ’892 patent is directed. EX1001, Cl. 1-2 preambles (each independent claim is directed to a “rail road hopper car”). As another example, the NSC ore car has a configuration similar to that of Lindström’s car—for instance, both cars have similar views that disclose similar arrangements of claimed features such as hoppers, trucks, lower discharge, slope sheets, side sills, top chords, sidewalls, sidewall stiffeners with lower portions outside the sidewall and upper portions inside the sidewall in web continuity. *Compare, e.g.,* EX1004 at 294 *with* EX1005 Figs. 1, 2, 5. Further, the NSC ore car would have required a door-opening mechanism; indeed, such mechanisms were ubiquitous on bottom-discharge ore cars. Thus, a POSITA would have known that some door opening mechanism is necessary for NSC’s ore car to function properly and that the absence of a door-opening mechanism in the NSC car drawings indicates that the particular mechanism is not critical and that any suitable mechanism would work. Given that the two cars are similar in overall configuration, a POSITA would have had a reasonable expectation of success in incorporating a door-opening mechanism like Lindström’s in the NSC ore-car design.

- h. [2m] “said first end section being free of longitudinally oriented elephant ears extending between said draft sill and said first end slope sheet;”

61. The NSC ore car disclosed in the 1946 Cyclopedia does not have elephant ears. The '892 patent states:

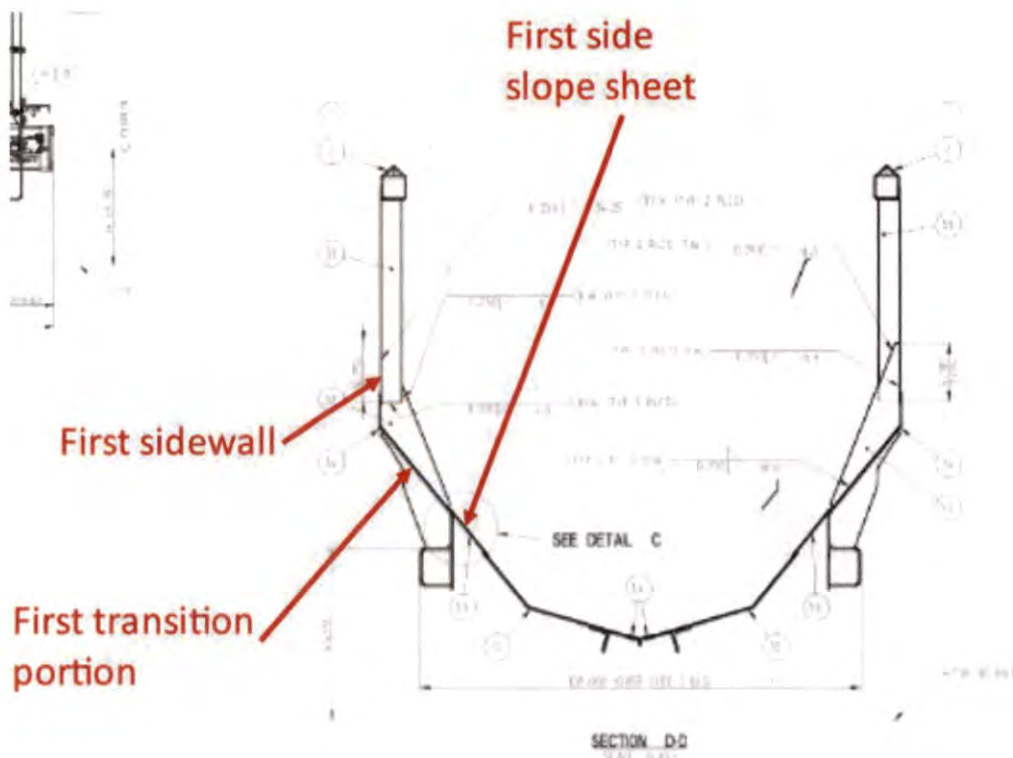
Car 20 has an end of car machinery space, indicated generally as 75, that is bounded by shear plate 76 on the bottom, the sloped end wall assembly 30 or 32 of the car on the top, main vertical central end post 80, and main side posts 82, 84 at the ends of main bolster 90. . . .

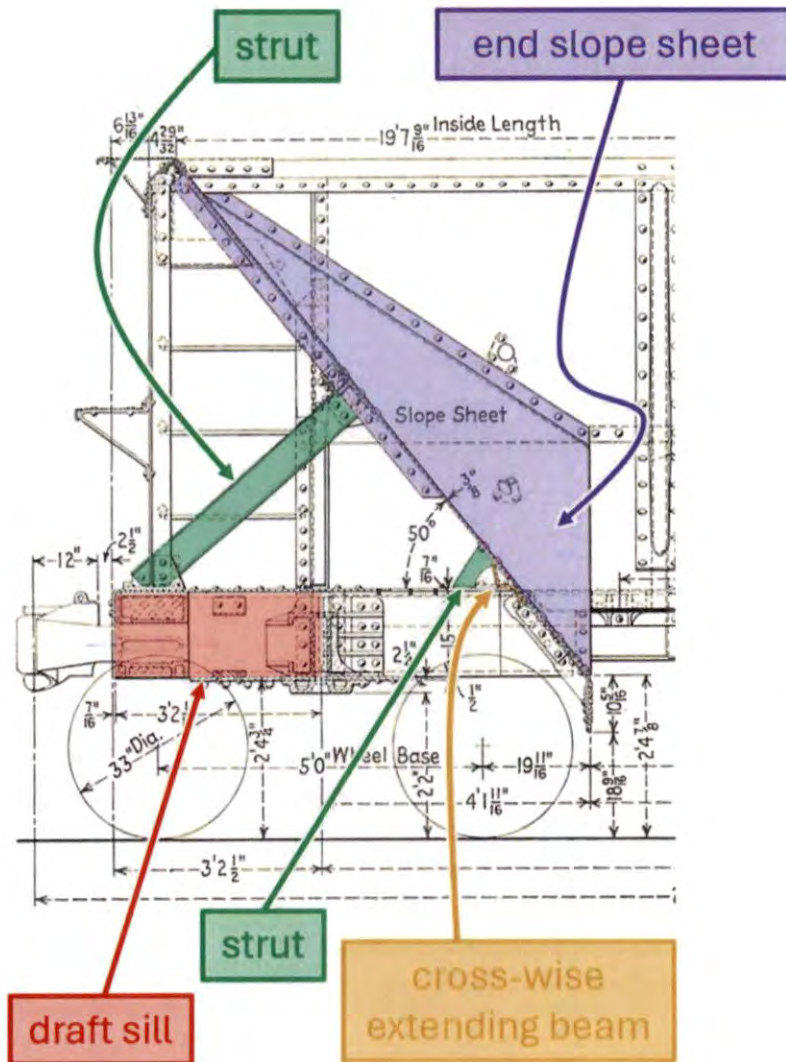
In existing cars, this space, 75, is often occupied or otherwise obstructed by other primary structure, such as so-called “elephant ears”. In this context, **“elephant ears” are large, substantially triangular planar plates**, sometimes provided with central lightening holes, ***that have one edge fixed along the junction of the center sill webs and the center sill cover plate***, and another edge welded to the end slope sheet. The third edge is typically a free edge.

EX1001 at 14:38-63 (emphasis added). As shown in the figures below, the NSC ore car does not have large triangular plates. Instead, the slope sheet is supported by two crosswise beams (one near the shear plate and another at the top of the slope sheet), a large strut positioned at a right angle to the slope sheet, and two small struts positioned near the bottom of the slope sheet. EX1004 at 294. The large strut and one of the two small struts may be seen in the drawing below. *Id.* Besides not being elephant ears, the small struts do not extend from the draft sill. *Id.* The '892 patent defines the draft sill as the portion of the center sill outboard of truck center. *Id.*; *see also* EX1001 at 14:31-34.

- b. [6b] “said hopper includes first and second sloped side sheets; and said first sloped side sheet meets said first sidewall at said transition portion.”

63. I have reviewed the infringement claim chart for Claim 6 that NSC served in the litigation *National Steel Car Limited v. FreightCar America, Inc. et al.*, No. 1:24-cv-00594 (D. Del.). That claim chart, shown below, explains NSC’s position on what portions of the accused products satisfy the elements of Claim 6. I note that NSC’s chart for Claim 6 substitutes the term “side slope sheet” for the claim term “sloped side sheet.” Thus, I understand NSC has construed “sloped side sheet” to refer to the “side slope sheet” 50 in the ’892 patent. This is confirmed by the arrows in NSC’s chart, point to a portion of the hopper that is not part of the side sheet.





EX1004, p.294.

2. Dependent Claim 6:

- a. [6a] "The rail road hopper car of claim 2 wherein said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof;"

62. This limitation is included here for reference.

64. The '892 patent's specification states: "The upper margin of the *side slope sheet 50* of the hopper discharge section is welded to the lower margin of the inclined or *sloped portion 98*, such that the structure presents a continuous sloped surface for containing, and then slidingly discharging, particulate lading." EX1001 at 15:46-50.

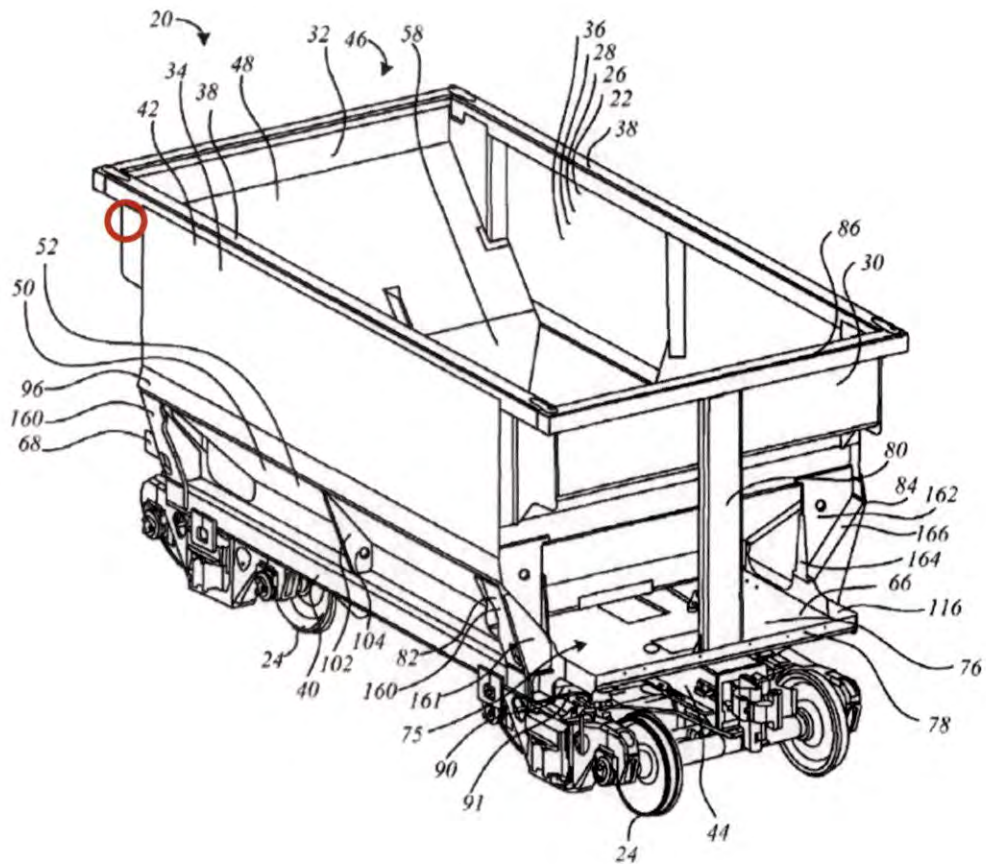


Figure 1

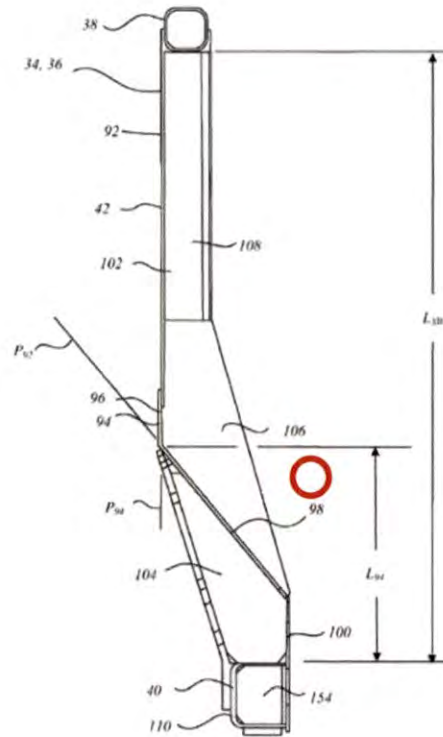


Figure 2c

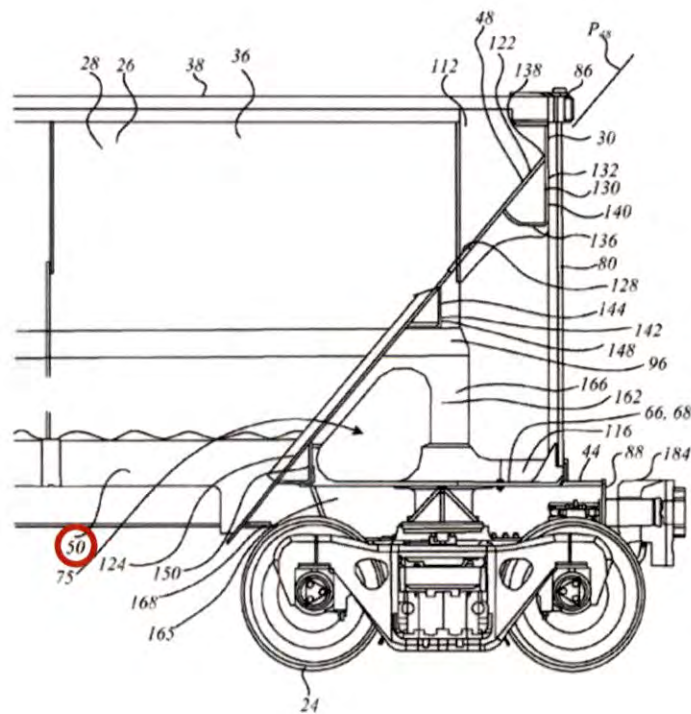
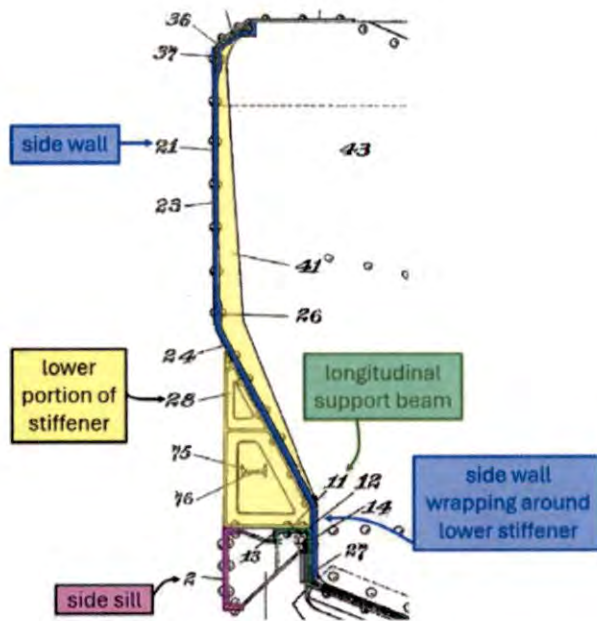


Figure 3b

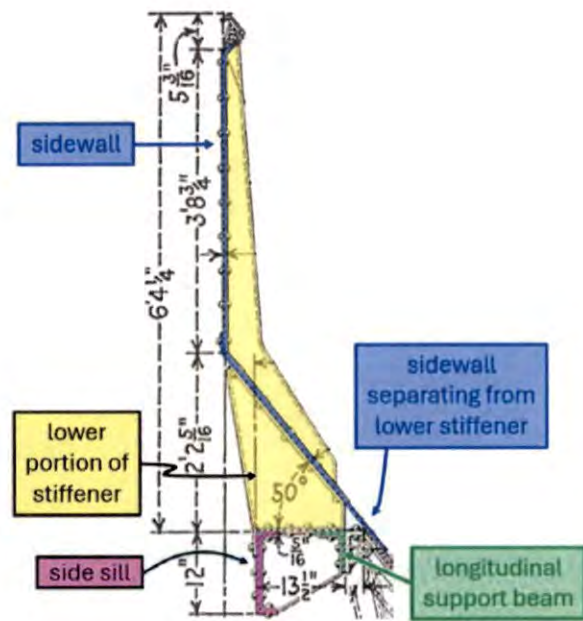
Id. at Figs. 1, 2c, 3b.

65. Under NSC's construction, which interprets "sloped side sheet" to refer to the "side slope sheet" 50, limitation [6b] is satisfied by an obvious modification of the 1946 Cyclopedia's NSC ore-car design in view of Lindström.

As shown below, both the 1946 Cyclopedia's NSC ore car and Lindström disclose sidewalls that extend downwards from a top chord and then pass from outboard to inboard across a two-part sidewall stiffener. Both references also disclose the lower portion of the stiffener being supported by a side sill on the outboard end and a longitudinal support beam on the inboard end. A difference between the references is that, at the inboard margin of the lower portion of the stiffener, the 1946 Cyclopedia's NSC ore car discloses the sidewall separating from the stiffener and continuing its downward-inboard slope; whereas Lindström discloses the sidewall remaining connected to the stiffener and sloping downward. The sidewall that Lindström discloses wraps around the inward side of the lower portion of the stiffener (28) and the longitudinally extending support member (11).



**Lindström
Fig. 5**



**NSC Ore Car
(Unmodified)**

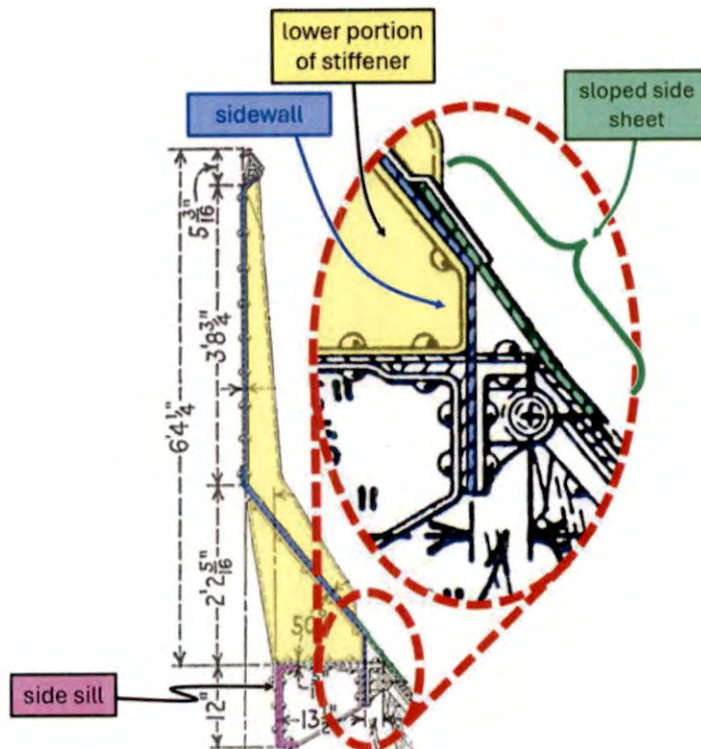
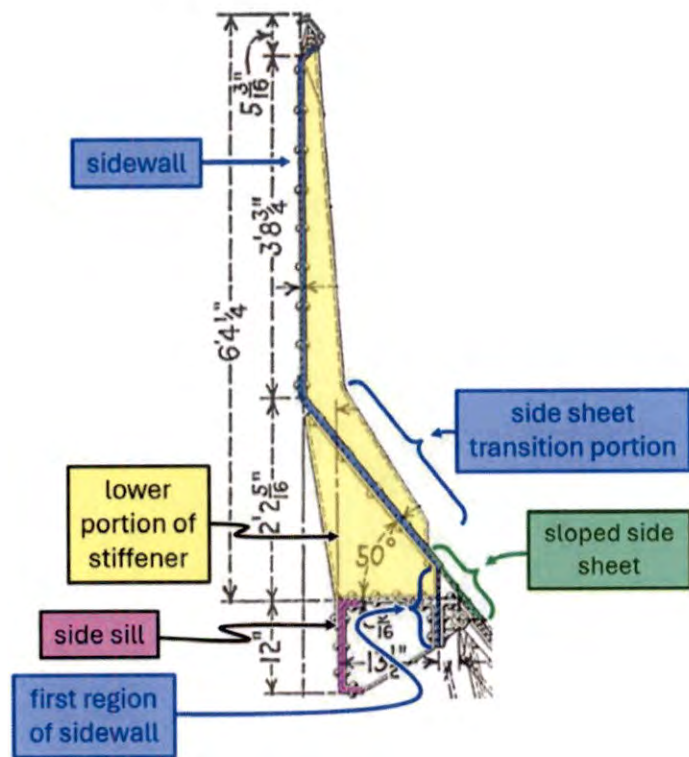
EX1005, Fig. 5; EX1004 at 294.

66. In view of Lindström, it would have been obvious to modify the side wall of the 1946 Cyclopedia's NSC ore car so that it too wraps around the inward side of the lower stiffener. The NSC ore car was ready for this improvement. As shown above, the NSC ore car has the same relevant structures as Lindström, arranged in the same way as in Lindström. For example, in both references, the inward side the lower stiffener is above and aligned with the inward side of the longitudinal support beam, which allows the sidewall to be secured thereto. The modification would also yield predictable results, including providing additional lateral stability to the side wall. A POSITA would have been motivated to make the

modification to provide such additional lateral stability to the side wall. A POSITA would understand that the lading in the hopper would tend to push the side wall and stiffener laterally outward, and that wrapping the bottom of the side wall around the stiffener and longitudinal support beam would help stabilize the side wall and stiffener against movement in the laterally outward direction. The modification amounts to mere application of a known technique (i.e., wrapping the side wall around the inward side of the stiffener) to a known device (i.e., the NSC ore car) that is ready for improvement to yield predictable results (e.g., providing additional lateral stability to the side wall).

67. After that modification, it would have been obvious to add a sloped side sheet, as shown below in green. A POSITA would be motivated to make this addition to ensure the side wall of the hopper has a continuous sloped surface without discontinuities that could impede the movement of the lading to the hopper doors. The unmodified NSC ore car, for example, teaches such a continuous sloped surface. The addition of a slope side sheet would simply replace the segment of the NSC ore car's sidewall that had extended downward and inboard of the outer stiffener before modification.

68. Modified in this way, the "first sloped side sheet meets said first sidewall at said transition portion."



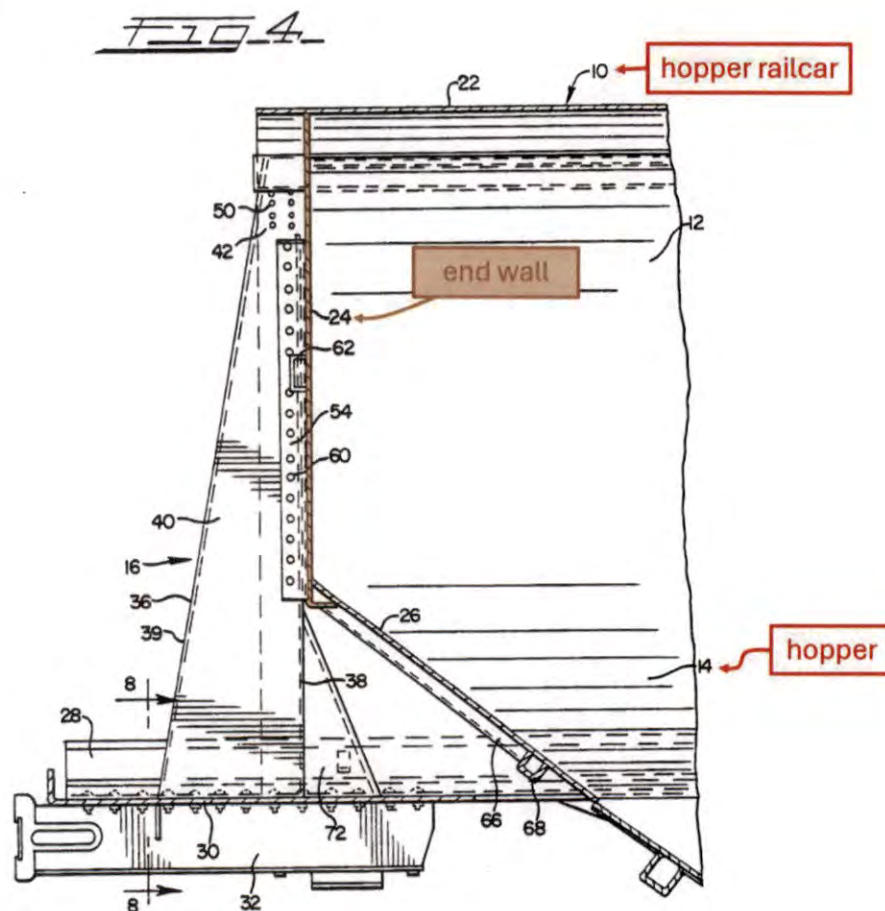
EX1004 at 294 (modified).

C. Ground 1c: Claim 9 – obviousness over the 1946 Cyclopedia in view of Lindström and Wong.

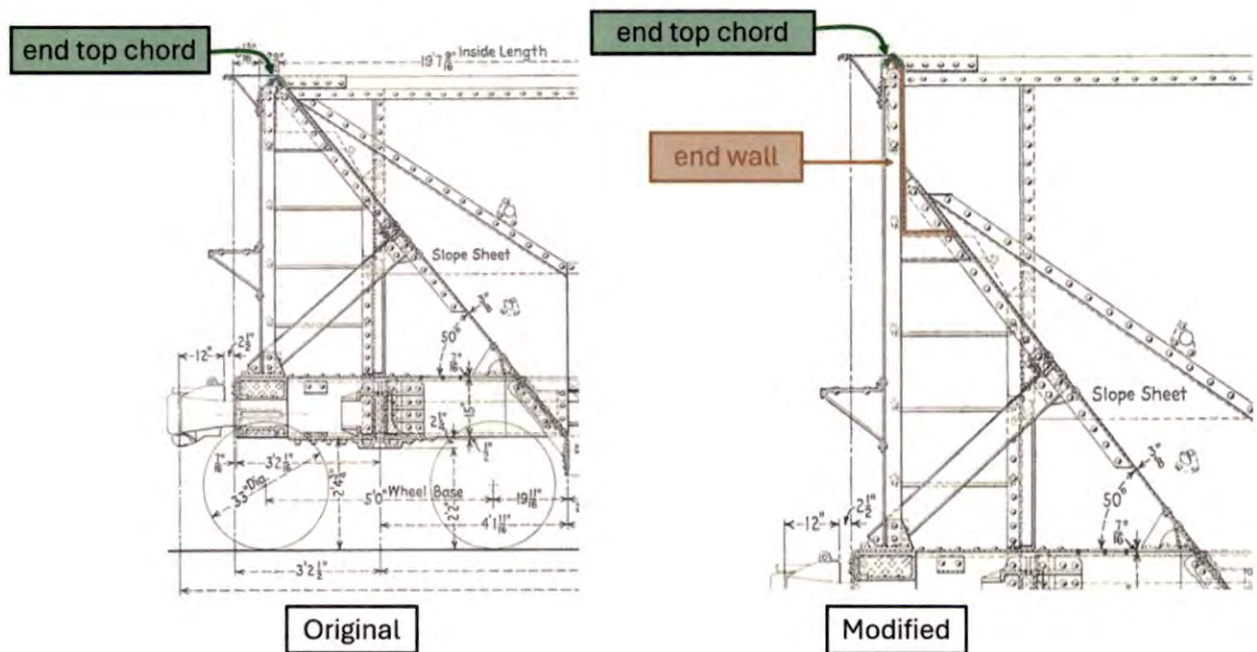
1. Dependent Claim 9:

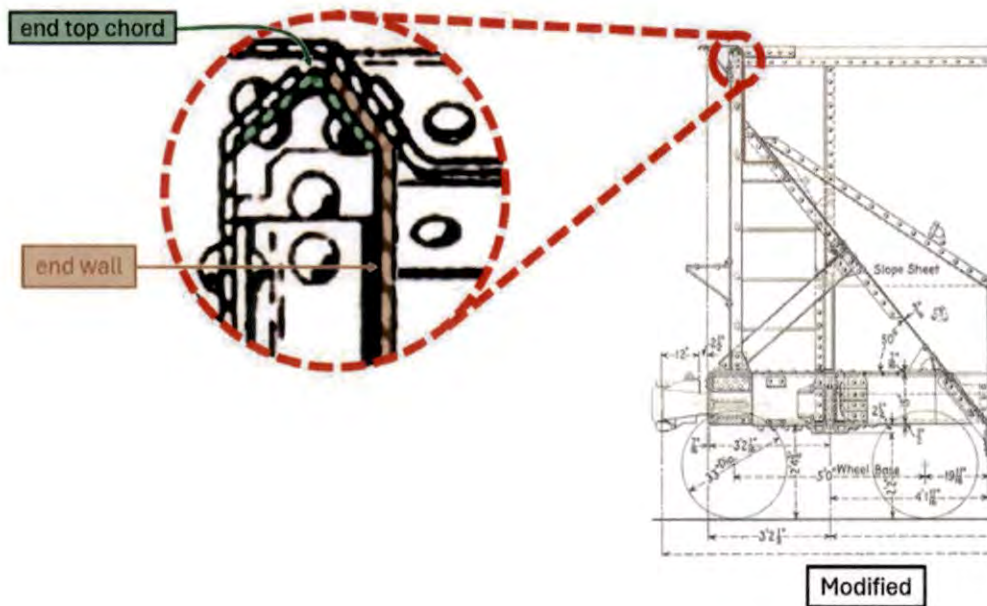
- a. [9a] “The rail road hopper car of claim 8 wherein said hopper has an end wall extending downward of said end top chord;

69. The 1946 Cyclopedia's NSC ore car, as modified in view of Wong, discloses this limitation. As shown below, Wong discloses a rail road hopper car ("hopper railcar" 10) with a hopper ("hopper" 14) and an end wall ("end sheet" 24) extending downward from the top of the rail car.



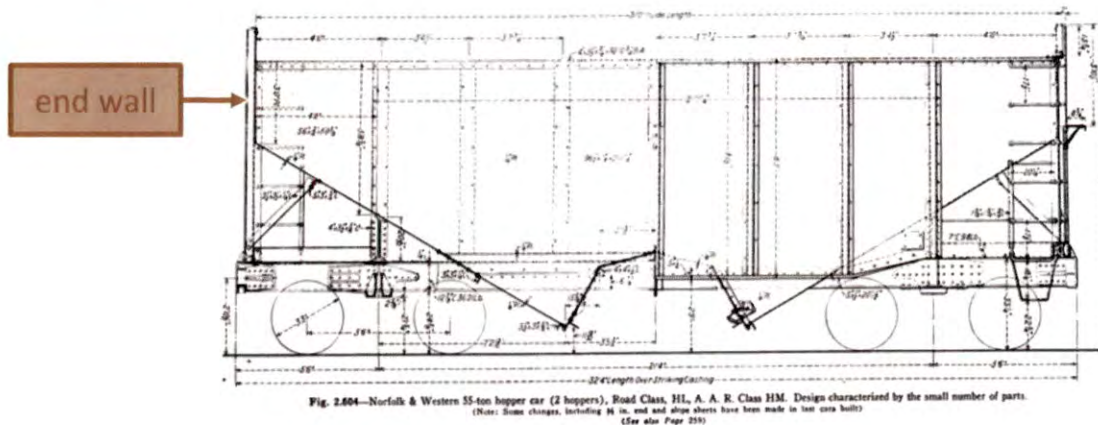
EX1006, Fig. 4. It would have been obvious to modify the 1946 Cyclopedia's NSC ore car to include an end wall similar to Wong's. As illustrated below, the modified car would disclose limitation [9a]. The modification could be made by either of two methods. First, by leaving the end slope sheets in place and increasing the overall height of the hopper. Second, by reducing the inclination of the slope sheets so that their outboard ends terminate at a lower height (*i.e.*, lower along the end wall). The exemplary illustration below shows such a modification using the first method:



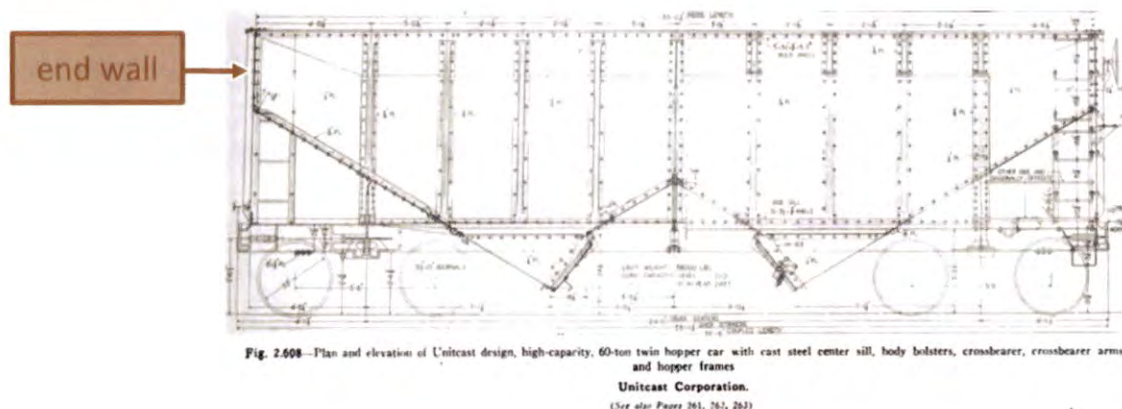


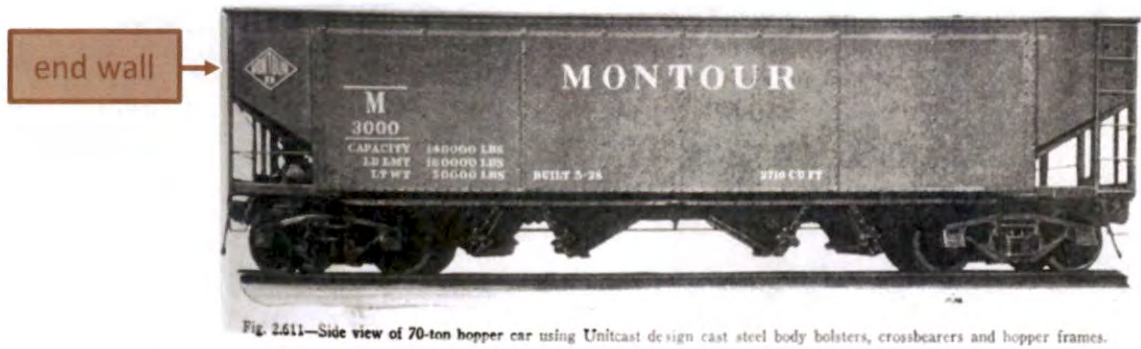
EX1004 at 294 (modified). In this simple modification, the height of the end post and side walls are increased, and the end top chord is shifted slightly longitudinally outboard such that the end post provides longitudinal support for the end wall. A POSITA would have had reason to modify the NSC design to incorporate an end wall, as in Wong. **First**, doing so would increase the hopper's volume without increasing the rail car's length or width (or even its height, if the end wall is added by altering the inclination of the slope sheets). Increasing volume was desirable, as it would enable the end user to load and unload the same amount of ore in fewer cars, which saves time. Indeed, Coates described how the L&Y Hopper Car was modified in this way in the 1904-1906 time frame, increasing the height of the hopper walls on the car by nine inches to increase the hopper's capacity. EX1007 at 262-65. **Second**, by decades before the 2009 priority date, end walls were common

and well-known optional features of hopper cars. For example, the 1946 Cyclopedia shows multiple examples of hopper cars with end walls, such as the following:



EX1004 at 258-59 (Norfolk & Western 55-ton hopper car).

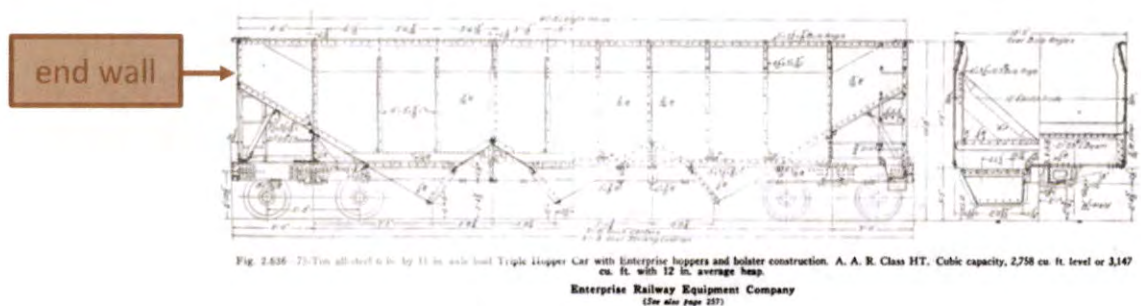




Id. at 260, 263 (Unicast Corporation hopper cars).

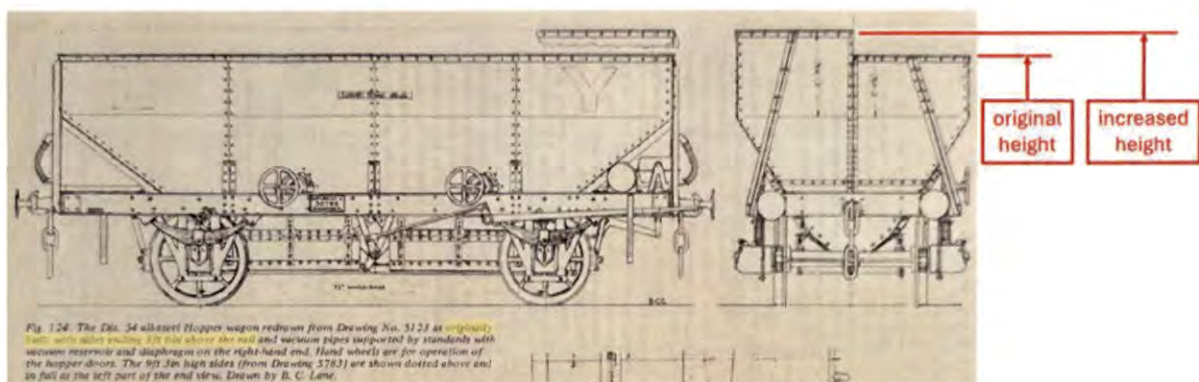


Id. at 277 (Bessemer & Lake Erie hopper car).



Id. at 275 (Enterprise hopper car). **Third**, incorporating an end wall (such as Wong's) in the NSC design would have been obvious to a POSITA because it is one of a finite number of well-understood options for the end of a hopper car. Those

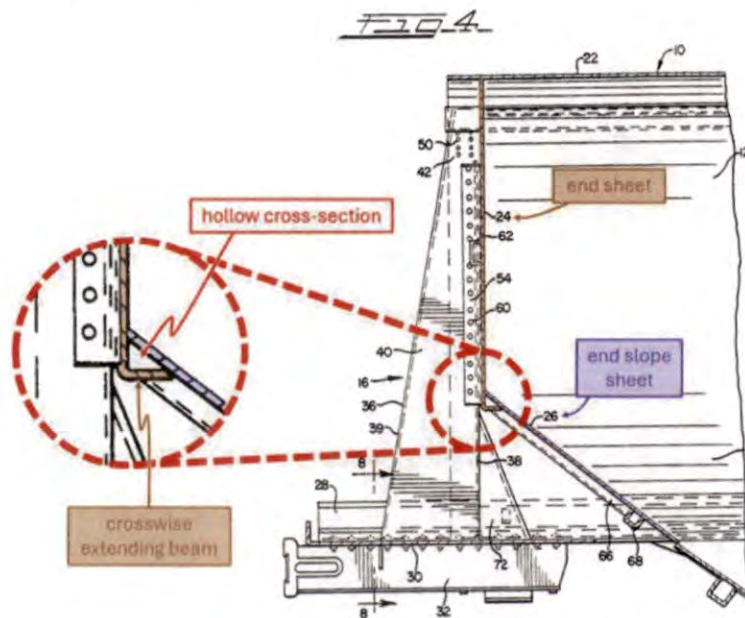
options are (i) incorporating an end wall or (ii) extending the slope sheet to the end top cord. A POSTIA would decide between these two options by considering design constraints that are standard and well-understood. These include conforming to maximum exterior dimensions of the railcar, maximizing hopper capacity, supporting the loads within the hopper including those seen at the slope sheet and hopper doors, and maximizing the car's efficiency in loading and discharging its intended lading. **Fourth**, Coates contains a suggestion to modify the NSC design to incorporate an end wall, as in Wong. As shown below, Coates describes how the height of the hopper walls on the L&Y Hopper Car was increased by nine inches—8'6" to 9'3" (see caption in the image below)—in the 1904-1906 time frame to increase the hopper's capacity. EX1007 at 263. This suggests increasing the height of the hopper walls of the NSC design, which would increase the height of the side walls and create end walls.



Id. at 262. Further, because end walls had been commonplace for decades before 2009, a POSITA would have had a reasonable expectation of success in incorporating an end wall in the NSC design disclosed in the 1946 Cyclopedia.

- b. [9b] “said upper, longitudinally outboard end of said first end slope sheet meets said downwardly extending end wall;
and said first cross-wise extending beam is located where said downwardly extending end wall meets said first end slope sheet; and
said first cross-wise extending beam is of hollow cross-section.”

70. The 1946 Cyclopedia’s NSC ore car, as further modified in view of Wong, discloses this limitation. Wong’s end wall, discussed above, is bent inwards at its lower end to contact the underside of the slope sheet. EX1006, Fig. 4. As shown below, this creates a hollow support beam that runs crosswise underneath the upper end of the slope sheet.



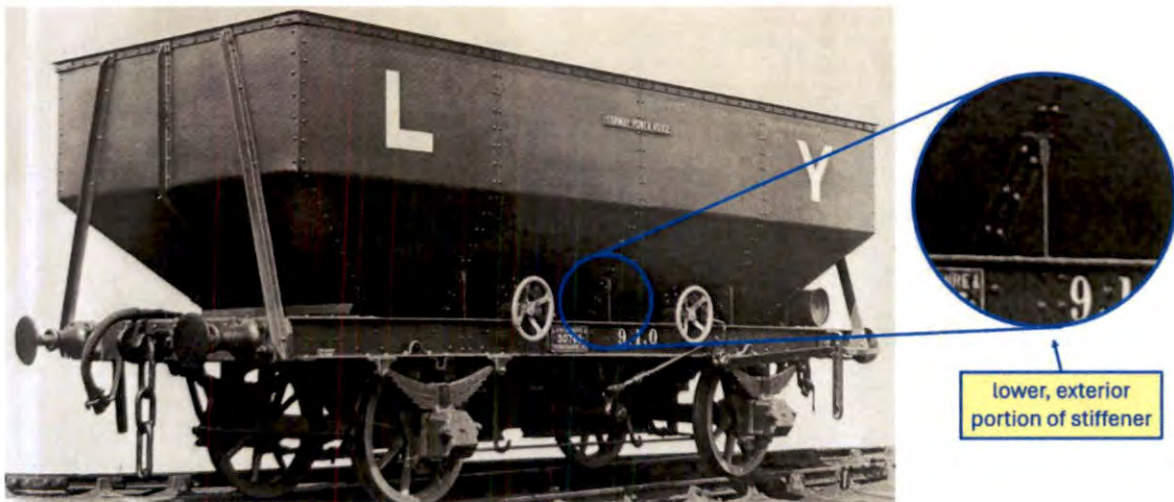
Id. As discussed above, it would have been obvious to modify the NSC ore car disclosed in the 1946 Cyclopedia to add an end wall, as in Wong. It also would have been obvious to use the specific end wall shown in Wong with a bent lower end, thereby forming the claimed crosswise extending beam. **First**, that modification employs well-known elements (end walls and end slope sheets) according to known methods (bending a flange of the end wall to create two lines of contact) to yield the predictable result of providing additional support for the slope sheet. **Second**, the modification uses the known technique of bending a flange of the end wall to support the end slope sheet that is taught in the “hopper railcar” of Wong (EX1006 at Abstract) to improve another hopper railcar (i.e., the NSC ore car in the 1946 Cyclopedia) in the same way. **Third**, the NSC ore car in the 1946 Cyclopedia was ready for the improvement of adding the end wall of Wong having a bent lower end. The NSC ore car possessed other structures to support that addition, including an end post for providing longitudinal support for the end wall, sidewalls that can be extended upwards, and an upper and longitudinally outboard flange of the sidewall that can provide lateral support for the end wall and bent lower end. EX1004 at 294-95. Applying the known technique of bending a flange of the end wall to support the end slope sheet to the NSC ore car in the 1946 Cyclopedia that was ready for that improvement would yield the predictable result of providing additional support for the end slope sheet. Moreover, a POSITA would have had a reasonable expectation

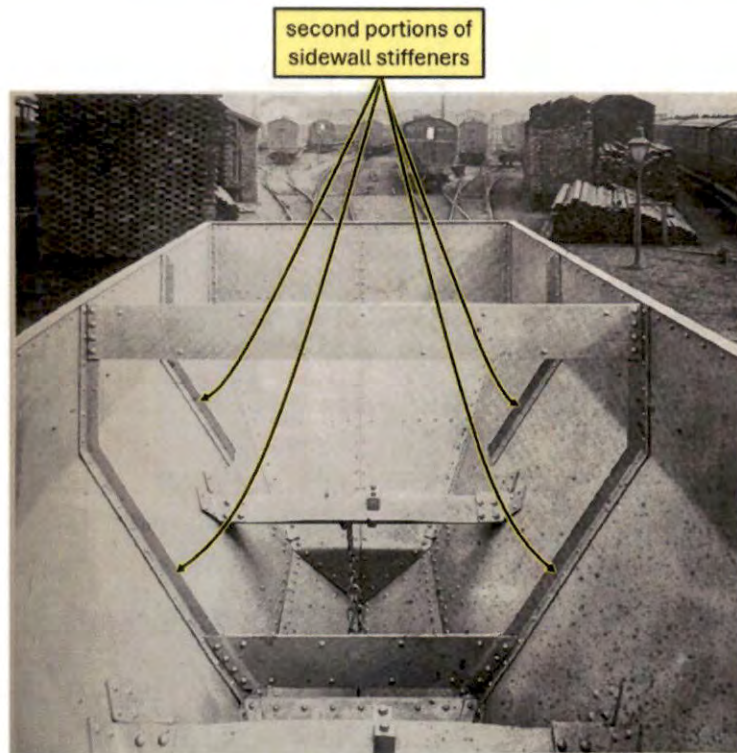
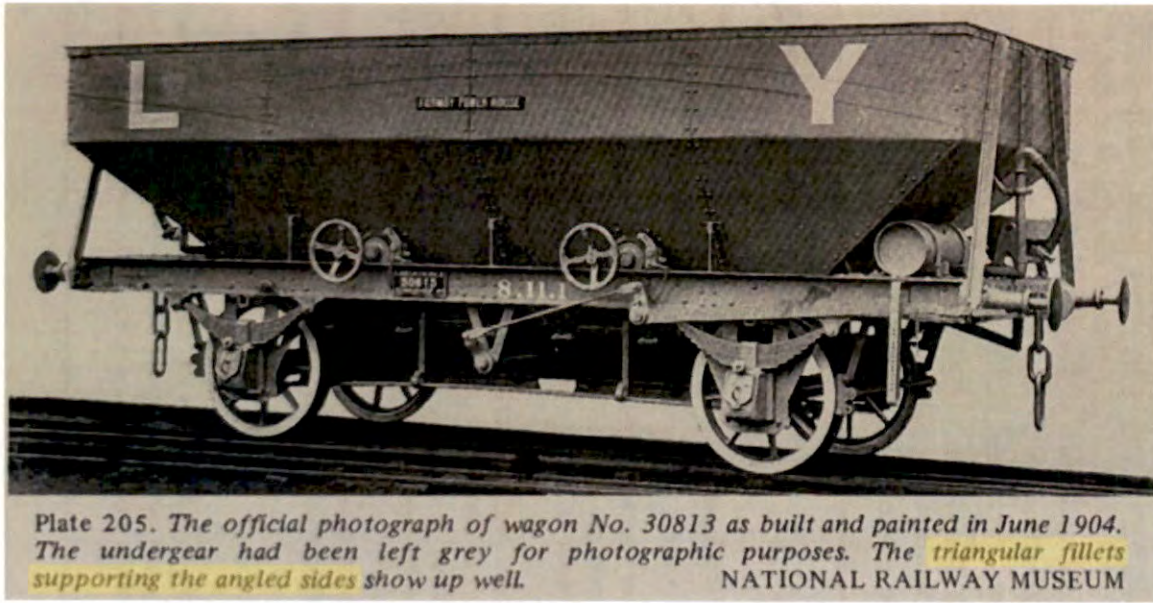
[illegible]

D. Ground 1d: Claim 15 – obviousness over the art in Ground 1b in view of Coates.

71. As shown below, Coates contains photographs of the L&Y Hopper Car sidewall stiffener having a lower, exterior (first) portion and an upper, interior

(second) portion aligned in the same vertical plane. The lower, exterior portion of the stiffener is a triangular flat bar mounted to the side wall with a pair of L-brackets and rivets. This can be seen most clearly in the enlarged portion of the first image appearing below. The caption in the second image appearing below specifically identifies these flat bars as “triangular fillets” supporting the angled sides. In the L&Y Hopper Car, the stiffener’s upper, interior portion is disclosed as a generally rectangular flat bar that is attached to the side sheet with a flange and rivets; this is shown in the third image appearing below.





EX1007 at 262-64, front cover. A POSITA would have had reason to make the stiffener of flat bar, and would have had a reasonable expectation of success in doing so. Flat bar is a common, inexpensive material that was regularly used in rail cars

long before 2009—indeed, back to at least the 1904-1906 L&Y hopper car. EX1007 at 262-64. Flat bar is particularly appropriate for use as a stiffener because it efficiently provides support in the vertical-transverse plane in which the sidewalls are loaded. Indeed, adding material to support the sidewalls in another plane would be largely wasted, leaving flat bar as the most efficient choice for the sidewall stiffeners in the 1946 Cyclopedia’s NSC ore car. Choosing flat bar as the material for the NSC ore car amounts to the simple substitution of one known material (i.e., flat bar) for another to obtain the predictable result of supporting the side wall. Flat bar is also one of a small number of identified, predictable materials for a sidewall stiffener. Incorporating flat bar as the material for NSC ore car’s sidewall stiffener would have been a simple process of using known methods and materials in an ordinary way—e.g., cutting the flat bar to the desired shape and connecting it to the sidewall with flanges and rivets. Thus, a POSITA would have had a reasonable expectation of successfully incorporating that material.

E. Ground 2a: Claim 1 – anticipation by Lindström, or at least obviousness over Lindström in view of the 1946 Cyclopedia.

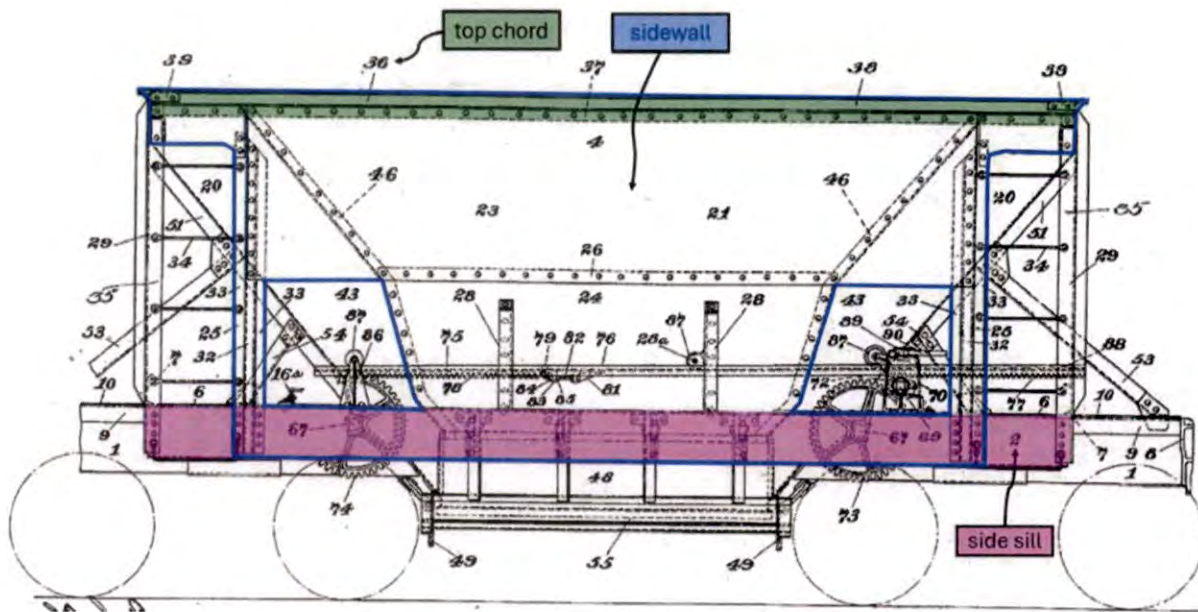
1. Independent Claim 1

- a. [1d] “said rail road car having a side sill and a top chord; said first upstanding sidewall extending from said side sill to said top chord;”**

72. Lindström discloses this limitation, as shown in Fig. 2 below.

Lindström discloses said rail road car having a side sill (“side sills” 2) and a top

chord (“top members” 36); said first upstanding sidewall (“combined side walls and sloping floors” 21 that “preferably comprise an upper side plate 23 and a lower or sloping floor plate 24,” EX1005 at 2:84-89) extending from said side sill to said top chord (shown in the figure below).



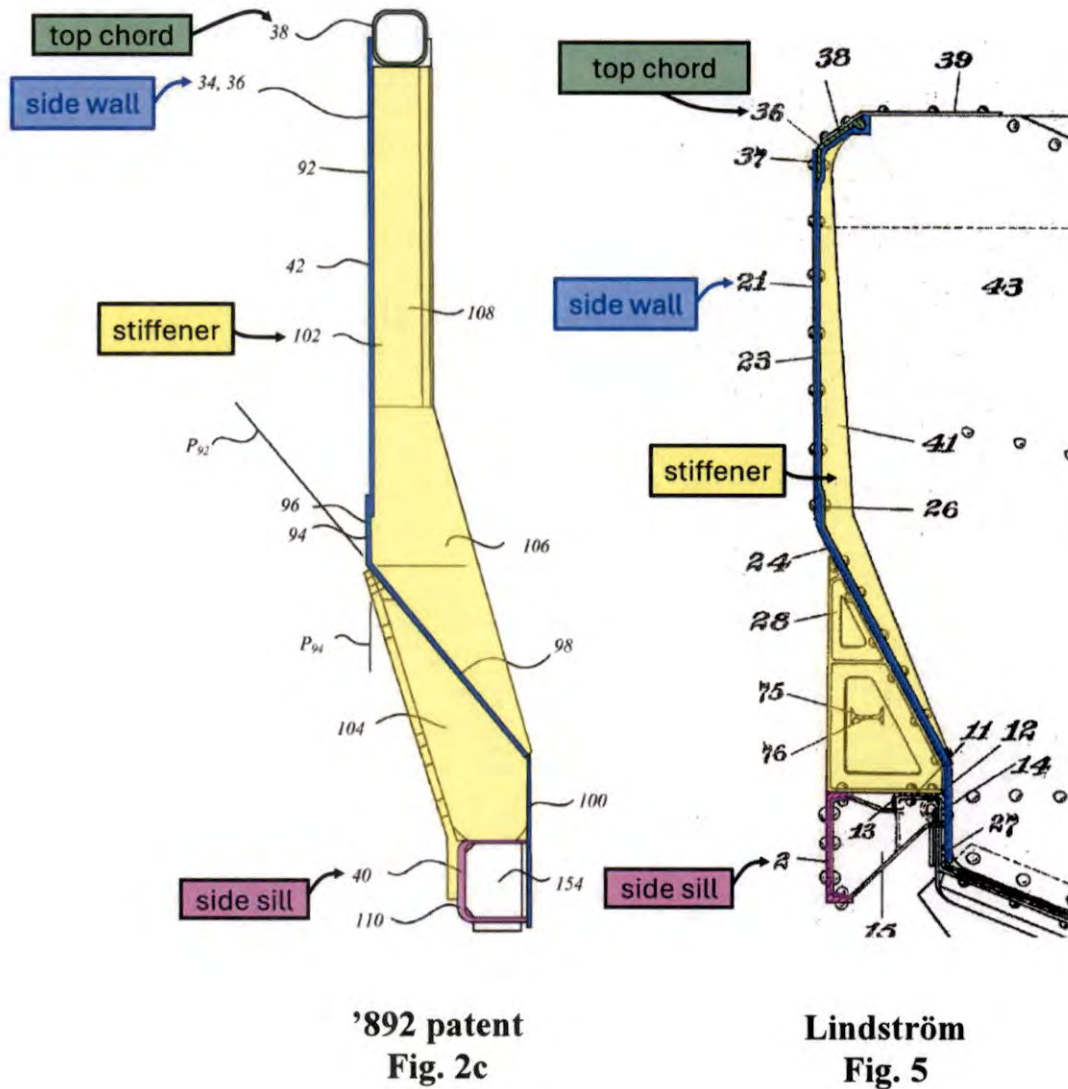
EX1005, Fig. 2.

- b. [1e] “said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;”

73. Lindström discloses this limitation, as shown below. As in the '892 patent, Lindström's side-wall stiffener has two portions: an upper portion attached to the interior surface of the side wall (stiffening “stakes” 41), and a lower portion attached to the exterior of the sidewall (stiffening “members” 28). EX1005, Fig. 5.

A POSITA would understand that both “stakes” 41 and “members” 28 are stiffeners

for the sidewall. Indeed, Lindström explicitly states: “*To assist in supporting and stiffening the combined side walls and sloping floor plate 21, 21, members 28 are provided* which are preferably of triangular form and secured to the longitudinally extending columns, viz., to the side sills 2, 2 and the members 11, 11 thereof, and to the sloping floor plates 24, 24.” EX1005 at 2:111-19. Lindström also states: “*To further stiffen and strengthen the combined side walls and sloping floors 21, 21 stakes 41 are provided* which are preferably of U-shape in cross section having lateral flanges, which are secured to the plates 23 and 24 by rivets or other suitable means.” *Id.* at 3:39-45. Moreover, Lindström’s “stakes” 41 and “members” 28 have the same shape and position as was common for sidewall stiffeners. *E.g.*, EX1004 at 294-95 (1946 Cyclopedia’s NSC ore car).



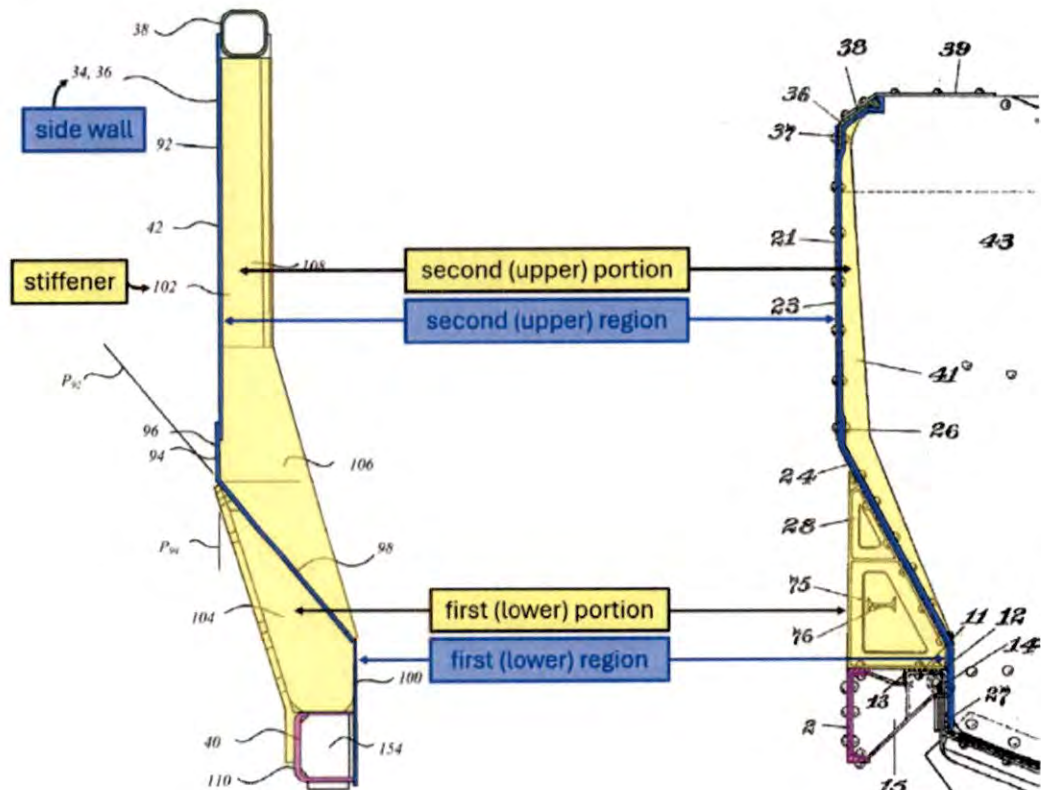
EX1001, Fig. 2c; EX1005, Fig. 5.

- c. [1g] “said sidewall stiffener having a first portion, said first portion being a lower portion thereof, said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion

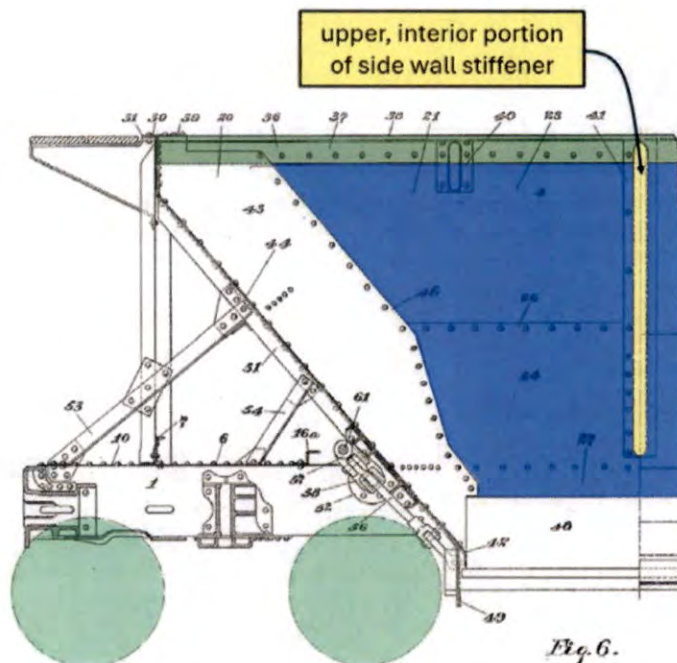
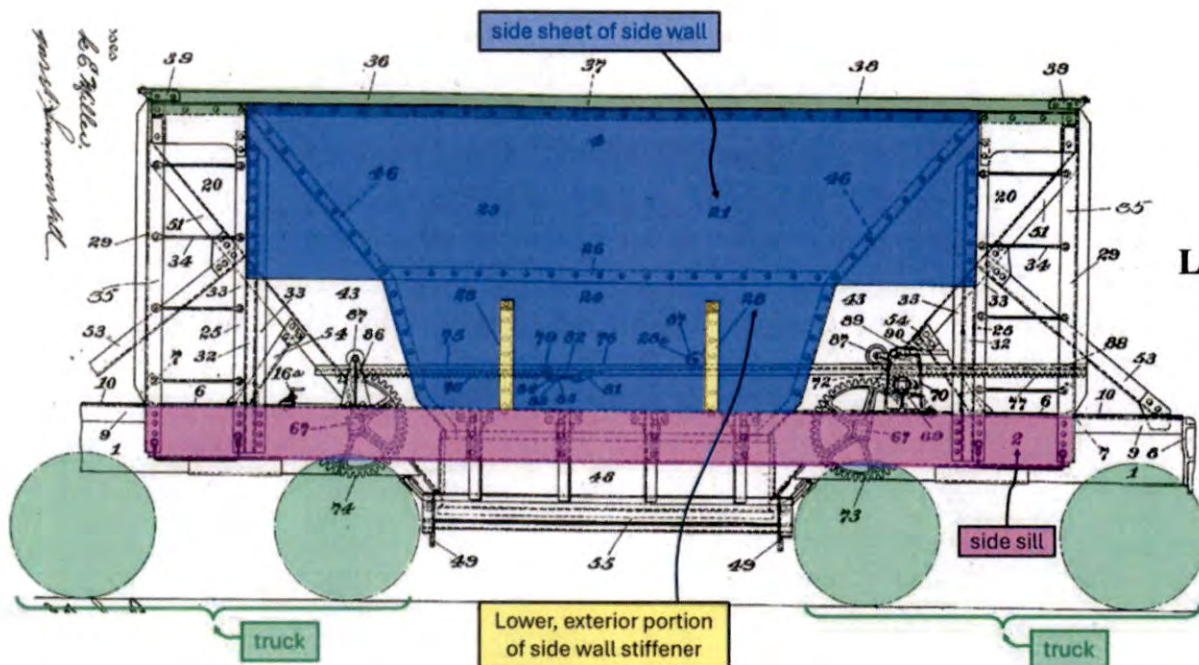
being mounted to said second region of said first upstanding sidewall;”

74. Lindström discloses this limitation, as shown below. Both portions of the side-wall stiffener may be seen in Lindström’s Fig. 5, which is an end view. See *supra* § V. E.1.b (discussing stiffening “stakes” 41 and stiffening “members” 28). The lower, exterior portion may also be seen in Lindström’s Fig. 2, which is a side view. The upper, interior portion may also be seen in Fig. 6, which is a cross-sectional side view.



'892 patent
Fig. 2c

Lindström
Fig. 5

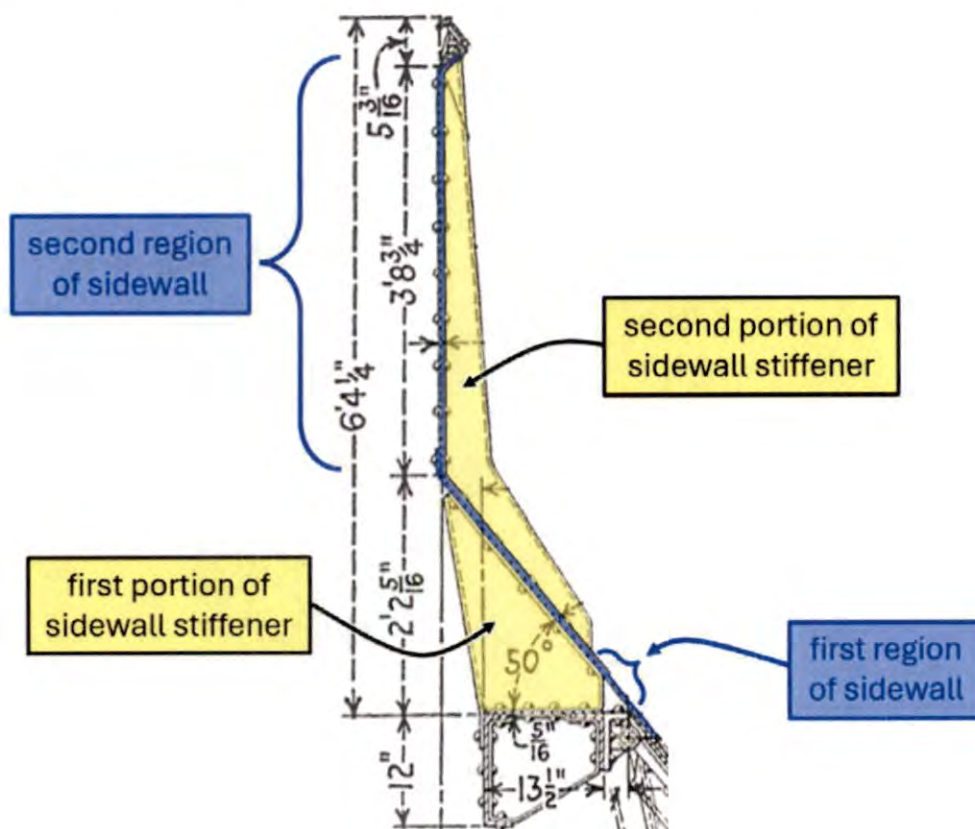


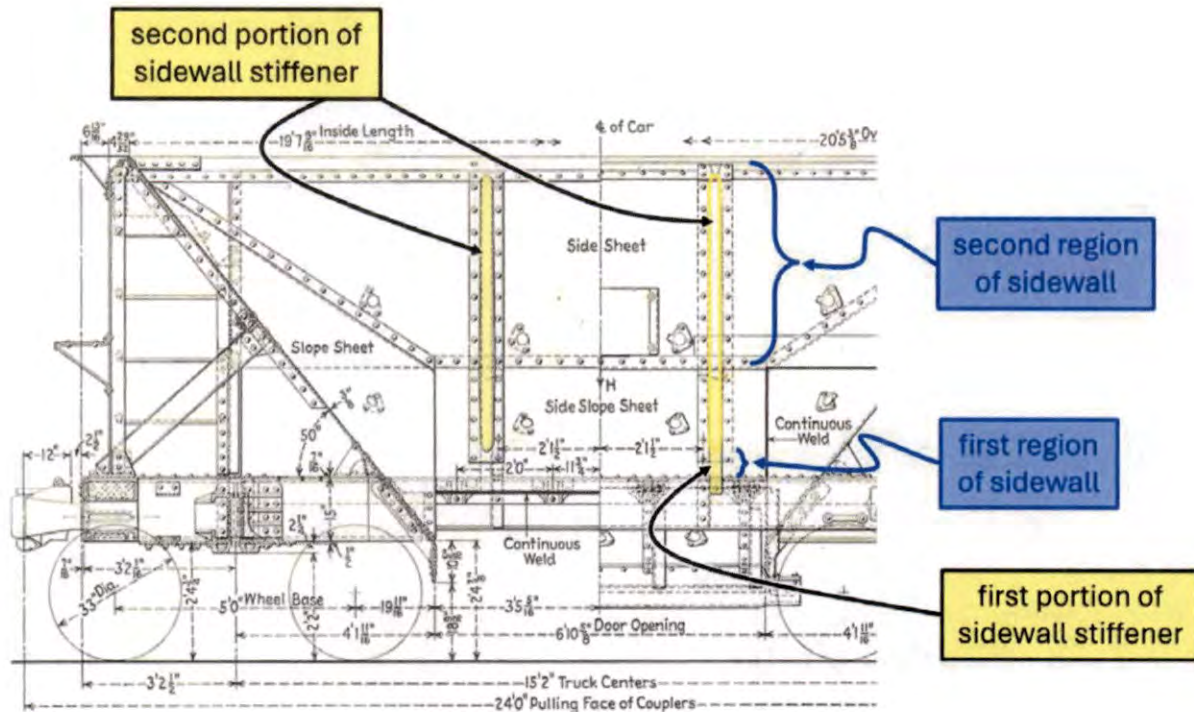
Lindström
Fig. 6

EX1001, Fig. 2c; EX1005, Figs. 2, 5-6.

- d. [1j] “said sidewall stiffener having web continuity between said first and second portions thereof.”

75. A POSITA would understand that the two portions of Lindström’s side-wall stiffener are arranged in the same vertical plane, as in the ’892 patent. *See supra* § V. E.1.c (showing EX1001, Fig. 2c; EX1005, Figs. 2, 5-6). Any other arrangement would subject the side walls to bending moments that could damage them. *Supra* § IV. A; *see generally supra* § IV. The 1946 Cyclopedia’s NSC ore car drawings also disclose two-part side-wall stiffeners with web continuity.





EX1004 at 294. Even supposing, for the sake of argument, that the portions of Lindström's side-wall stiffener were not aligned in the same vertical plane, a POSITA would have been motivated to so align those portions, as in 1946 Cyclopedia's NSC ore car. For example, the POSITA would be motivated to avoid the bending moments discussed earlier. As another example, aligning side-wall stiffeners in a vertical-transverse plane had become commonplace at least by 1946—indeed, they date back to at least the 1904-1906 L&Y conversion. EX1007 at 262-64. In fact, in the ore-car section of the 1946 Cyclopedia, three of the four ore cars for which schematics are provided have two-part side wall stiffeners with web continuity. EX1004 at 289-300 (Pressed Steel car, p. 290; Enterprise car, p. 292; NSC car, p. 294).

Aligning the portions in this way would be no more than combining prior art elements (stiffeners with inside and outside portions) according to known methods (aligning inside and outside portions) to yield predictable results (e.g., supporting the side sheet, transferring load to the side sill, and avoiding moments). Such alignment would also be the application of a known technique (aligning inside and outside portions of the sidewall stiffener) from the L&Y hopper car and the 1946 Cyclopedia ore cars to improve a similar device (Lindström).

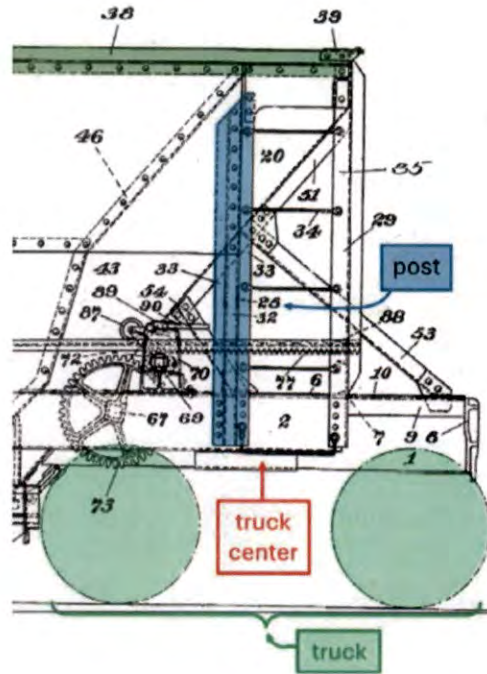
F. Ground 2b: Claims 2-14 – obviousness over Lindström in view of Wong, and optionally the 1946 Cyclopedia.

1. Independent Claim 2

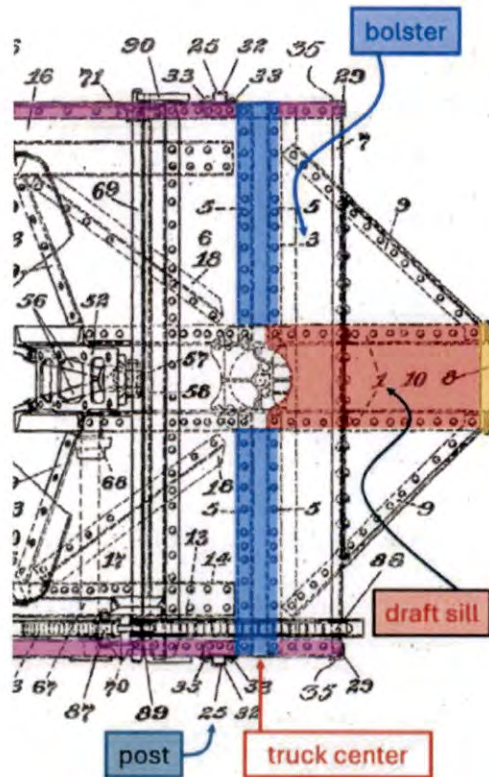
- a. [2f] **“said first end section having a first draft sill and a main bolster extending cross-wise to said first draft sill, said first draft sill and said main bolster intersecting at a first truck center, said first truck being located centrally under said first truck center;**

76. Lindström expressly discloses “draft sills 2” and “bolsters 3.” EX1005 at 1:81-83. Lindström’s figures show these structures in the claimed arrangement. Specifically, Figure 2 shows that truck center is located just outboard of post 25, and Figure 1 shows that the first draft sill and the first main bolster intersect at truck center. *Id.*, Figs. 1-2. Moreover, a POSITA would have known to position the main bolster at truck center. For example, doing so was common. *E.g.*, EX1004 at 294 (NSC ore car having main bolster at truck center). Further, a POSITA would be

motivated to align load-transferring elements. *E.g., supra* § IV. A.; *see generally supra* § IV.



Lindström
Fig. 2



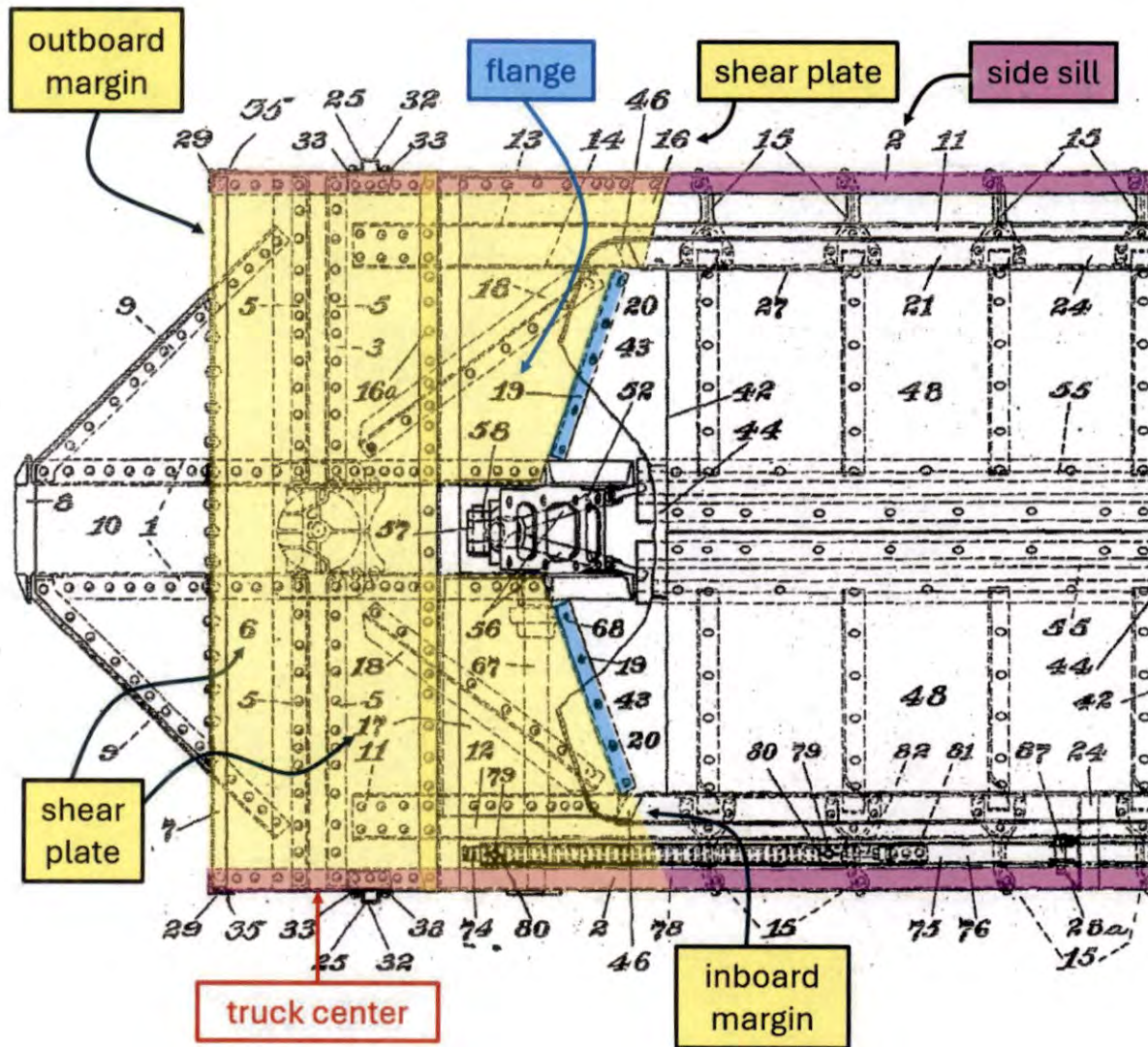
Lindström
Fig. 1

EX1005, Figs. 1-2.

- b. [2h] **“said first end section having a shear plate mounted overtop of said first draft sill and said main bolster; said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet; said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;”**

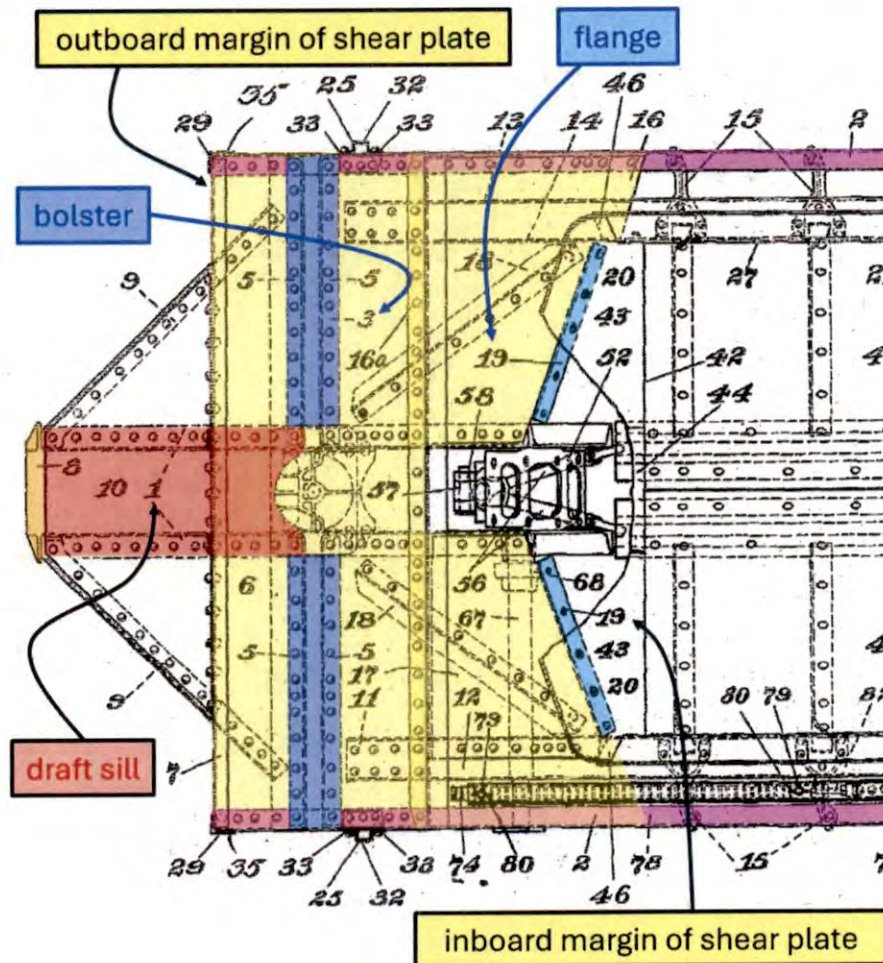
77. Lindström discloses three plates that together comprise the shear plate at one end of the hopper car: “plates” 6, 16, and 17. EX1005, Fig. 1. “Plate” 6 has a rectangular horizontal face that extends from side to side, extends outboard to the outboard margin, and extends inboard to slightly overlap with “plates” 16 and 17. *Id.* “Plates” 16 and 17 include “flanges” 19 and are symmetrically placed on either side of the longitudinal centerline. *Id.*, Fig. 1, 4:29-33 (“the flanges 19 of the plates 16 and 17”). They extend longitudinally inboard of their overlap with “plate” 6 to the longitudinally inboard end of “flanges” 19, laterally outboard to the side, and laterally inboard to a set of longitudinally aligned rivets. At the inboard ends of “plates” 16 and 17 are downwardly angled flanges 19 that are riveted to the underside of the slope sheet, specifically, to the sloping end plates of the slope sheet. EX1005 at 2:36-39 (“At their inner edges each of these plates 16 and 17 are provided with flanges 19 which are secured to the sloping end floors, hereinafter more fully described.”), 4:29-33 (“The lower portions of the sloping end floor plates are secured to the flanges 19 of the plates 16 and 17 thus providing additional connections

between the body and the underframe.”). The annotated version of Lindström’s Fig. 1 below shows the shear plate at one end of the car (in yellow).



Id., Fig. 1. Lindstrom also teaches that generally triangular plate 10 may be formed as part of plate 6. *Id.* at 2:4-8 (“member 10 may be a continuation or part of the horizontal plate 6”). In this version (embodiment) of the Lindstrom car, the shear plate would also include plate 10.

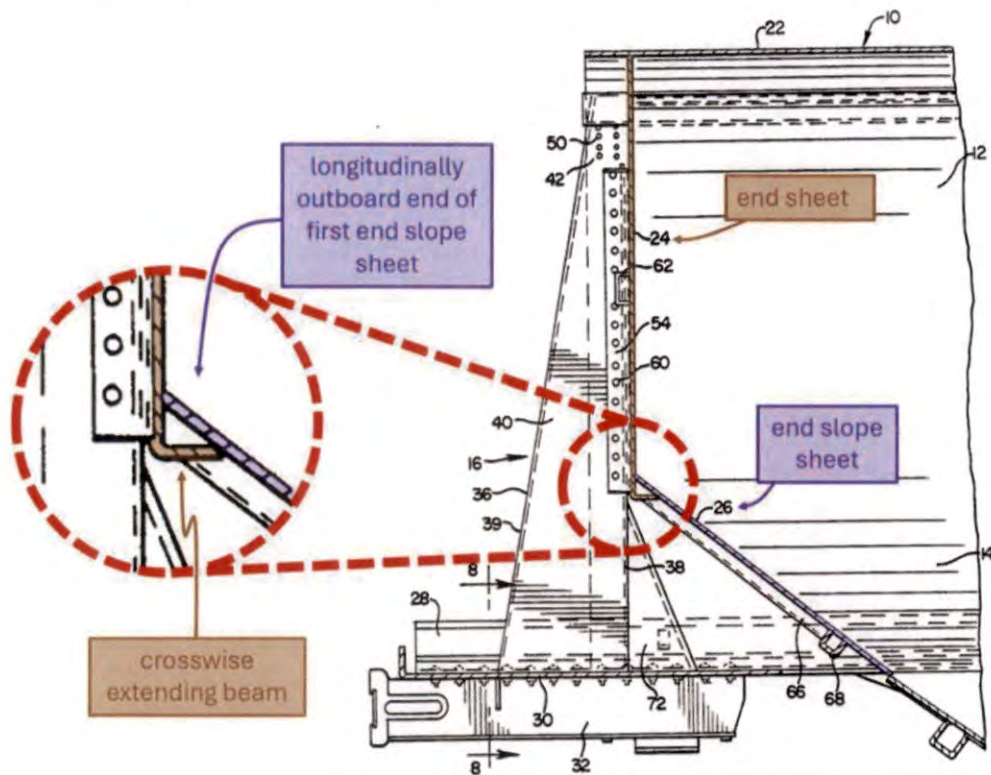
Lindström's shear plate satisfies limitation [2h], as shown below. The inboard margin of the shear plate is adjacent to the inboard end of slope sheet because the two structures are riveted together (via flanges 19) at the inboard end of the slope sheet. EX1005 Fig. 1, 2:36-39 ("plates 16 and 17 are provided with flanges 19 which are secured to the sloping end floors"), 4:29-33 ("The lower portions of the sloping end floor plates are secured to the flanges 19 of the plates 16 and 17").



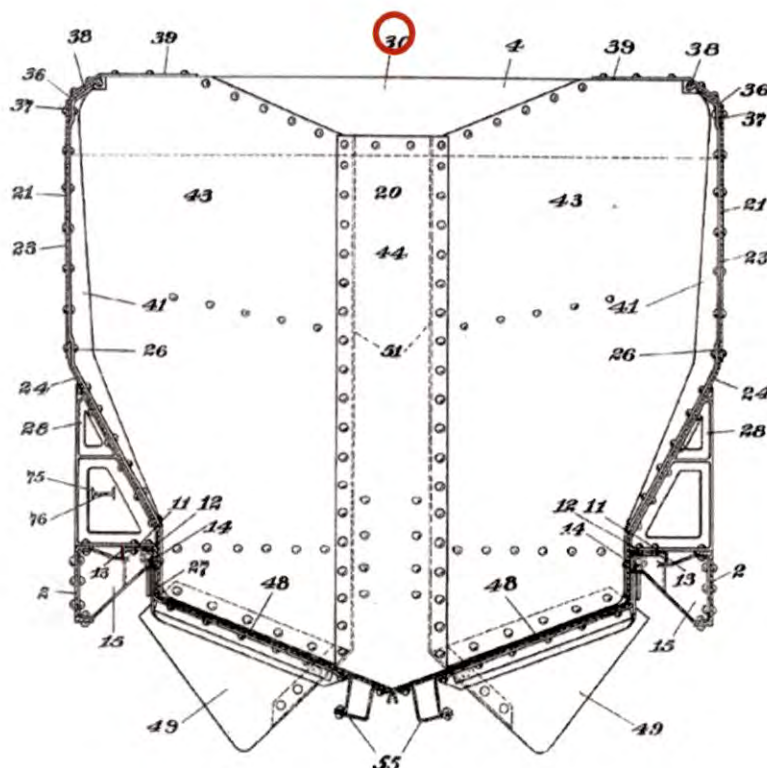
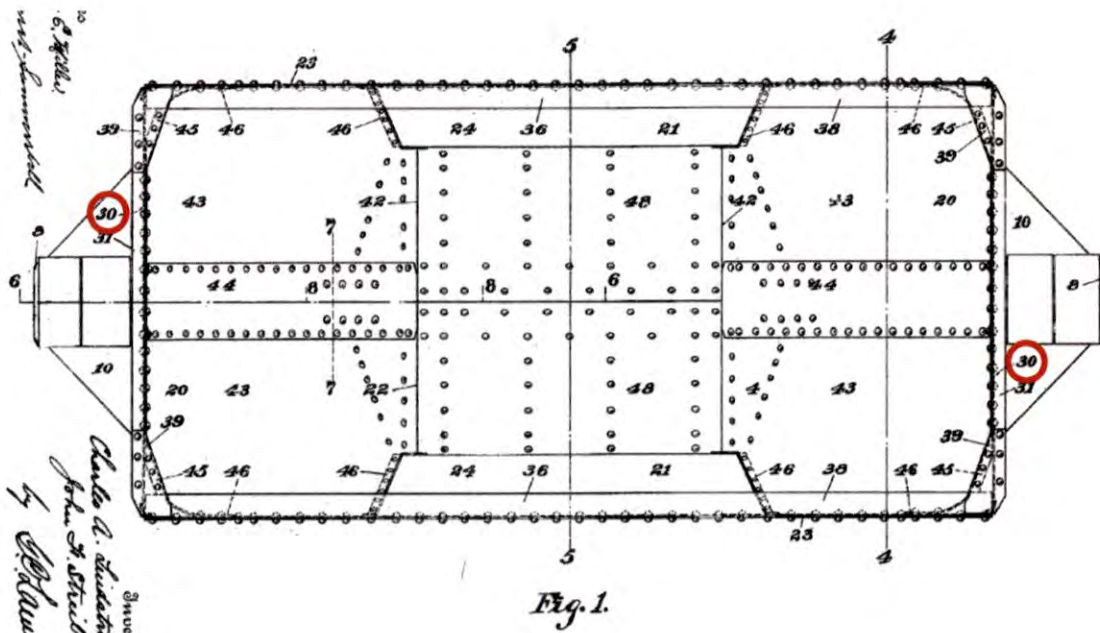
Id., Fig. 1.

- c. [2i] “said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;”

78. As discussed above in connection with Ground 1b, and as shown below, Wong discloses a cross-wise extending beam for reinforcing the upper end of the slope sheet (“end slope sheet” 26). *See supra* § V. B.1.d.



EX1006, Fig. 4. Lindström discloses an end wall (“plate” 30 that “forms an end wall of the car body.” EX1005 at 2:123-27.



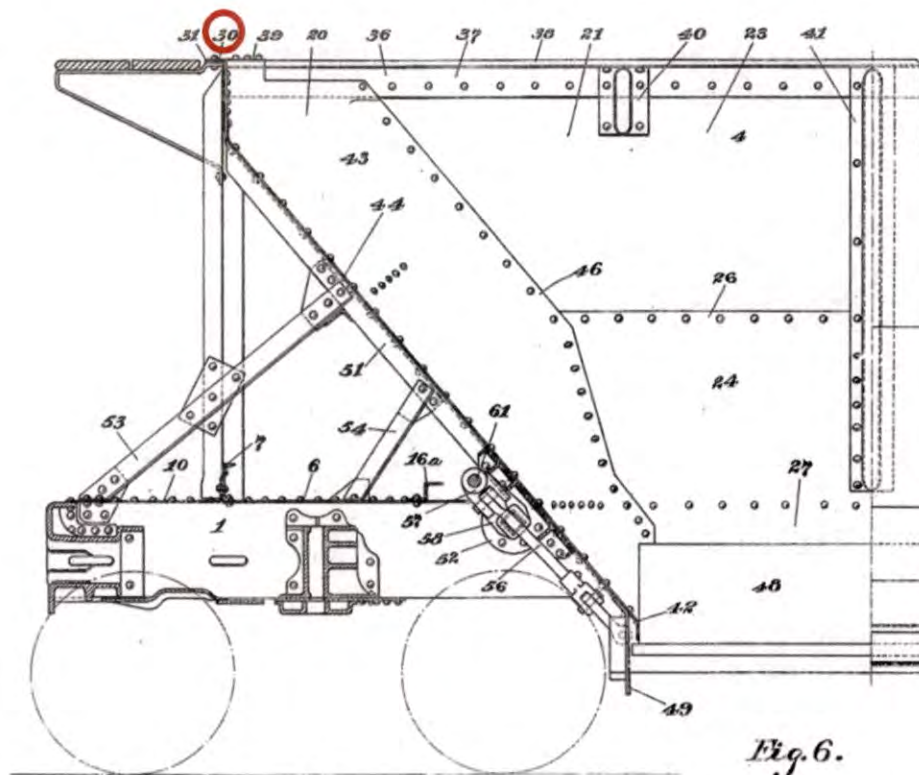
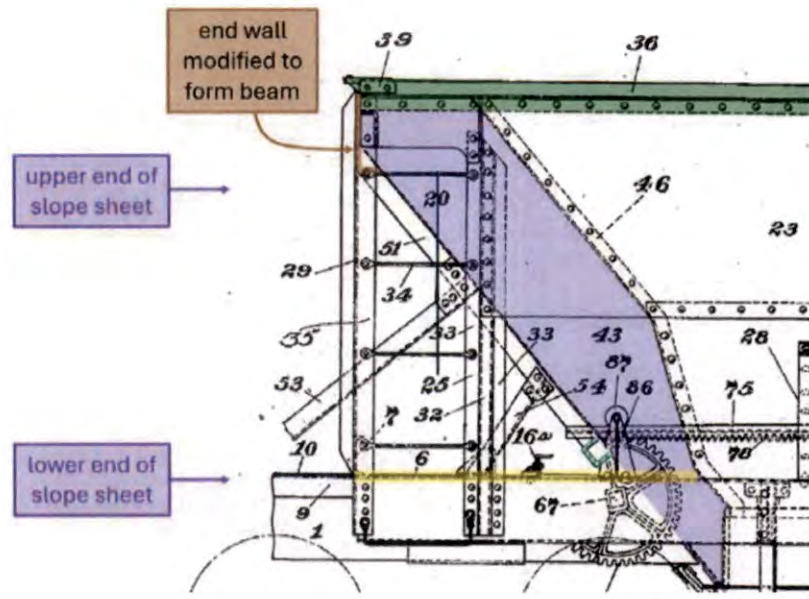


Fig. 6.

EX1005, Figs. 1, 5-6. For the reasons set forth in Ground 1b, it would have been obvious to modify Lindström's end wall ("plate" 30) to support the upper, outboard end of the slope sheet with a crosswise, L-shaped beam as in Wong. *See supra* § V. B.1.d. A POSITA would have been motivated to make the modification. For example, Wong and the Lindström are in the same field of hopper railcars. EX1006, Abstract ("hopper railcar"); EX1005 at 1:11-13 & Figs 1-2 ("dumping car" with a hopper). That is the same field to which every claim of the '892 patent is directed. EX1001, Cl. 1-2 preambles (each independent claim is directed to a "rail road hopper car"). As another example, a POSITA would have understood the benefits of further reinforcing the slope sheet at its upper end. A POSITA would have understood that,

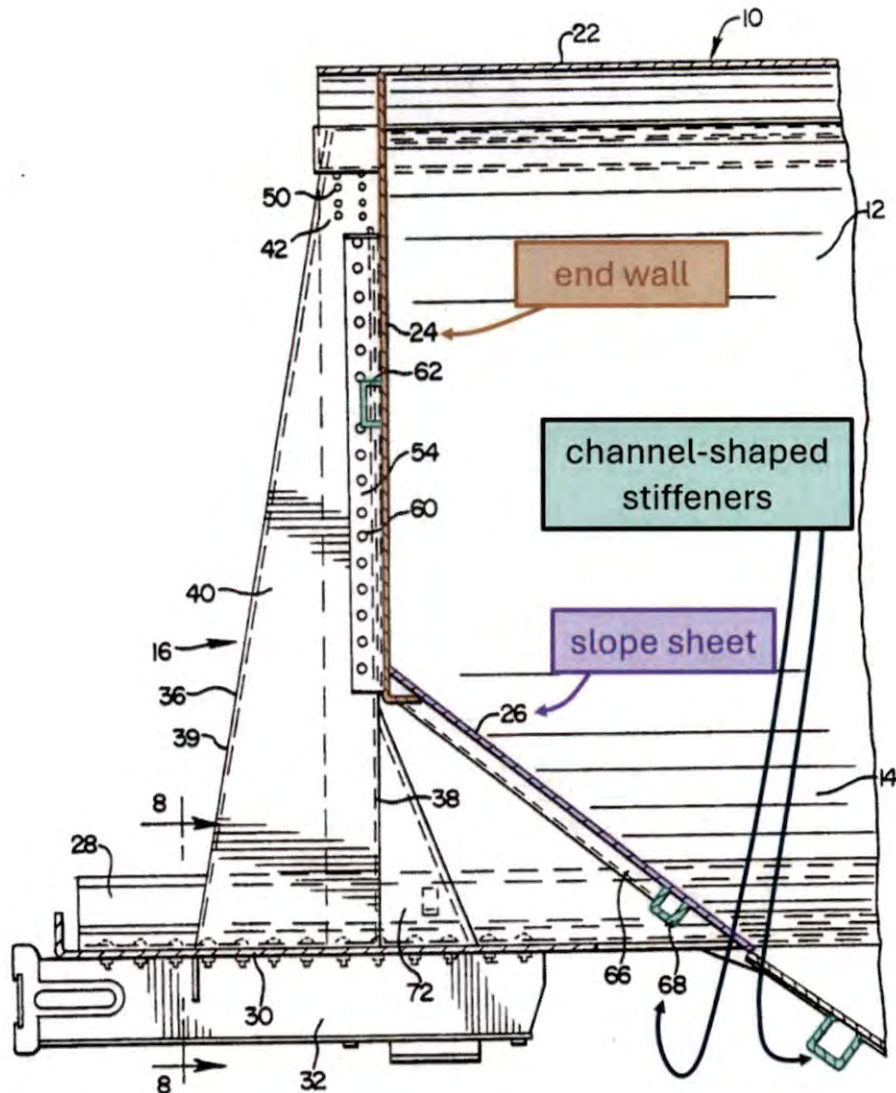
at that upper end, a load in the hopper creates a stress concentration at the intersection of the end slope sheet and the end top chord, which is shown below. A POSITA would have understood that the stress concentration could be ameliorated by spreading the load over a larger area, for example, through techniques discussed above. Another known way to accomplish that was (and is) to support the upper, outboard end of the slope sheet with a cross-wise, L-shaped beam as in Wong. A POSITA would have had a reasonable expectation of success in making this modification including because it is a straightforward modification of Lindström's existing end wall 30. EX1005 at 2:123-27 (plate 30 "forms an end wall of the car body"). Specifically, Lindström's end wall would be slightly lengthened and bent inward at its lower end, as shown below. This straightforward modification can be accomplished with the well-known technique of bending a plate ("plate" 30). Lindström is ready for improvement, including already having a plate to extend and bend.



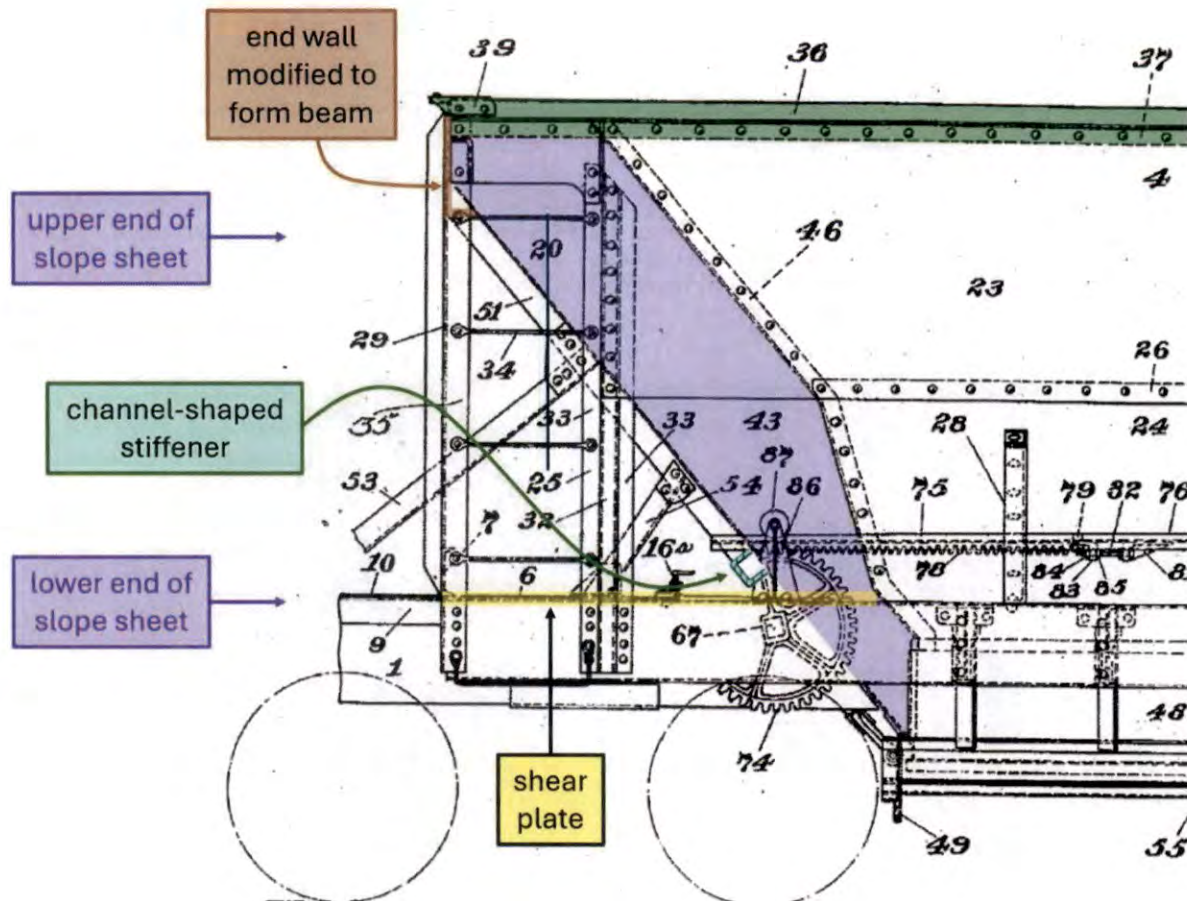
EX1005, Fig. 2 (modified).

- d. [2j] said lower, longitudinally inboard end of said first end slope sheet being reinforced by a second cross-wise extending beam;

79. As shown below, Wong discloses a hollow reinforcement beam at the inboard end of the slope sheet that the patent refers to as “channel stiffener member 68.” EX1006 at 4:50-56. For the reasons set forth in Ground 1b, it would have been obvious to modify Lindström’s design to support the lower, inboard end of the slope sheet with a U-shaped hollow beam, as in Wong. *See supra* § V. B.1.d (limitation [2i]).



EX1006, Fig. 4. A POSITA would have had a reasonable expectation of success in making this modification because it is a straightforward addition of a U-shaped beam to the underside of Lindström's slope sheet, as shown below. That modification uses a standard component (a U-shaped hollow beam). A POSITA would have known to use any means of joining that standard component to the slope sheet, such as welding or rivets.

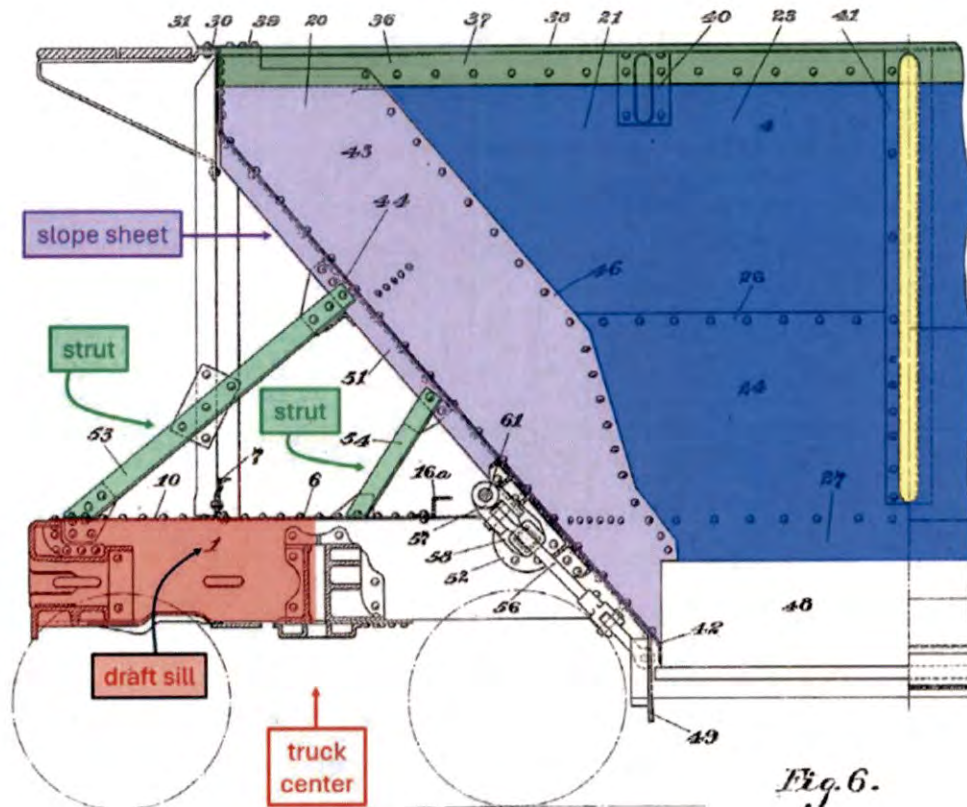


EX1005, Fig. 2 (modified).

- e. [2m] “said first end section being free of longitudinally oriented elephant ears extending between said draft sill and said first end slope sheet;”

80. As discussed above in connection with Ground 1b, the '892 patent defines elephant ears as “large, substantially triangular planar plates.” *See supra* § V. B.1.h. As shown below, Lindström’s slope sheets are not supported by elephant ears, but by larger struts 53 and a smaller struts 54 in a manner that resembles truss elements. Trusses are used in many structures for carrying loads from one element to another. EX1005 at 4:34-42 (“To assist in supporting and bracing the body 4,

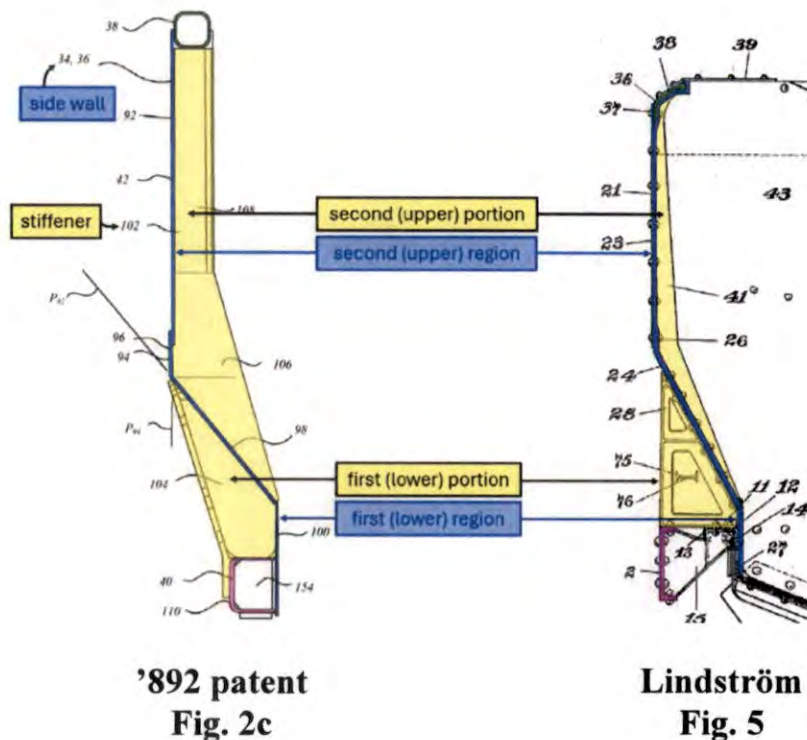
members 53 and 54 are provided, each of which is preferably of angular form. One end of each of these members is preferably secured to one of the sills 1, and each member extends upwardly and the upper end thereof may be connected with the flange 51 of one of the floor plates 43 by rivets or other suitable means.”).



EX1005, Fig. 6. In addition, the smaller strut does not extend between the draft sill and the slope sheet. *Id.* Thus, Lindström’s car has no elephant ears over the shear plate and under the slope sheet.

2. **Dependent Claim 3: “The rail road hopper car of claim 2 wherein said first and second portions of said sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.”**

81. The two portions of Lindström’s stiffener are substantially vertically aligned when seen in a sectional view looking along the car, as shown below.



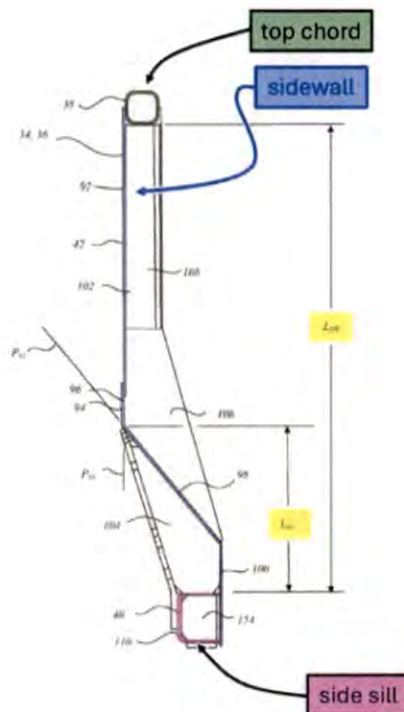
EX1001, Fig. 2c; EX1005, Fig. 5. A POSITA would understand that the two portions of Lindström’s side-wall stiffener are arranged in the same vertical plane, as in the ’892 patent, because any other arrangement would subject the side walls to bending moments that could damage them. *Supra* § IV. A; *see generally supra* § IV. Even assuming, for the sake of argument, that Lindström did not disclose this vertical alignment, a POSITA would have been motivated to so align those portions,

as in 1946 Cyclopedia's NSC ore car, for the same reasons noted for limitation [1j].

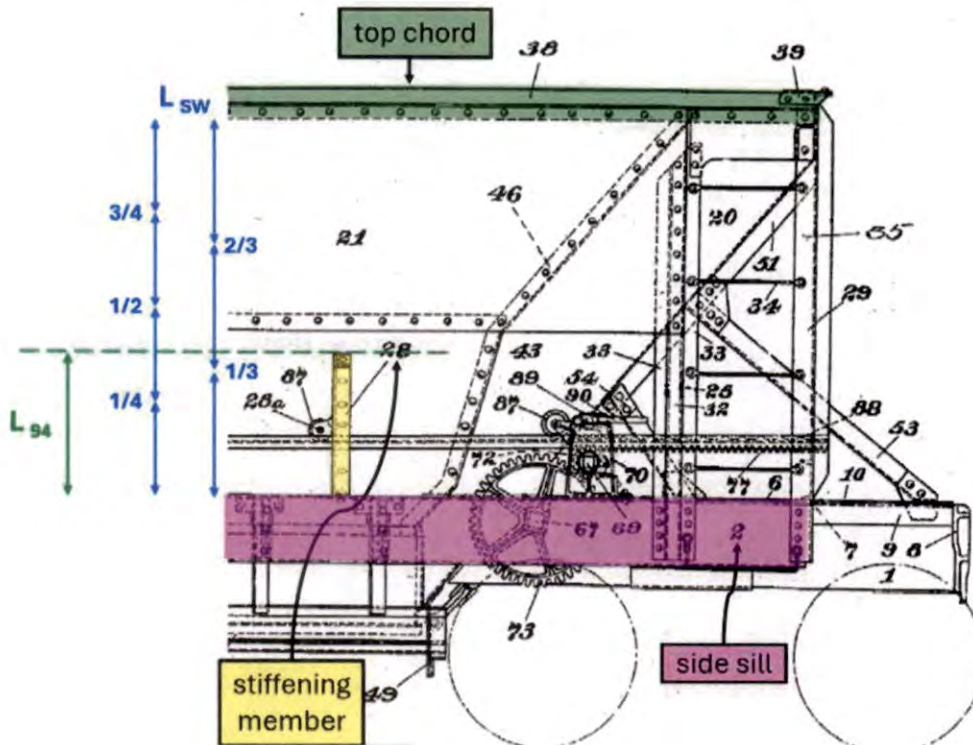
Supra § V. E.1.d.

3. **Dependent Claim 5: “The rail road hopper car of claim 4 wherein said first sidewall has an overall height from said first side sill to said first top chord, L , and said transition portion is located a distance above said first side sill that is in the range of $\frac{1}{4}$ to $\frac{2}{3}$ L .”**

82. The '892 patent's only disclosure of this limitation is in Fig. 2c, shown below, and in the text in column 15, lines 58-63. As shown below and to the left, the '892 patent compares the height of the side wall, labeled L_{sw} , and the distance from the side sill to the juncture of the upper vertical (second) region of the side walls and the sloped (third) region of the sidewall, labeled L_{94} . EX1001, Fig. 2. The text states that distance L_{94} “may lie in the range of $\frac{1}{4}$ to $\frac{2}{3}$ of the distance L_{sw} .” *Id.* at 15:61-62.



Id., Fig.2c. As shown below, Lindström discloses that its distance L_{94} is between $1/4$ and $2/3$ of L_{sw} , as required by Claim 5.



EX1005, Fig. 2. It would have been obvious to select dimensions consistent with the Lindström's drawings and with the NSC ore car for the additional reason that the precise dimensions are a matter of design choice. A POSITA would know to modify the angle of the transversely angled portion of the side sheet—thereby modifying the location of the transition portion—based on design constraints that are standard and well-understood, including maximizing hopper capacity, supporting the loads within the hopper including those seen at the slope sheet and hopper doors, and maximizing the car's efficiency in loading and discharging its intended lading. Selecting elements that efficiently carry the loads from the longitudinal beam at the top of the

hopper car to the still, aligning them co-planarly, spacing them properly, connecting various elements to reduce stress concentration, supporting the weights on bolsters, etc. are all examples of engineering practices for maximizing capacity and efficiency. A POISTA would be aware of such practices.

4. Dependent Claim 6:

- a. **[6a] “The rail road hopper car of claim 2 wherein said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof;”**

83. This limitation is included here for reference.

- b. **[6b] “said hopper includes first and second sloped side sheets; and said first sloped side sheet meets said first sidewall at said transition portion.”**

84. The written description of the '892 patent uses the term “sloped side sheet” only once, where it states: “Lower portion 124 tapers in width to match the narrowing width between the *sloped side sheets* with which it mates.” EX1001 at 16:34-36 (emphasis added). The lower portion 124 is a sloped portion of end wall 30. *Id.* at 16:29-30 (“End walls 30, 32 each include upper and lower sloped surface members 122 and 124”). End wall 30 with its lower portion 124 is shown in Fig. 3a below.

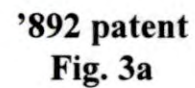


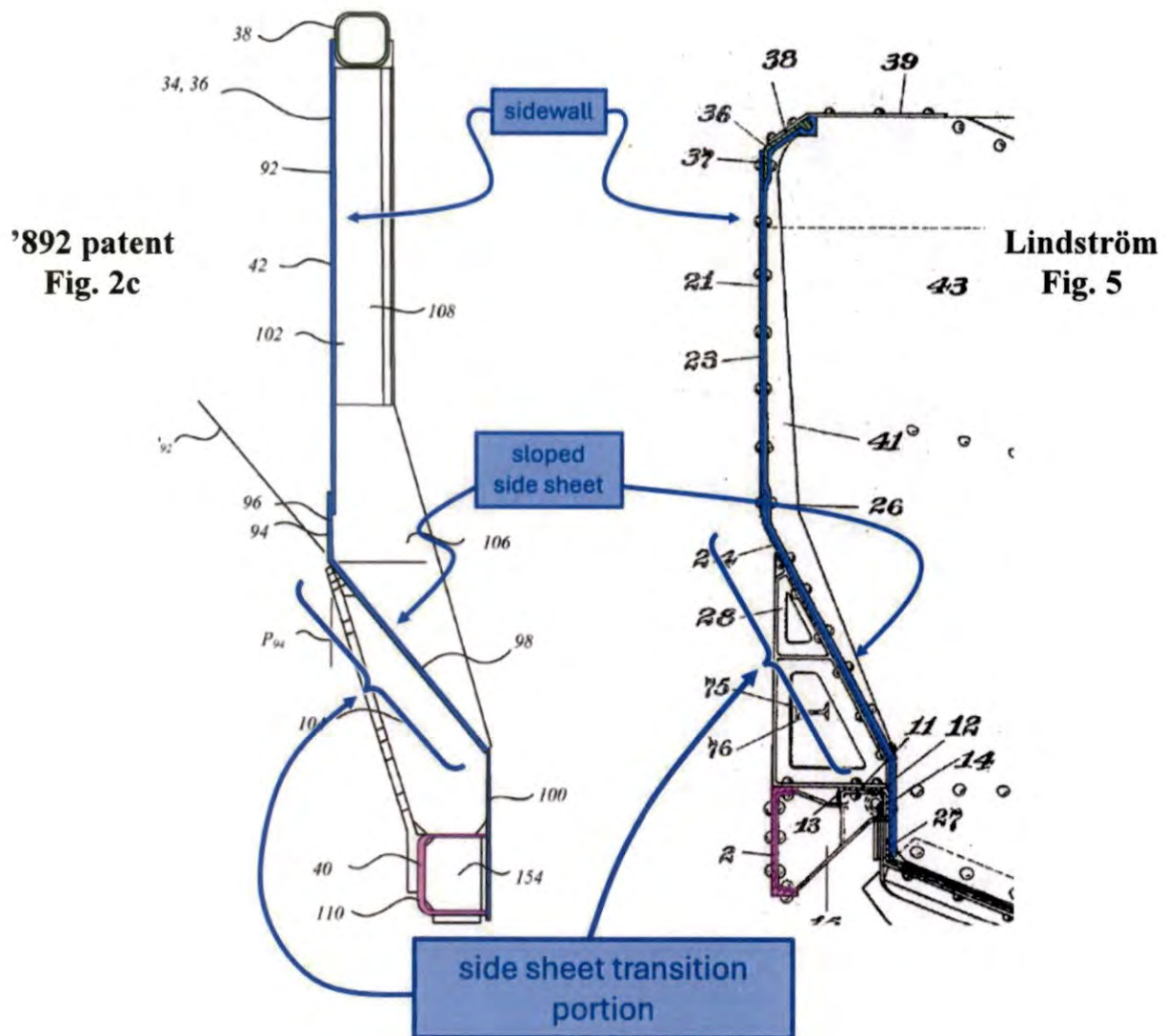
Fig. 1 is a schematic diagram of a vertical member 100, such as a pile, driven into the ground. The member has a top flange 38 and a side wall 34, 36. A sloped portion of the side wall 98 is spaced above a shear plate 154. The member is driven into the ground by a force P_v , and a reaction force P_v is shown at the base. The member is surrounded by soil 102, and a sloped portion of the side wall 98 is spaced above the shear plate 154.

'892 patent
Fig. 2c

Id., Fig. 2c. Accordingly, a POSITA would conclude that the “sloped side sheets” recited in limitation [6b] are the sloped portions 98 of side walls 34, 36.

Limitation [6b] recites that the first sloped side sheet, which is part of the first side wall, “meets” the first side wall. Claim 6’s requirement that the sloped side sheet “meets” the side wall must therefore be satisfied by a sloped side sheet that forms part of the side wall.

Lindström discloses the same structure. As shown below, Lindström has a sloped side sheet that forms part of the car’s side wall. And as in the ’892 patent, the sloped side sheet is located in the same part of the side wall as the transition portion. Lindström therefore discloses limitation [6b] under any reasonable interpretation of the claim language.

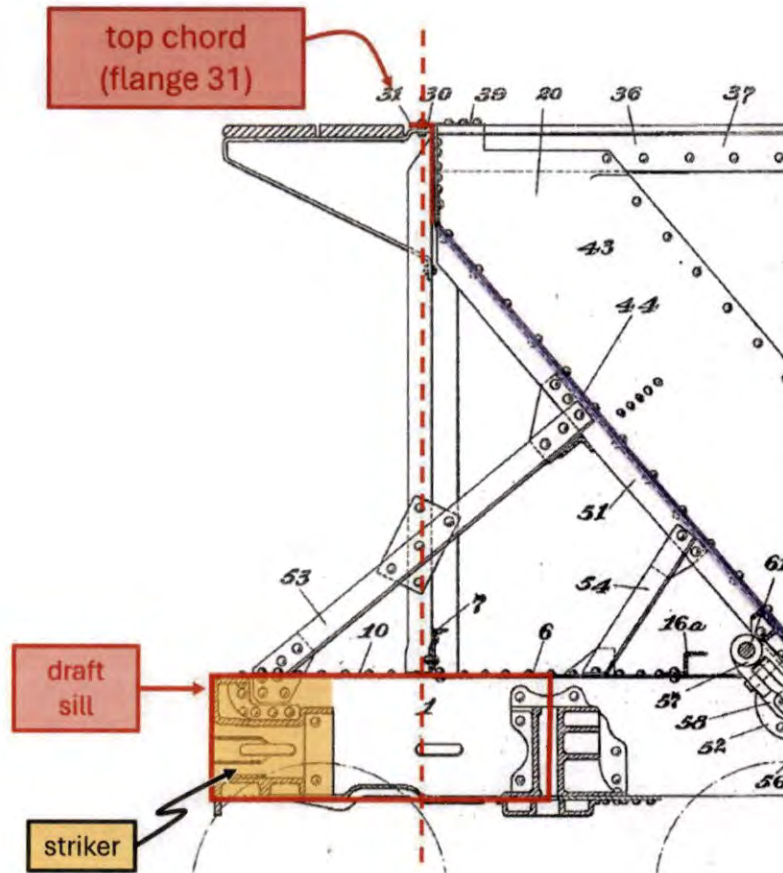


EX1001, Fig. 2c; EX1005, Fig. 5.

- c. [8b] “and an end post extends from said draft sill to said end top chord, said end post being mounted above said draft sill between said truck center and said striker.”

85. As discussed in connection with Ground 1b, and as shown below, the 1946 Cyclopedia’s NSC ore car drawings disclose an end post extending from the draft sill (between truck center and the striker) to the end top chord.

truck center and the striker, and (ii) a vertical end post would extend down from the top chord to a point between truck center and the striker, as shown below. *Id.*

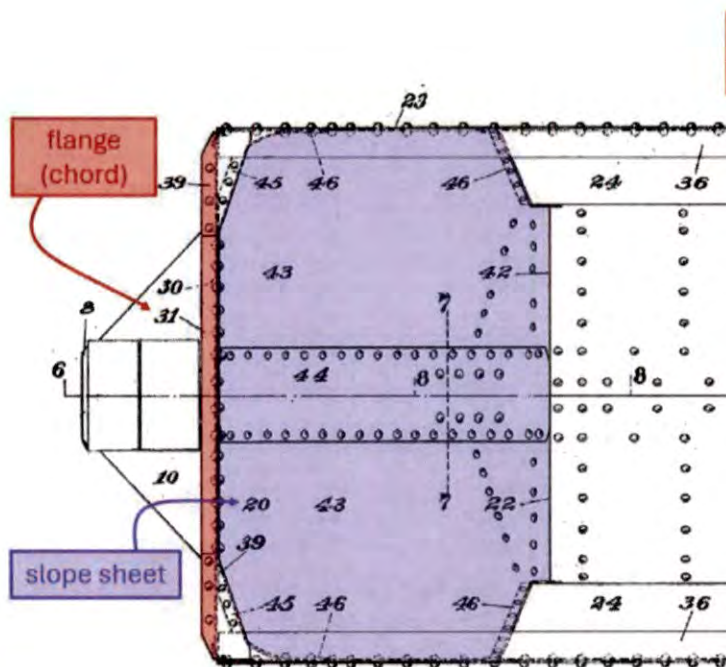


EX1005, Fig. 6.

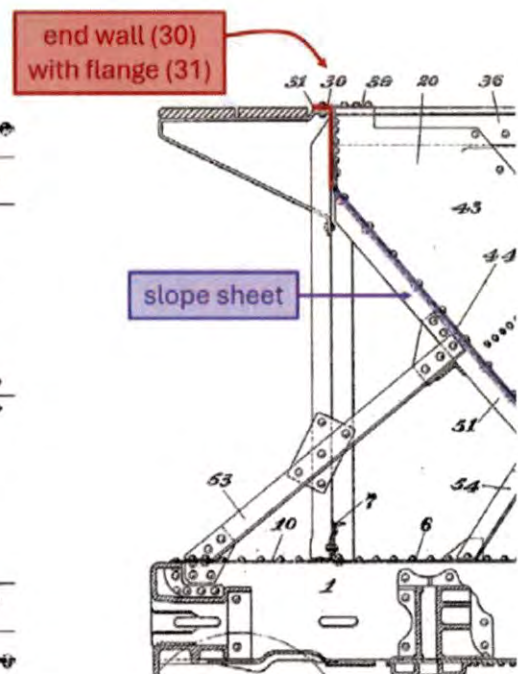
5. Dependent Claim 9:

- a. [9a] “The rail road hopper car of claim 8 wherein said hopper has an end wall extending downward of said end top chord;

86. Lindström discloses this limitation, as shown below.



Lindström
Fig. 1



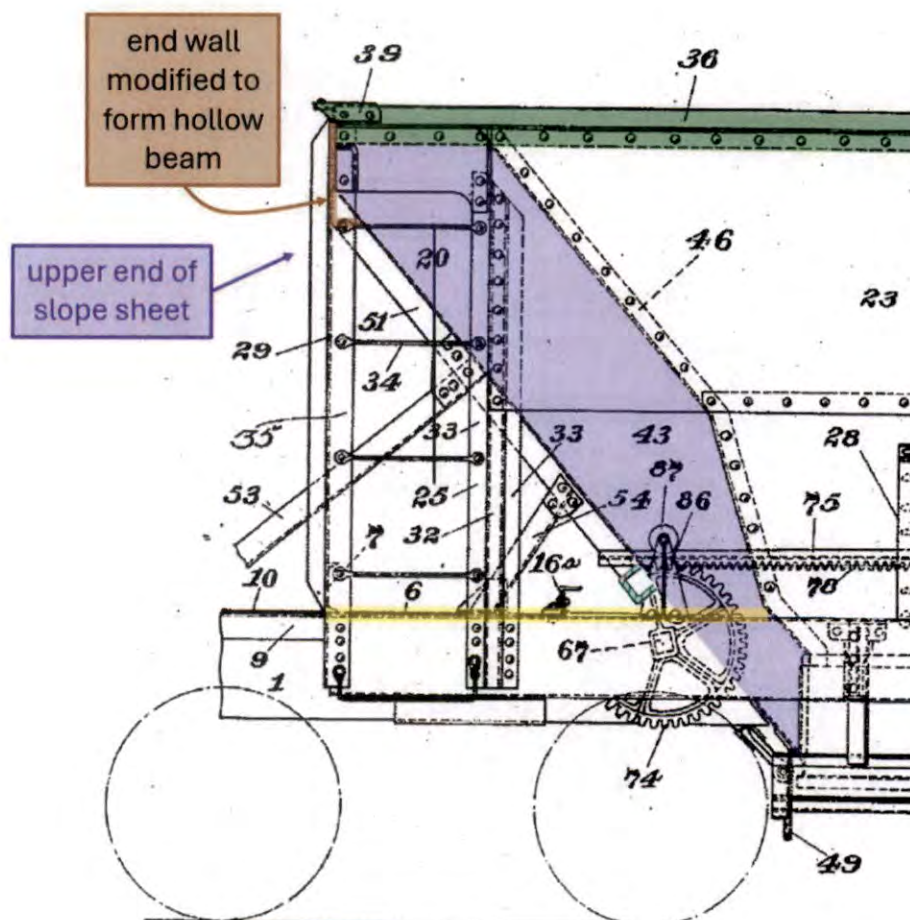
Lindström
Fig. 6

Id., Figs. 1, 6.

- b. [9b] “said upper, longitudinally outboard end of said first end slope sheet meets said downwardly extending end wall;
and said first cross-wise extending beam is located where said downwardly extending end wall meets said first end slope sheet; and
said first cross-wise extending beam is of hollow cross-section.”

87. As discussed above in connection with limitation [2i], it would have been obvious to modify Lindström’s car design to support the upper, outboard end of the slope sheet with a crosswise, L shaped beam as in Wong. *See supra* § V.

F.1.c. The resulting modified car design would satisfy limitation [9b], as shown below. That is, said upper, longitudinally outboard end of said first end slope sheet (“sloping end floors” 20) meets said downwardly extending end wall (modified “plate” 30 that “forms an end wall of the car body,” EX1005 at 2:123-27); and said first cross-wise extending beam (end wall modified to form beam) is located where said downwardly extending end wall meets said first end slope sheet (see figure below); and said first cross-wise extending beam is of hollow cross-section (see figure below).



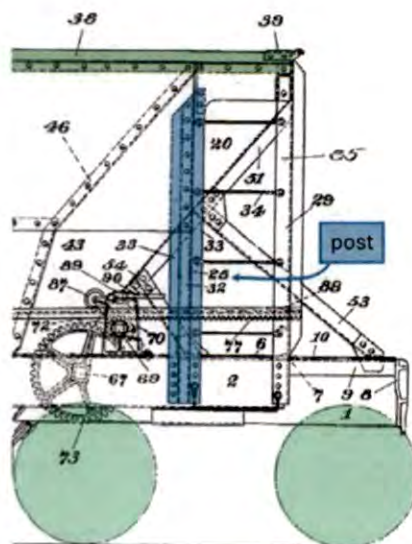
EX1005, Fig. 2 (modified).

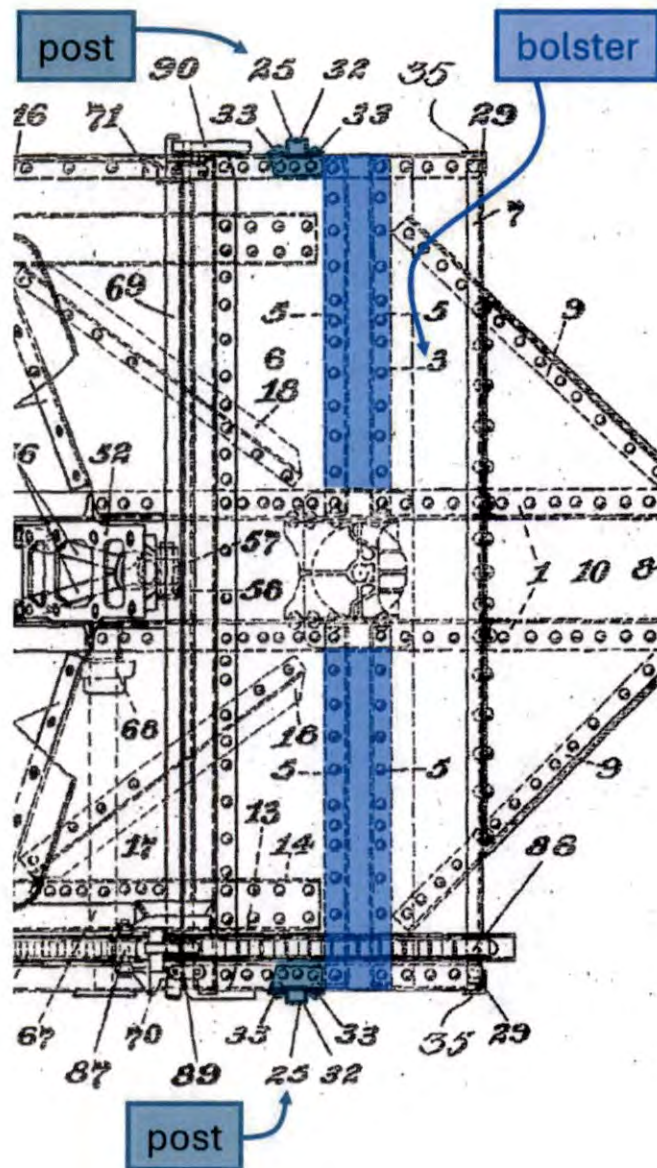
6. **Dependent Claim 11: “The rail road hopper car of claim 10 wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.”**

88. The '892 patent discloses “corner posts” 82 and 84 that do not extend upward from the true corners of the railcar, but rather from “the junction of the laterally outboard ends of left and right hand main bolster and side sills.” EX1001 at 14:21-23. Lindström discloses corner posts (“posts” 25) whose corrugated portions mate with the side walls:

Each of the posts 25 is preferably provided with a channel shaped corrugation 32 and with flanges 33, 33 which flanges may be secured to the side sill 2. When these posts 25 are secured to the side sill 2, the corrugations 32 extend outwardly beyond the vertical plane of the side sill and at their upper portion are connected with the side wall sheets 23 by rivets or other suitable means.

Id. at 2:129-3:8. Posts 25 are positioned just laterally inboard of the bolster ends, as shown below.





Id., Figs. 2-3. A POSITA would consider Lindström's posts 25 to extend upwardly from the ends of the bolster, as required by Claim 11.

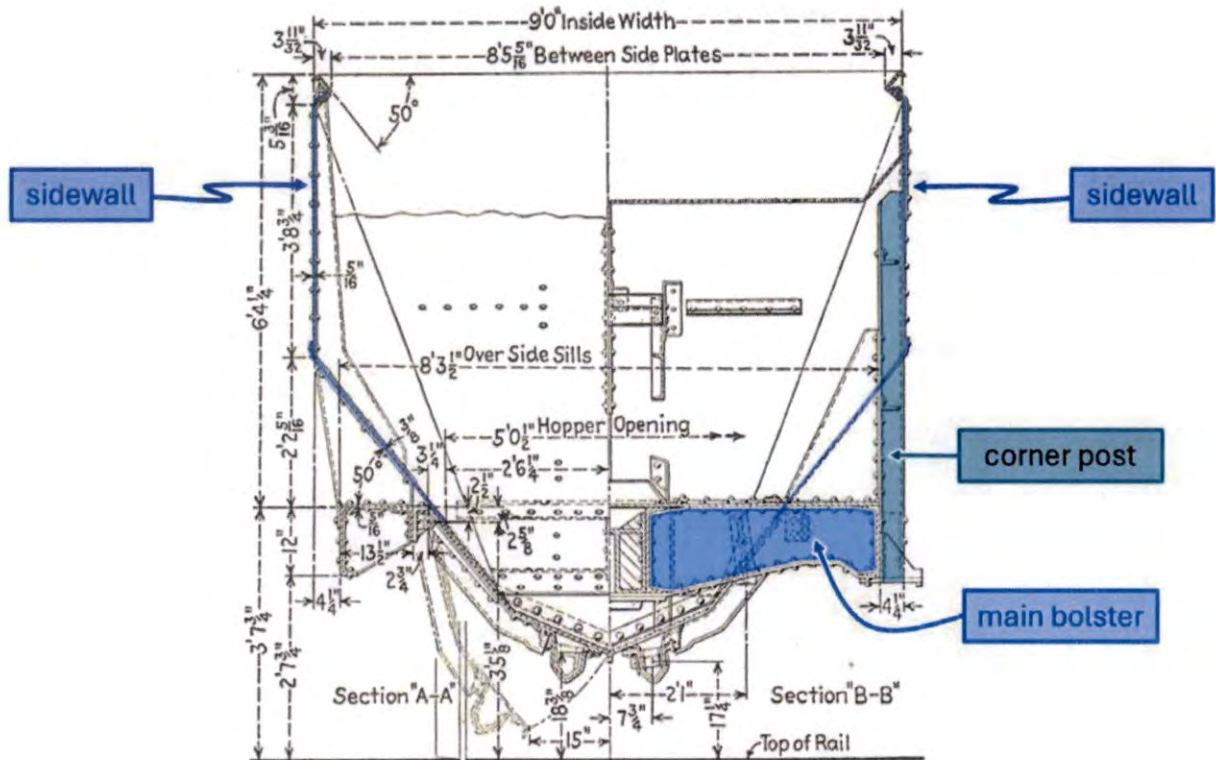
Additionally, it would have been obvious to move Lindström's posts 25 slightly longitudinally outboard, so that they could be more directly supported by the bolster. A POSTIA would be motivated to do so to eliminate the bending moments imparted when a load is transferred from Lindström's posts 25 to its

The drawing is a detailed technical illustration of a car body, showing the internal structure and various components. Key features include:

- corner posts**: Indicated by arrows pointing to the vertical structural members at the corners.
- second end of main bolster**: Indicated by an arrow pointing to the upper horizontal structural member on the left side.
- first end of main bolster**: Indicated by an arrow pointing to the lower horizontal structural member on the left side.
- sidewalls**: Indicated by arrows pointing to the vertical structural members along the sides of the car body.
- main bolster**: Indicated by an arrow pointing to the central horizontal structural member at the bottom.

The drawing also includes various labels for specific components and dimensions, such as:

- Quarter Section "A-A"**: A section line indicating a quarter section of the car body.
- Rivets can this side only both ends of car**: A note indicating the rivet placement on the ends of the car.
- Rivet heads flattened to 1/4" on under side**: A note indicating the rivet head placement on the underside.
- Rivet heads flattened to 1/4" on opposite side of brake cyl.**: A note indicating the rivet head placement on the opposite side of the brake cylinder.
- Continuous Weld**: A note indicating the type of weld used in certain areas.
- Flatten all rivets to 1/4" on all sloping surfaces inside of car**: A note indicating the rivet head placement on the sloping surfaces.
- Weld to Platform Plate**: A note indicating the weld connection to the platform plate.
- 4" of Car**: A dimension indicating the width of the car body.
- Side Sheet**: A label for the side sheet component.
- Slope Sheet**: A label for the slope sheet component.
- Side Slope Sheet**: A label for the side slope sheet component.
- Continuous Weld**: A label for the continuous weld component.
- Weld**: A label for the weld component.
- Door Opening**: A label for the door opening component.
- 32" Truck Centers**: A dimension indicating the truck centers.
- 240" Pulling Face of Couplers**: A dimension indicating the pulling face of the couplers.



EX1004 at 294-95.

VI. GROUNDS AND COMBINATIONS

89. I have reviewed all grounds and combinations of prior art references referenced in this declaration, and I agree that each ground would render obvious the relevant claims. In particular, the following combinations of prior art references would be successfully combined and modified as described. Although I have not illustrated each modification, I have considered them all as part of this analysis to reach my conclusions.

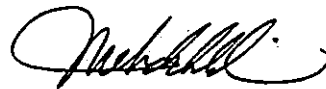
GROUND 1a	Claim 1: 1946 Cyclopedia
GROUND 1b	Claims 2–8, 10–14: 1946 Cyclopedia, Lindström and optionally Wong
GROUND 1c	Claim 9: 1946 Cyclopedia, Lindström and Wong
GROUND 1d	Claim 15: The art in Ground 1b and Coates
GROUND 2a	Claim 1: Lindström and optionally the 1946 Cyclopedia
GROUND 2b	Claims 2–14: Lindström, 1946 Cyclopedia and Wong
GROUND 2c	Claim 15: The art in Ground 2b and Coates

VII. CONCLUSION

I reserve the right to supplement my opinions in the future to respond to any arguments or positions that the patent owner may raise, taking account of new information as it becomes available to me.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

May 27, 2025



Mehdi Ahmadian, Ph.D.

Exhibit 3

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FREIGHTCAR AMERICA, INC.,
Petitioner,

v.

NATIONAL STEEL CAR LIMITED,
Patent Owner.

Case IPR2025-01047
Patent 8,132,515

**DECLARATION OF MEHDI AHMADIAN
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,132,515**

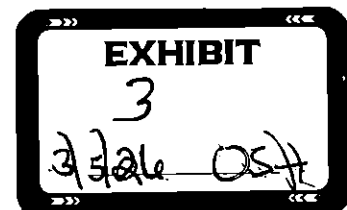


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A. Ground 1: Claims 1–2 are obvious over Hart and the 1906 Cyclopedia.....	31
1. Independent Claim 1	31
a. [1a] “A railroad hopper car for carrying particulate material, said hopper car comprising: a hopper; first and second end	

sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction; said hopper being suspended between said first and second end sections,” 31

- b. [1c] “said first end section including a draft sill extending in the longitudinal direction, a main bolster extending crosswise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;” 33
- c. [1e] said hopper car being free of primary structure directly above said shear plate of said first end section under said overhang of said first end slope sheet of said hopper;” 35
- d. [1f] “one of: (a) said first end slope sheet has an upper margin and said hopper car includes an end post extending upwardly from said draft sill to said upper margin of said first end slope sheet; and (b) said first end slope sheet has an upper margin terminating at an end wall, and said hopper car includes an end post extending upwardly from draft stub sill to said end wall;” 41
- e. [1g] “said shear plate has a longitudinally outboard margin and said draft sill has a striker located outboard of said longitudinally outboard margin of said shear plate, and said end post is one of: (a) rooted to said draft sill adjacent to said striker; (b) rooted to said shear plate adjacent to said longitudinally outboard margin of said shear plate;” 45
- f. [1h] “said bolster has first and second laterally outboard distal ends, and said hopper car has corner posts extending upwardly from said

	distal ends of said bolster to said first end slope sheet; and”	51
g.	[1i] “said hopper car has a machinery space bounded by (a) said first end slope sheet; (b) said shear plate of said first end section; (c) said end post; and (d) said corner posts, and said machinery space is free of any other primary structure.”	52
B.	Ground 2: Claim 3 is obvious over Hart, the 1906 Cyclopedia and Schuller.	53
1.	Dependent Claim 3: “The railroad hopper car of claim 1 wherein: said hopper car has at least one longitudinally hinged discharge door, said discharge door being movable cross-wise between open and closed positions; and a longitudinally acting pneumatic actuator is at least partially lodged in said machinery space directly above said draft sill.”	53
C.	Ground 3: Claim 4 is obvious over Hart, the 1906 Cyclopedia, Schuller and Karig.	56
1.	Dependent Claim 4: “The railroad hopper car of claim 3 wherein a brake reservoir is also at least partially lodged in said machinery space.”	56
D.	Ground 4: Claims 5-6 are obvious over Hart, the 1906 Cyclopedia and Campbell ’652.....	57
1.	Dependent Claim 5	57
a.	[5a] “The railroad hopper car of claim 1 wherein: said shear plate is mounted above, and to, said main bolster and defines an upper flange thereof;”	57
b.	[5b] “said main bolster has a lower flange downwardly spaced from said upper flange,	

	said lower flange terminating at respective distal end portions at either side of said car;”	57
c.	[5c] “said car includes a side sill running along said car between said first and second end sections;”	58
d.	[5d] “said side sill has an upper flange, said upper flange of said side sill being substantially co-planar with, and connected to, said shear plate; and”	60
e.	[5e] “said side sill has a lower flange, said lower flange of said side sill being substantially co-planar with a respective one of said distal end portions of said lower flange of said main bolster.”	61
E.	Ground 5: Claims 7–16, 20–23, 24–28, and 30–31 are obvious over Hart in view of the 1906 Cyclopedia and Wong.	61
1.	Independent Claim 7	61
a.	[7h] “said hopper car has a first end wall member running cross-wise between said first and second side walls; said first end slope sheet has an upper margin that meets said first end wall member at a first junction; said first end wall member extends upwardly from said first junction; said first end wall member has a lower portion extending downward of said first junction; said lower portion of said first end wall member and said upper margin of said first end slope sheet co-operate to define portions of the cross-section of a second hollow section beam extending cross-wise across said hopper car between said first and second side walls.”	61

2.	Dependent Claim 9: “The railroad hopper car of claim 7 wherein said laterally extending member has a pair of first and second spaced apart toes, and said laterally extending member is mounted toes-in against said first end slope sheet, whereby said first hollow section beam is defined by said laterally extending reinforcement and said first end slope sheet.	63
3.	Dependent Claim 11: “The railroad hopper car of claim 10 wherein said laterally extending reinforcement is an angle iron mounted toes-in to said first end slope sheet.”	65
4.	Dependent Claim 16: “The railroad hopper car of claim 15 wherein said intermediate beam includes a cross-wise extending structural member mounted toes-in against said first end slope sheet to define a closed hollow section.”	66
5.	Independent Claim 24	67
a.	24[g] “said draft sill having longitudinally extending draft sill webs;”	67
F.	Ground 6: Claims 17–19 are obvious over Hart in view of the 1906 Cyclopedia, Wong and Campbell ’051	68
1.	Dependent Claim 17: “The railroad hopper car of claim 7 wherein said first and second side walls of said hopper car define sidewalls of said hopper, and said first and second side walls include end portions that are stepped laterally inboard, and said second hollow section beam extends between said end portions of said first and second side walls that are stepped laterally inboard.”	68
2.	Dependent Claim 19: “The railroad hopper car of claim 18 wherein: there is an end wall that extends from sidewall to sidewall; said end wall has an upper portion that has an upper margin terminating at a top	

	chord of said end wall; said first end slope sheet has an uppermost margin, said uppermost margin of said first end slope sheet meeting said end wall along a first juncture; said end wall has a lower portion extending below said first juncture, said lower portion being bent to define a portion of said second hollow section beam; and said end post extends past said second hollow section beam along said end wall to mate with said top chord of said end wall.”.....	70
G.	Ground 7: Claims 21–22 and 29 are obvious over Hart in view of the 1906 Cyclopedia, Wong and Schuller.....	72
1.	Dependent Claim 21: “The railroad hopper car of claim 20 wherein: said hopper has a movable door by which egress of lading is governed; said hopper car has an actuator and a drive train, said drive train being connected between said actuator and said door, said actuator being operable to move said door; and said actuator is mounted in said machinery space.”	72
H.	Ground 8: Claims 32–34 are obvious over Lindström in view of Wong, Ratcliffe 1 and Hart.	73
1.	Independent Claim 32	73
a.	[32a] “A railroad hopper car, said hopper car comprising: a hopper; first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction; said hopper being suspended between said first and second end sections,”.....	73
b.	[32b] “said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;”	74

- c. [32c] “said first end section including a draft sill extending in the longitudinal direction, said draft sill having first and second spaced apart longitudinally running draft sill webs and a draft pocket defined therebetween;” 76
- d. [32d] “said first end section including a main bolster extending cross-wise to said draft sill; said first end section having a truck center where said main bolster meets said draft sill; said draft sill having a striker end longitudinally outboard of said truck center; said first end section including a shear plate; said shear plate overlying said draft sill webs and said main bolster, said shear plate extending longitudinally along said draft sill and cross-wise from side to side of said hopper car; said shear plate having an outboard margin running across said car distant from said truck center and proximate said striker end;” 76
- e. [32e] “said first end slope sheet over-hanging said shear plate of said first end section;” 79
- f. [32f] first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls; 80
- g. [32g] “there being a first end wall extending between said first and second side walls; said first end slope sheet having an uppermost margin, said uppermost margin meeting said first end wall at a first junction; said hopper car having a first beam extending cross-wise between said first and second side walls at said first junction of said uppermost margin of said first end slope sheet and said first end wall,

	said first beam being a beam of hollow section;”	81
h.	[32h] “said first end wall is surmounted by a cross-wise running top chord; said first end wall includes a panel extending downwardly from said cross-wise running top chord;”	84
i.	[32i] “said first end section includes an end post extending upwardly of said draft sill, said end post being mounted above said draft sill distant from said truck center and proximate said striker end; said end post extending upwardly to meet said first beam and said top chord;”	84
j.	[32j] “said first end section being free of longitudinally oriented elephant ears extending upwardly of said draft sill webs of said draft sill to meet said first end slope sheet;”	86
k.	[32k] “said hopper car having a second beam extending cross-wise between said first and second side walls, said second beam being a beam of hollow section; and said second beam being connected to said shear plate.”	87
2.	Dependent Claims	89
a.	Dependent Claim 33: “The railroad hopper car of claim 32 wherein a third beam is mounted across said first end slope sheet intermediate said first and second beams.”	89
I.	Ground 9: Claims 35–44 are obvious over Lindström in view of Wong, Ratcliffe 1, Hart and the 1946 Cyclopedia.	90
1.	Dependent Claim 35: “The railroad hopper car of claim 32 wherein: said main bolster has first and second ends; and respective first and second corner posts are mounted to said first and second ends of	

	said main bolster and extend upwardly therefrom to meet said first end slope sheet.”	90
2.	Dependent Claim 36: “The railroad hopper car of claim 35 wherein: a machinery space is defined above said shear plate and under said first end slope sheet; and a door actuator is mounted above said shear plate and under said first end slope sheet.”	94
3.	Dependent Claim 39: “The railroad hopper car of claim 32 wherein said draft sill has a longitudinally outboard end, and a striker plate mounted at said longitudinally outboard end; and said draft sill has a length between said truck center and said striker plate that is less than 50 inches.”	102
4.	Dependent Claim 40:	103
	a. [40c] “said first side wall has a predominantly upwardly running side wall stiffener mounted thereto, said side wall stiffener being located at a longitudinal station intermediate the trucks;”	103
	b. [40h] “said side wall stiffener having web continuity between said first and second portions thereof”	105
5.	Dependent Claim 43: “The railroad hopper car of claim 40 wherein: said first side wall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said side wall stiffener from an inboard margin thereof to an outboard margin thereof; said hopper includes first and second sloped side sheets; and said first sloped side sheet meets said first side wall at said transition portion.”	107
6.	Dependent Claim 44: “The railroad hopper car of claim 43 wherein said first side wall has an overall height from said side sill to said top chord, L, and	

said transition portion is located a distance above said
side sill that is in the range of $\frac{1}{4}$ to $\frac{2}{3}$ L.” 109

VI. GROUNDS AND COMBINATIONS 112

VII. CONCLUSION 1

I, Mehdi Ahmadian, Ph.D., declare as follows:

1. I am making this declaration at the request of FreightCar America, Inc. ("FCA"). I have been retained by FCA as a technical expert in this matter.

2. I am being compensated for my work on this matter and I am being reimbursed at cost for my expenses. My compensation in no way depends upon the outcome of this proceeding. I do not own any stock in FCA and, to my knowledge, I have no financial interest in FCA.

3. In preparation for this declaration, I have considered the following materials:

Exhibit No.	Description
1001	U.S. Patent No. 8,132,515 ("the '515 Patent")
1002	File History of the '515 Patent
1004	Excerpts from <i>1946 Car Builders' Cyclopedia</i> , 17 th ed. ("1946 Cyclopedia")
1005	U.S. Patent No. 1,321,928 ("Lindström")
1006	U.S. Patent No. 4,941,411 ("Wong")
1007	<i>Excerpts from Lancashire & Yorkshire Wagons, Vol. II</i> , by Noel Coates, Copyright 2006 ("Coates")
1008	U.S. Patent No. 992,192 ("Hart")
1009	Excerpts from <i>The Car Builders' Dictionary, 1906 Edition</i> ("1906 Cyclopedia")
1010	Excerpts from <i>Car Builders' Dictionary, 1912 (Seventh) Edition</i> ("1912 Cyclopedia")

Exhibit No.	Description
1011	Excerpts from <i>Car Builders' Cyclopedia of American Practice, Tenth Edition—1922</i> (“1922 Cyclopedia”)
1012	U.S. Patent No. 1,537,051 (“Campbell ’051”)
1013	U.S. Patent No. 1,999,652 (“Campbell ’652”)
1014	U.S. Patent No. 3,710,729 (“Schuller”)
1015	U.S. Patent No. 4,348,962 (“Smith”)
1016	Excerpts from <i>COAL CARS: The First Three Hundred Years</i> , by Martin Robert Karig III, Copyright 2007 (“Karig”)
1017	Excerpts from <i>Modern Private Owner Wagons on British Rail</i> , by David Ratcliffe, Copyright 1989 (“Ratcliffe 1”)
1018	Excerpts from <i>Private-Owner Wagons in Colour, For the Modeller and Historian</i> , by David Ratcliffe, Copyright 2009 (“Ratcliffe 2”)
1019	Excerpts from <i>Wagons of the Final Years of the British Railways</i> , By David Larkin, Copyright 2008 (“Larkin 1”)
1020	Excerpts from <i>Working Wagons</i> , Vol. 3 1980–1984, by David Larkin, Copyright 2001 (“Larkin 2”)
1021	Excerpts from <i>Wagon Recognition</i> , Vol. 1 Carkinds – B to W, by Martin Buck and Mark Rawlinson (“Buck”)
1024	Excerpts from <i>Private Owner Wagons</i> , Vol. 1, by Andrew Marshall, Copyright 1989 (“Marshall”)

4. I have also relied on my education, training, and experience, and my knowledge of pertinent literature in the field of the ’515 patent.

I. EXPERIENCE AND QUALIFICATIONS

5. My experience and qualifications are summarized in my *curriculum vitae*, a copy of which is attached hereto as Appendix A.

6. I am currently employed as J. Bernard Jones Chair of Mechanical Engineering at Virginia Polytechnic Institute and State University ("Virginia Tech"). I am also the Director of the Center for Vehicle Systems and Safety (CVeSS) and the Railway Technologies Laboratory (RTL) at Virginia Tech. I am the founding director of CVeSS, RTL, Virginia Institute for Performance Engineering and Research (VIPER), and the Advanced Vehicle Dynamics Laboratory (AVDL).

7. I hold four degrees, three of which are in the field of Mechanical Engineering. I obtained my Doctor of Philosophy degree in Mechanical Engineering from the State University of New York at Buffalo in 1984. I obtained my Master of Business Administration (MBA) from Pennsylvania State University – Behrend College in 1994. I obtained my Master of Science (MS) in Mechanical Engineering from the State University of New York at Buffalo in 1982. I obtained my Bachelor of Science (BS) in Mechanical Engineering from the State University of New York at Buffalo in 1980. I worked at General Electric Transportation Systems from 1993-1995 before joining Virginia Tech as an assistant professor in 1995. Since joining Virginia Tech, a substantial portion of my research has been directed to the railroad

industry and railroad systems. This research is evident in the hundreds of publications, books, book chapters, and presentations listed in my CV.

8. I have over 25 years of experience as an independent consultant on matters related to product liability and patent litigation cases involving a broad spectrum of passenger cars, commercial vehicles, and railway systems. I have also assisted clients on issues related to vehicle dynamics and handling, electromechanical systems, braking, rollover stability, and active safety systems. I have broad technical experience in advanced vehicular systems for railway and heavy vehicles, including railway control and safety systems.

9. I have authored more than 500 publications and hold 12 U.S. and international patents. Additionally, I have edited eight technical volumes on various engineering topics. I have served as Editor of the International Journal of *Vehicle System Dynamics* (2008 to 2022) and Editor-in-chief of the *Journal of Vibration and Control* (2014 to 2023). I have also served as the Editor-in-Chief of *Shock and Vibration* (2011-2016), the Editor-in-Chief of *Advances in Automotive Engineering* (2012-2014), and Editor for *Smart Materials Research* (2010-2014), *Advances in Mechanical Engineering* (2008-2014), and *Mechanical Engineering* (2010-2014). I have also served as an Associate Editor for the *ASME Journal of Vibration and Acoustics* (1989-1996), the *AIAA Journal* (2000-2008), and *Shock and Vibration* (2003-2011). I have served on the editorial boards of *Advances in Theoretical and*

Applied Mechanics (2012 to present), *Nonlinear Analysis and Differential Equations* (2013 to present), and the *Journal of Theoretical and Applied Vibration and Acoustics* (2018 to present).

10. I am a Fellow of the Society of Automotive Engineers (SAE International) (2001 to present), a Fellow of the American Society of Mechanical Engineers (“ASME”) (1984 to present), a Fellow of the International Society for Condition Monitoring (“ISCM”) (2021 to present), a Fellow of the International Institute of Acoustics and Vibration (“IIAV”) (2021 to present), and an Associate Fellow of the American Institute for Aeronautics and Astronautics (“AIAA”) (1984 to present). I have also been a Member of the American Railway Engineering and Maintenance-of-Way Association (“AREMA”) (2011 to present), American Society of Education for Engineers (1984-2001), and Tau Beta Pi National Engineering Honorary Society (1979 to present)

11. I have received several professional awards throughout my career, including most recently being awarded the 2024 Society of Automotive Engineers (SAE) Medal of Honor (the highest recognition of lifetime achievement, bestowed on one SAE member per year) and the 2023 Virginia Tech Alumni Award for Research Excellence (regarded as the most prestigious Virginia Tech award for significant life-long research) for my research contributions.

12. I am an inventor on the following issued patents:

- Kinetic Energy-Harvesting Device for Powering and Charging Railway and Other Applications, U.S. Patent 12,088,180, September 10, 2024.
- Dual-action rotary dynamic load stabilization pneumatic valve system, U.S. Patent 9,975,392, May 22, 2018.
- A Compact Lightweight Double-piston Magnetorheological (MR) Damper with large adjustable dynamics force, Chinese Patent # ZL 201110420869.8, December 25, 2013.
- A Compact Lightweight Double-piston Magnetorheological (MR) Damper, Chinese Patent # ZL 201110418073.9, January 9, 2014.
- Doppler Sensor for the Derivation of Torsional Slip, Friction, and Related Parameters, U.S. Patent 8,294,883, October 23, 2012.
- Doppler Sensor for the Derivation of Torsional Slip, Friction and Related Parameters, U.S. Patent 7,705,972, April 27, 2010.
- No Jerk Semiactive Suspension System, U.S. Patent 6,115,658, September 5, 2000.
- No Jerk Semi-active Skyhook Control Methods and Apparatus, Canadian Patent Application, No. 09/225,147, December 17, 1999.
- Self-Steering Locomotive Truck, U.S. Patent 6,006,674, December 28, 1999.
- Self-Steering Locomotive Truck, U.S. Patent 5,746,135, May 5, 1998.
- Self-Steering Locomotive Truck, U.S. Patent 5,613,444, March 25, 1997.
- Electromagnetically Operated Pneumatic Valve Assembly for an Electrical Contactor Actuator, U.S. Patent 5,409,036, April 25, 1995.

II. APPLICABLE LEGAL STANDARDS

13. I have been asked to provide my opinions related to whether claims of U.S. Patent. No. 8,132,515 (“the ’515 patent”) are anticipated and/or would have

been obvious to a person of ordinary skill in the art at the time of the alleged invention, in view of the prior art.

14. I am an engineer by training and profession. The opinions I am expressing in this report involve the application of my training and technical knowledge and experience to the evaluation of certain prior art with respect to the '515 patent.

15. Although I have been involved as a technical expert in patent matters before, I am not an expert in patent law. Therefore, attorneys from Knobbe, Martens, Olson & Bear have provided me with guidance as to the applicable patent law in this matter. The paragraphs below express my understanding of how I must apply current principles related to patent validity in my analysis.

16. It is my understanding that a claim is "anticipated" if a person of ordinary skill in the art (POSITA), reading a prior art reference at the time of the invention, would have understood the reference to disclose each limitation of the claim.

17. It is my understanding that a claim is "obvious" if the claimed subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time of the alleged invention. I understand that the following factors must be evaluated to determine whether a claim would have been obvious: (i) the scope and content of the prior art; (ii) the differences, if any, between each claim of the '515

patent and the prior art; (iii) the level of ordinary skill in the art at the time of the claimed invention; and (iv) additional considerations, if any, that indicate that the invention was obvious. I understand that these “additional considerations” are often referred to as “secondary considerations” or “objective indicia” of non-obviousness.

18. I also understand that the frame of reference when evaluating obviousness is what a hypothetical person of ordinary skill in the pertinent art would have known at the time of the claimed invention. I understand that the hypothetical person of ordinary skill is presumed to have knowledge of all pertinent prior art references.

19. I understand that a prior art reference may be a pertinent prior art reference (or “analogous art”) if (i) it is in the same field of endeavor as the patent, or (ii) if it is pertinent to the problem that the inventors were trying to solve. I understand that a reference is reasonably pertinent if it logically would have commended itself to an inventor’s attention in considering the problem at hand. If a reference relates to the same problem as the claimed invention, I understand that supports use of the reference as prior art in an obviousness analysis.

20. It is my understanding that the law recognizes several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include:

- combining prior art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- a predictable use of prior art elements according to their established functions;
- using known techniques to improve similar devices (methods, or products) in the same way;
- using a feature that was commonly used on similar devices and well-known in the field;
- applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success (in which case a claim would have been obvious to try);
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and

- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

21. I understand that a prior art reference may also suggest a combination with another prior art reference or a modification in view of another reference. In that case, even if the prior art reference does not explicitly or inherently disclose the limitation, the motivation to modify the prior art reference to include the limitation may exist within the prior art reference itself. Thus, the limitation would have been obvious over that prior art reference alone.

22. I understand that “secondary considerations” must be considered as part of the obviousness analysis when present. I further understand that the secondary considerations may include: (1) a long-felt but unmet need in the prior art that was satisfied by the claimed invention; (2) the failure of others; (3) skepticism by experts; (4) commercial success of a product covered by the patent; (5) unexpected results achieved by the claimed invention; (6) industry praise of the claimed invention; (7) deliberate copying of the invention; and (8) teaching away by others. I am not aware of any evidence of secondary considerations that would suggest that the claims of the ’515 patent would have been nonobvious at the time of the claimed invention.

23. I understand that when assessing obviousness, using hindsight is impermissible; that is, what is known today or what was learned from reading the asserted patent should not be considered. The asserted patent should not be used as a road map for selecting and combining items of prior art. Rather, obviousness must be considered from the perspective of a person of ordinary skill at the time the alleged invention was made. (See paragraph 30 for discussion of invention date.)

24. I also understand that an obviousness analysis must consider the invention as a whole, as opposed to just a part or element of the invention. I understand this “as a whole” assessment to require showing that one of ordinary skill in the art at the time of invention, confronted by the same problems as the inventor and with no knowledge of the claimed invention, would have selected the elements from the prior art and combined them in the claimed manner.

III. THE '515 PATENT

A. Overview of the '515 Patent

25. The '515 patent describes a bottom-discharge hopper car, a railway freight car loaded through the hopper's open top and discharged through doors at the bottom of the hopper. The hopper's forward and rear walls—called “slope sheets”—incline toward the bottom center of the car to channel the payload to the hopper doors. The '515 patent describes reinforcing the slope sheets with transverse support beams under the slope sheet. By supporting the slope sheets with transverse beams,

the space below the slope sheet—called the “machinery space”—is not encumbered by support structures and can house machinery such as equipment for opening the hopper doors.

26. During prosecution, the applicant overcame the Examiner’s rejection of original Claim 1 by arguing that the prior art had support structures—large triangular plates known as “elephant ears”—that obstructed the machinery space. The Examiner thereafter allowed 44 claims. Each claim required either open machinery space below the slope sheets, crosswise reinforcement beams on the slope sheets, or both.

27. But although applicant persuaded the Examiner that slope-sheet support beams and open machinery spaces were novel, they were a century old when the applicant filed its patent application in 2009. For example, the primary prior art reference in this petition—U.S. Patent No. 992,192—issued to Harry Hart in 1911. Many other hopper cars from the first half of the twentieth century also used support beams to keep their machinery spaces open.

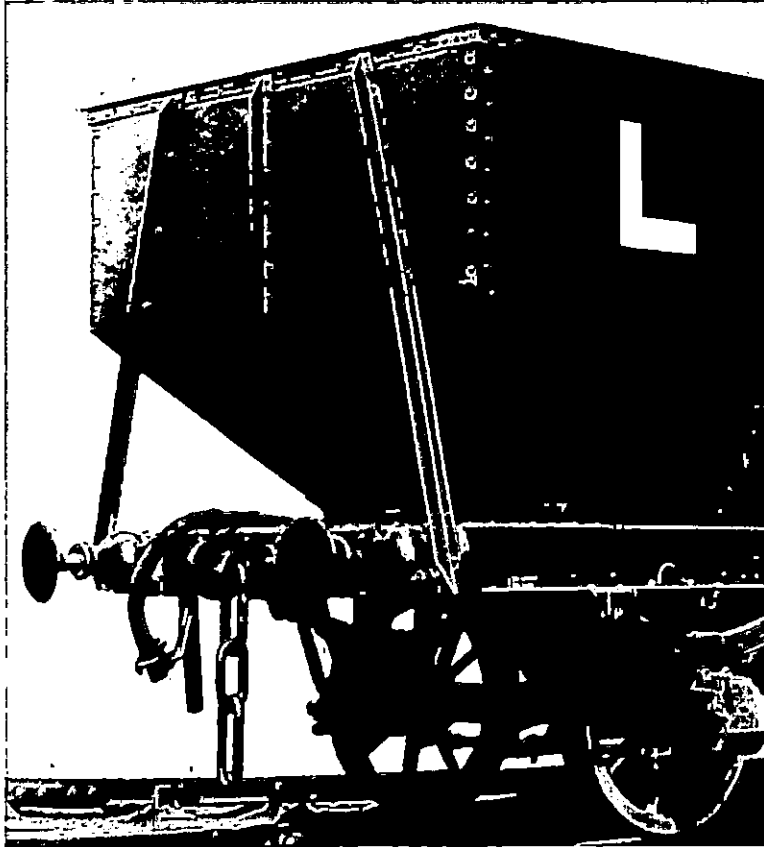
28. The claims of the ’515 patent are unusually lengthy because they recite a host of hopper-car components widely used many decades before applicant’s filing date. Because these features are used in the claimed hopper car just as they have always been used in the prior art, their inclusion in the challenged claims would have been obvious to a person of ordinary skill in the art (or “POSITA”).

Claim 6, rewrote several claims in independent form, and made other amendments. *Id.* at 288. The new independent claims were 6, 16, 25, 27, 33, and 43. *Id.* Each independent claim required an open machinery space or excluded elephant ears such as those in Smith. *See, e.g., id.* at 273–81.

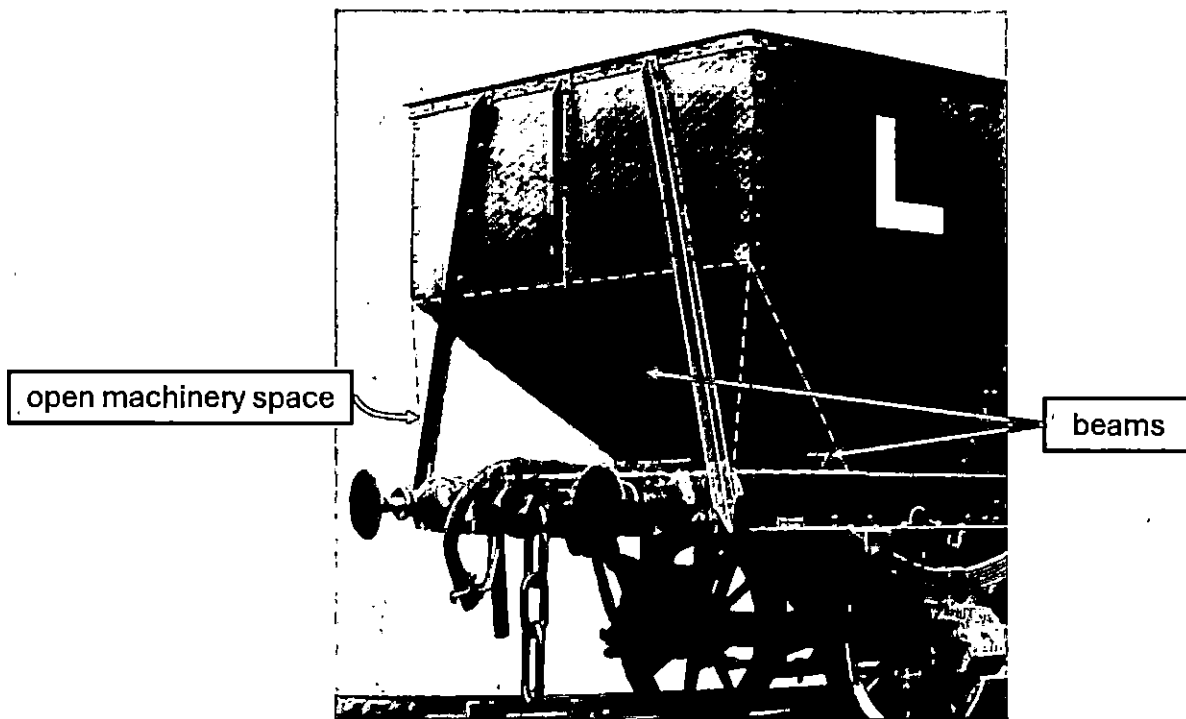
34. On November 1, 2011, the Examiner allowed all pending claims without applying or discussing any prior art submitted with the RCE. *Id.* at 305–39.

35. However, the Patent Office did not have the most relevant evidence. The prior art contained numerous hopper cars with open or unobstructed machinery spaces. To keep their machinery spaces unobstructed, these hopper cars used reinforcement beams that extended along the underside of the slope sheet, either crosswise or longitudinally.

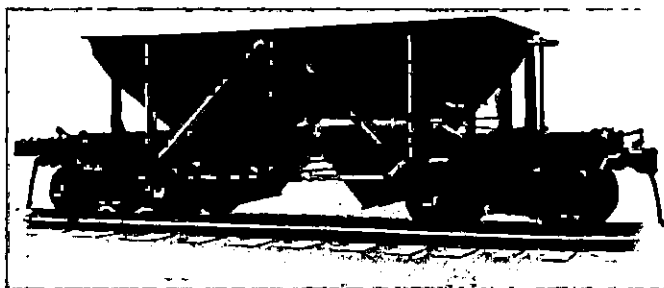
36. For example, historian Noel Coates reproduced photographs from England’s National Railway Museum of a hopper car manufactured for the Lancashire & Yorkshire Railroad in 1904. EX1007 at cover, 265 (“L&Y hopper car”) (shown below).



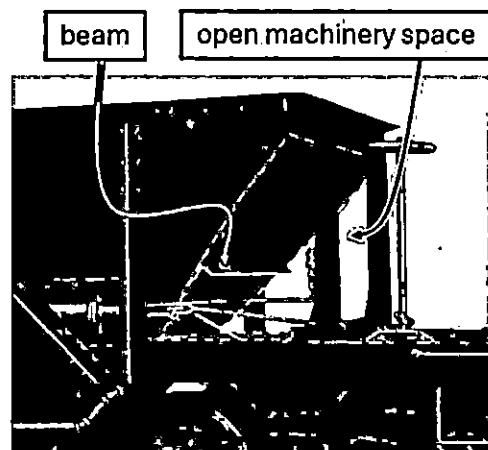
37. The L&Y car supported its slope sheet with one crosswise beam and one longitudinal beam, creating the unobstructed machinery space shown below. *Id.* The car has two end posts but, like the end post and corners posts of the '515 patent's sole embodiment, these posts are at the car's perimeter, not within its machinery space.

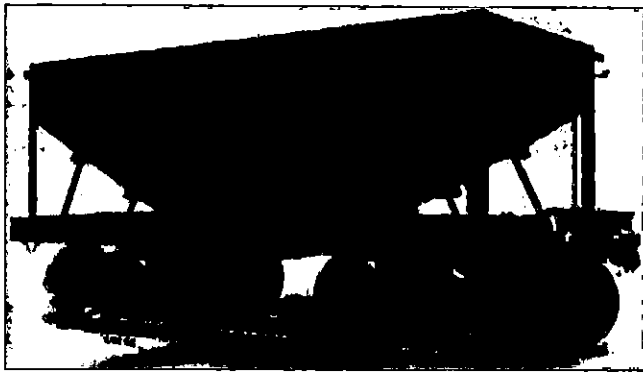


38. Later hopper cars also employed reinforcement beams to achieve an open machinery space. A few examples are shown below.

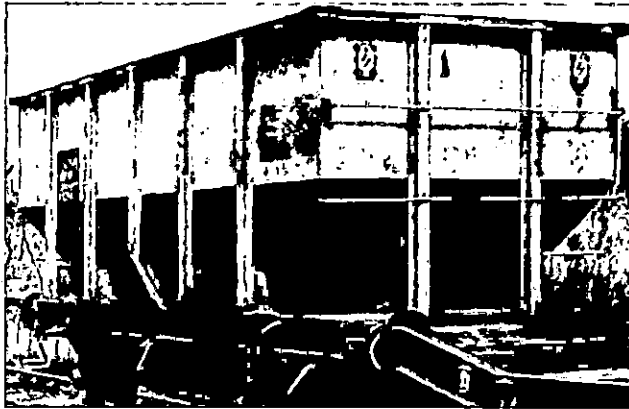
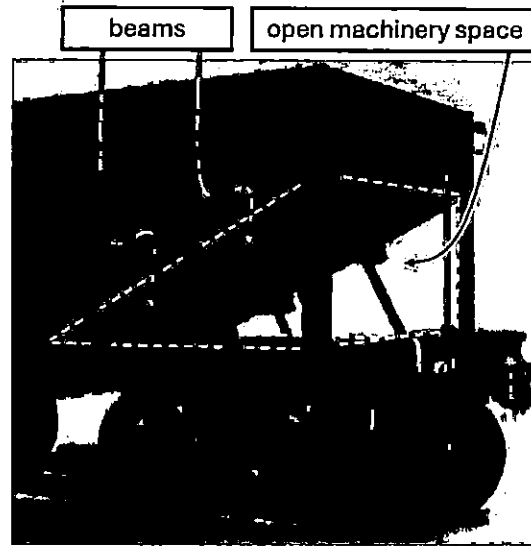


Kilbourne & Jacobs Hopper Car (1912)

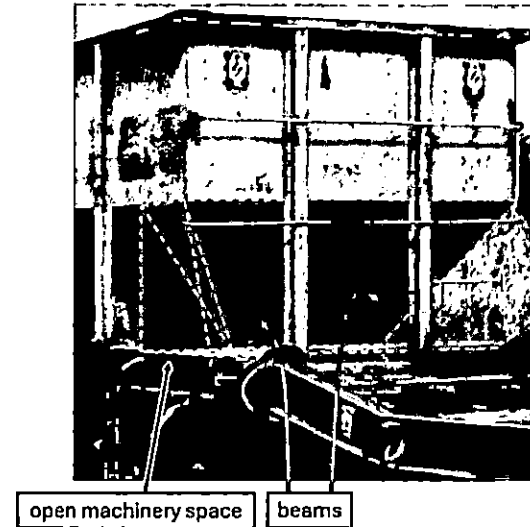




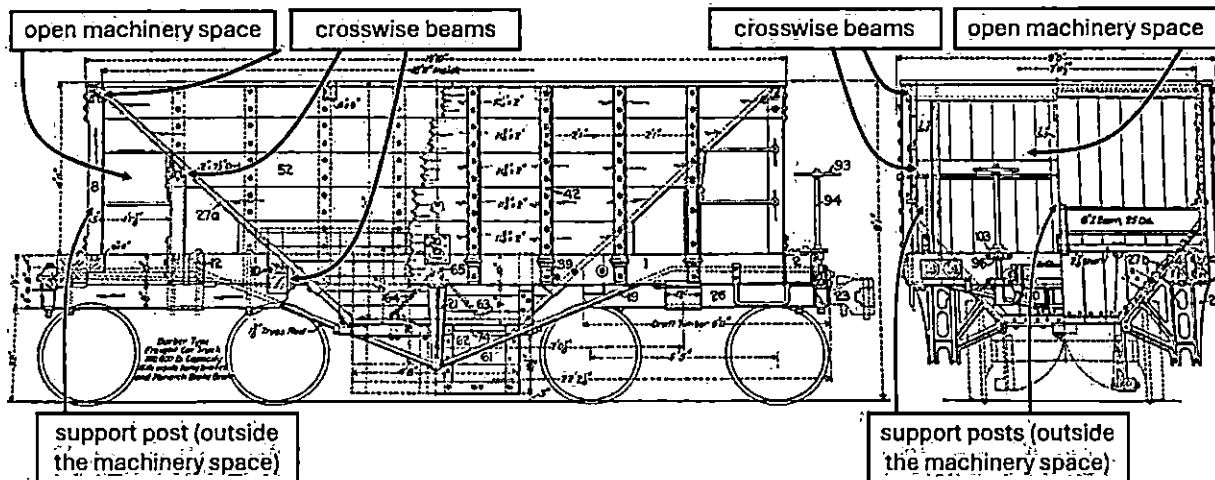
Gregg Co. Hopper Car (1922)



BR Shildon Hopper Car (1963)

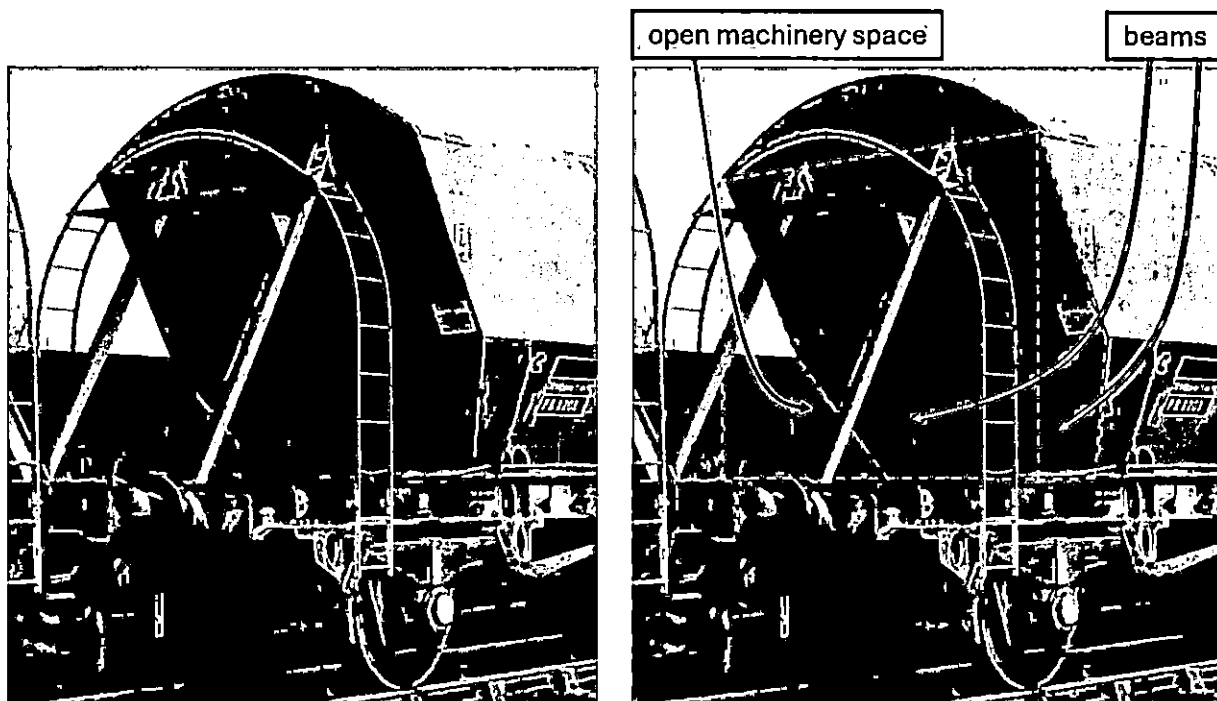


EX1010 at 208, Fig. 24 (Kilbourne & Jacobs); EX1011 at 1113, Fig. 2904 (Gregg);
EX1019 at 39 (BR Shildon).



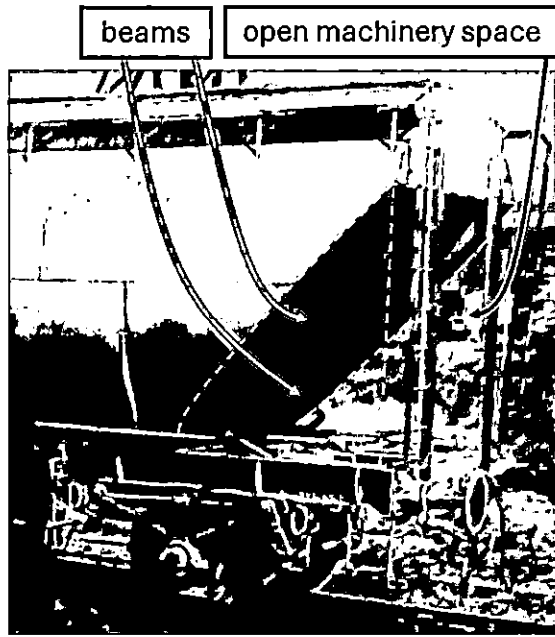
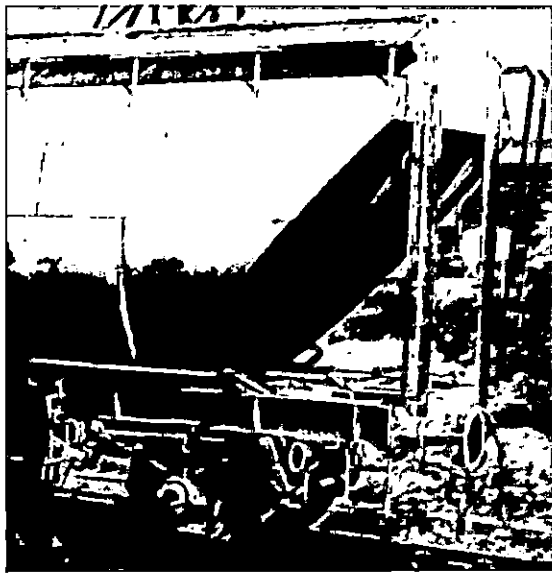
M&SP Ore Car – 1906 Cyclopedia

EX1009 at 118.



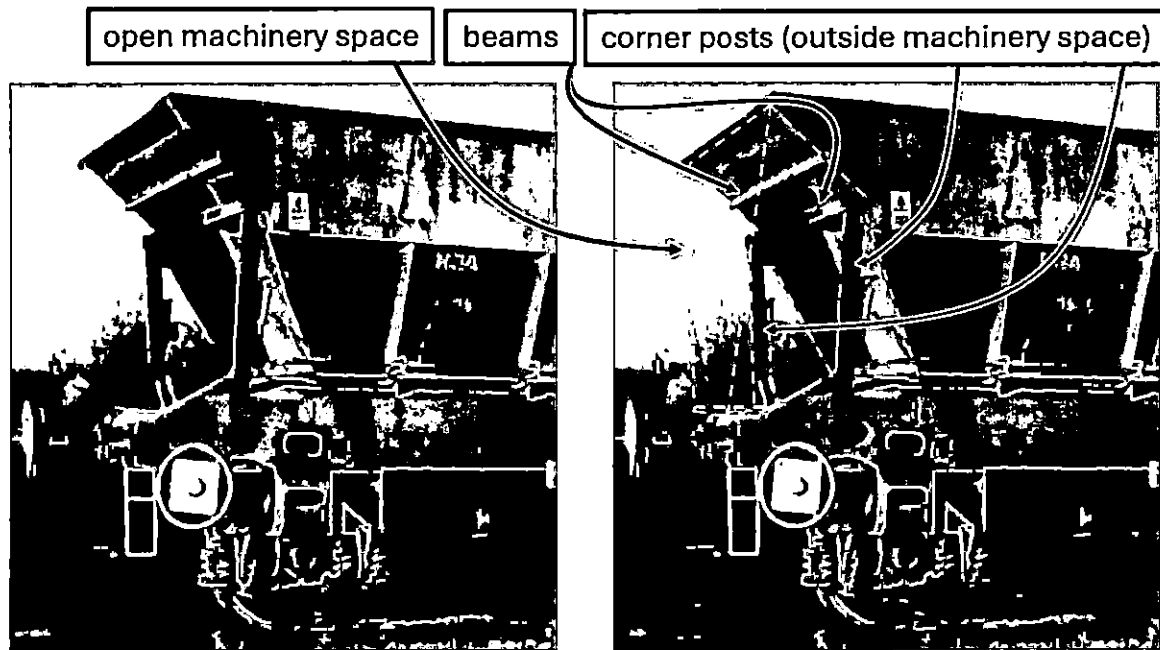
BP Chemicals Hopper Car (1971)

EX1020 at 62.



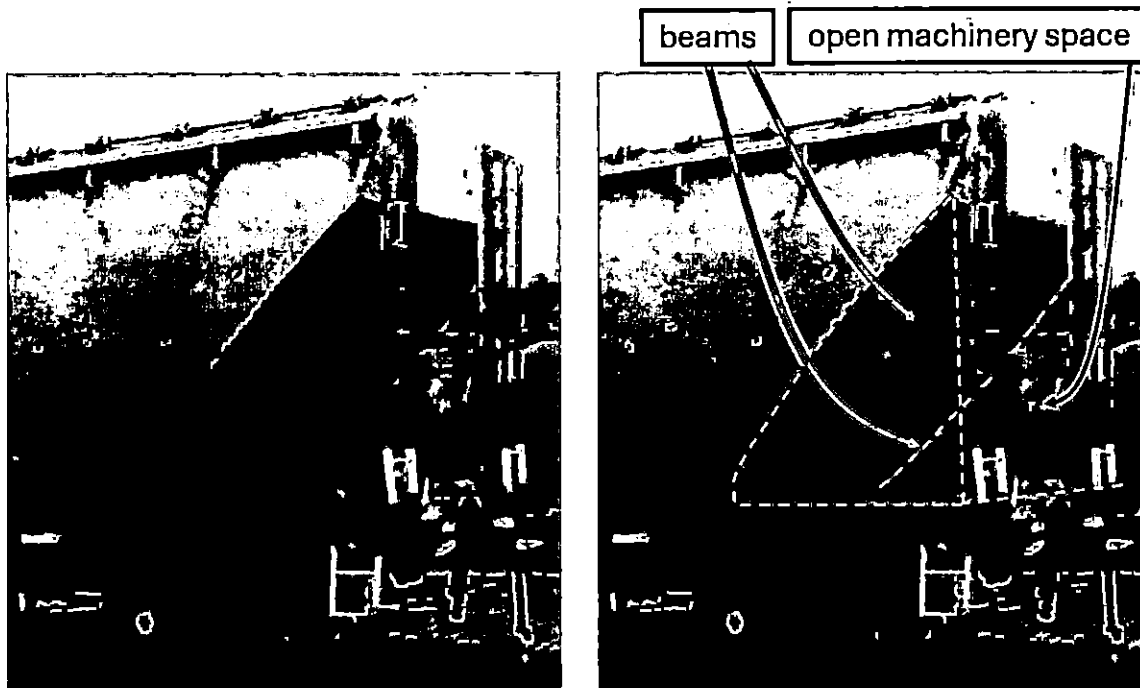
British Steel Hopper Car (1971)

EX1018 at 27.



Marcroft Hopper Car (1994 Conversion)

EX1021 at 55.



Steetley Hopper Car (1971)

EX1024 at 27.

39. Finally, Hart also discloses a hopper car with crosswise beams and an open machinery space. EX1008. As the principal reference in my declaration, Hart is discussed in detail below.

D. Claim Construction

40. It is my understanding that in determining whether a patent claim is anticipated by or obvious in view of the prior art, the Patent and Trademark Office construes the claim by giving the claim terms their plain and ordinary meaning, as they would have been understood by a POSITA at the time of the invention in view of the intrinsic record (patent claims, patent specification, and file history). I

understand that a patent and its prosecution history are considered “intrinsic evidence” and are the most important sources for determining how a POSITA would understand claim language.

41. Most claim terms in the '515 patent are conventional names for standard rail-car features. Other claim terms are expressly defined in the specification of the '515 patent. Except where the intrinsic evidence indicates that the inventors adopted a special definition of a claim term, I have interpreted each claim term in accordance with its plain and ordinary meaning as it would have been understood by a person of ordinary skill in the art at the time of the invention.

E. Level of Ordinary Skill in the Art of the '515 Patent

42. It is my understanding that, when interpreting the claims of the '515 patent and evaluating whether a claim would have been obvious, I must do so based on the perspective of a person of ordinary skill in the art at the time of invention (POSITA). (See paragraph 30 for discussion of invention date.)

43. I understand that, in determining the level of ordinary skill in the art, several factors are considered. Those factors may include: (i) the type of problems encountered in the art; (ii) prior art solutions to those problems; (iii) the rapidity with which innovations are made; (iv) the sophistication of the technology; and (v) the educational level of active workers in the field. A person of ordinary skill in the art

must have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

44. The claims of the '515 patent are directed to reinforcing and assuring the structural integrity of a railway hopper car. Accordingly, a person of ordinary skill in the art to which the '515 patent pertains (POSITA) would have had at least a bachelor's degree in a discipline related to mechanical engineering, physics, structural design, or an equivalent discipline, and at least two years of experience designing or analyzing rail cars or similar vehicles.

45. My opinions herein would remain the same even if the invention date, field of endeavor, or level of ordinary skill were slightly different.

46. I qualify as a POSTIA based on my education and experience described herein and in my CV. *Supra* § I. ; App'x A.

IV. CONCEPTS RELATED TO THE '515 PATENT

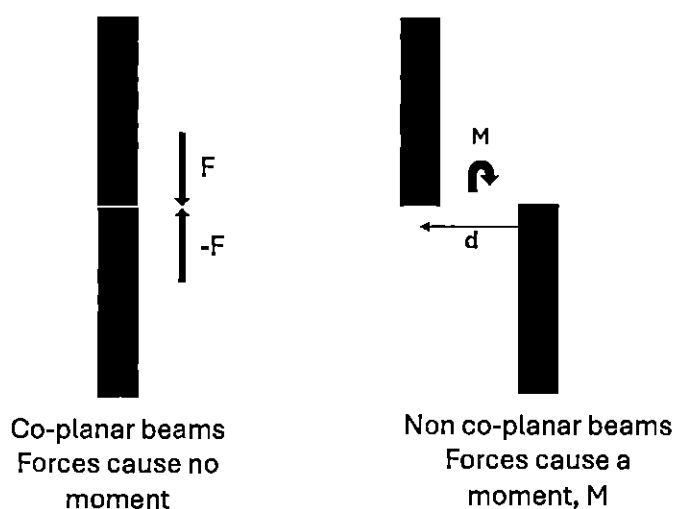
A. Transmitting Loads Through Co-Planar Reinforcing Elements

47. The use of elements that allow transferring loads and forces from one part of a structure to another part is not novel. It has been practiced in various embodiments for decades in various structures, including railcars, dating back to before the priority dates of the subject patents.

48. Aligning those load-transferring elements, e.g., making them co-planar in a plane through the axis of load transfer, offers benefits related to simplicity and

efficiency in design and analysis, particularly in situations where the structure is two-dimensional or can be reasonably approximated as such. It also allows for a more efficient transfer of forces without causing an out-of-plane bending.

49. As shown below, the action and reaction forces are aligned in a co-planar structure, and no bending moment is generated. When they are not co-planar, a bending moment (M) is generated, directly proportional to the magnitude of the forces and their misalignment, known as the moment arm, d . The simplicity and efficiency of co-planar structures such as the beams shown below and in many hopper car structures are known to a POSITA.



B. Stiffening a Flat Structure by Adding Ribs Was Not Novel

50. It was known to a POSITA long before the priority date that ribs are frequently used to improve the strength of sheet metal parts and reduce their deformation when subjected to heavy loading. It was known that a structure made of sections with sheet metals tends not to be strong and lacks stiffness and resistance

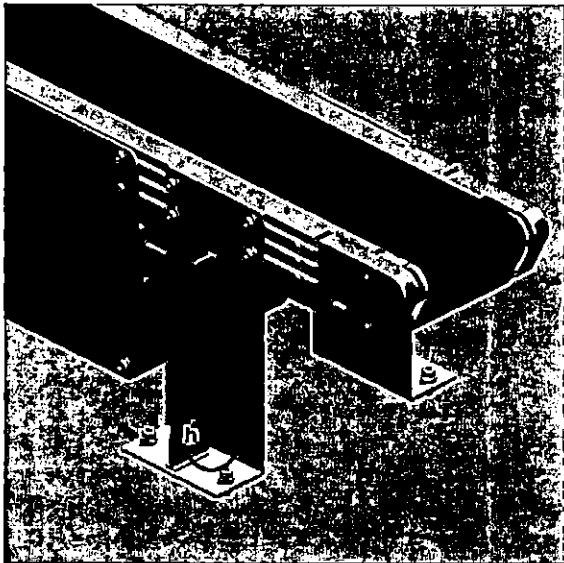
to bending. When subjected to large forces, such sheet metals can bow or bend in response to forces they are subjected to, such as those occurring in sidewall elements of a hopper car filled with heavy cargo like iron ore. Adding stiffening elements such as ribs, flanges, hems, flat elements, C-channels, L-brackets, or tubing to sheet metal parts increases their resistance to deformation when subjected to pressures caused by heavy loads. They do so by increasing the effective thickness of the sheet metal in the direction for which bending is to be prevented.

C. Making Reinforcing Elements from Flat Bar Was Not Novel

51. It was known to a POSITA long before the priority date that elements used for stiffening a sheet metal are often applied in the form of a rib made from flat bar. Flat bars have superior weight efficiency and cost-effectiveness to resist bending in the plane of the flat bar. A flat-bar rib, such as the one shown below, resists bending deformation in direct proportion to its height, h . Flat bars used in this fashion can be connected to supported material by separate L-brackets, incorporated flanges, welding (as shown below), or through other means. The plane (or “web”) of such flat bars can also take any of a multitude of cross-sectional shapes; for example, as shown below, a flat bar can be in a trapezoid form.

52. The stiffening effect of flat-bar ribs was known to POSITAs long before the priority date. Equally known was the spacing of such flat bars. It was known to a POSITA that flat-bar ribs are uniformly spaced along the length of a structure, such

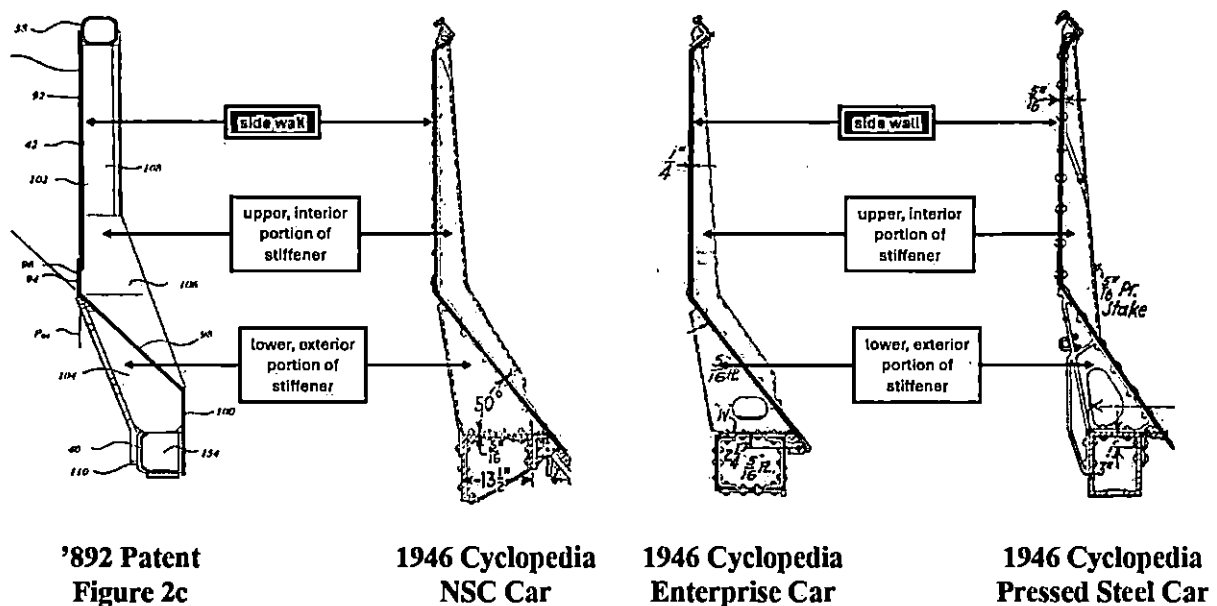
as the sidewalls of a hopper railcar, to reduce warping and offer deformation resistance when the hopper is loaded. This spacing can be seen in the railcars discussed in the following section.



D. Web Continuity Was Not Novel in 2009

53. Side-wall stiffeners with two parts (e.g., 104 and 106 in '515 patent Fig. 2c above) having web continuity were common in hopper cars used to transport minerals such as coal and iron ore long before the priority date. For example, the 1946 Cyclopedia has a section regarding hopper ore cars. EX1004 at 290-95. In that ore-car section of the 1946 Cyclopedia, three of the four schematics in the section disclose two-part side-wall stiffeners with web continuity. *Id.* at 290, 292, 294. Those three schematics have rear section views that show both the interior and exterior portions of the stiffener in relation to the side wall. *Id.* The arrangement of

those stiffeners with respect to the sidewall is very similar—almost identical—to the arrangement thereof shown in Figure 2c of the '515 patent, as shown below. *Id.* For example, in each, the side wall has an upper vertical, outside aspect, below which the side wall angles laterally inward and downward between the two portions of the stiffener; the upper portion of the stiffener is attached to the interior side of the vertical and angled aspects of the side wall; the lower portion of the stiffener is attached to the exterior side of the angled aspect of the side wall; this setup is over, and transfers load to, the side sill. *Id.*

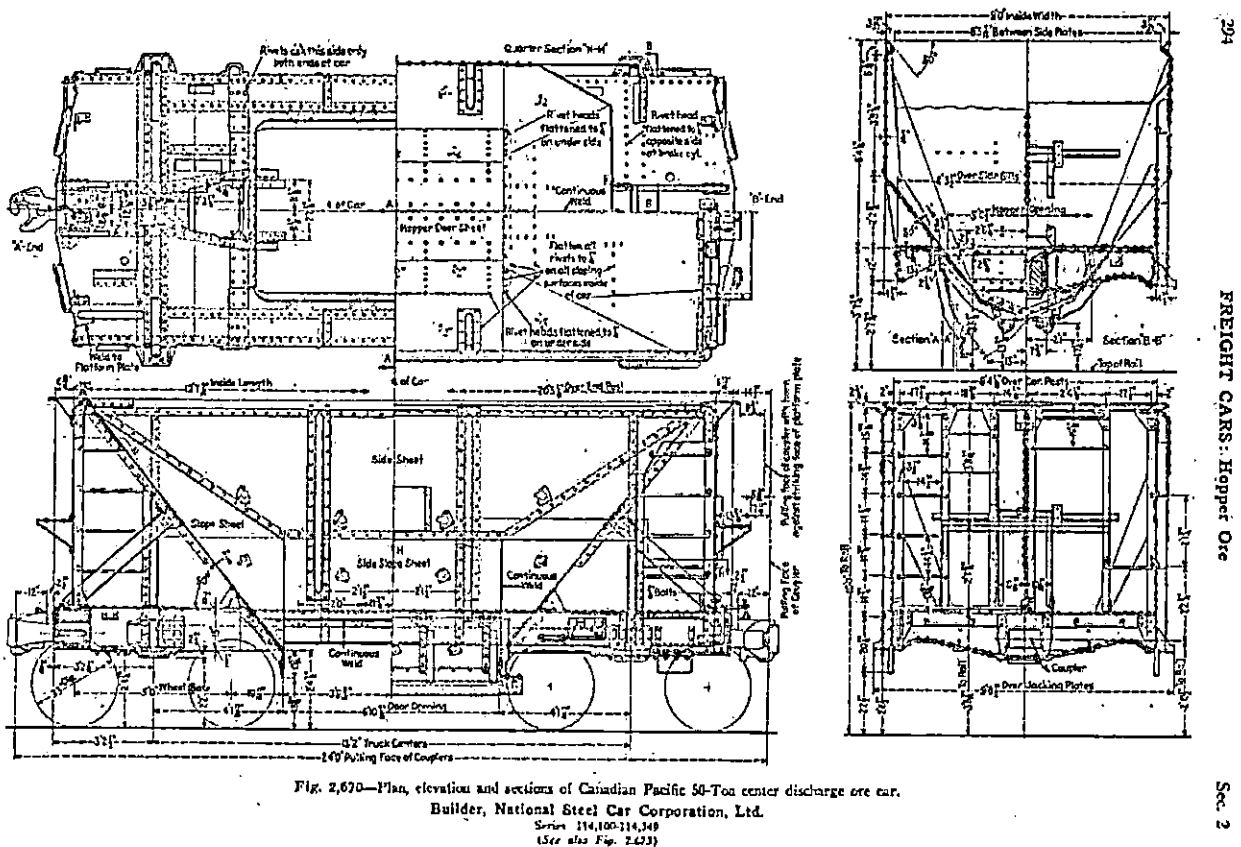


EX1001 at Fig. 2c; EX1004 at 294 (NSC Car); 292 (Enterprise Car); 290 (Pressed Steel Car).

E. Interpreting Technical Schematics from the 1940s

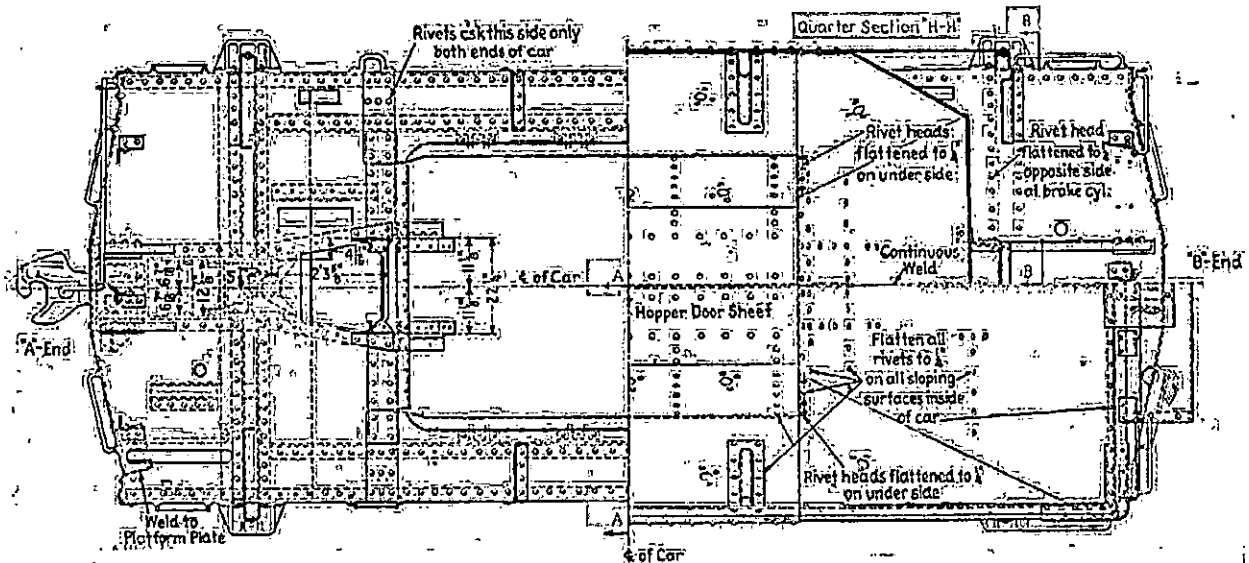
54. 1946 Cyclopedia contains four drawings of the NSC ore car, shown below. EX1004 at 294. These drawings are arranged in accordance with

conventions that were common in the twentieth century, but that are less common today in the era of CAD-generated drawings. In three of those drawings, different sections views are shown on left and right sides and/or the top and bottom portions. I will therefore briefly explain what is being shown in each of the four drawings.

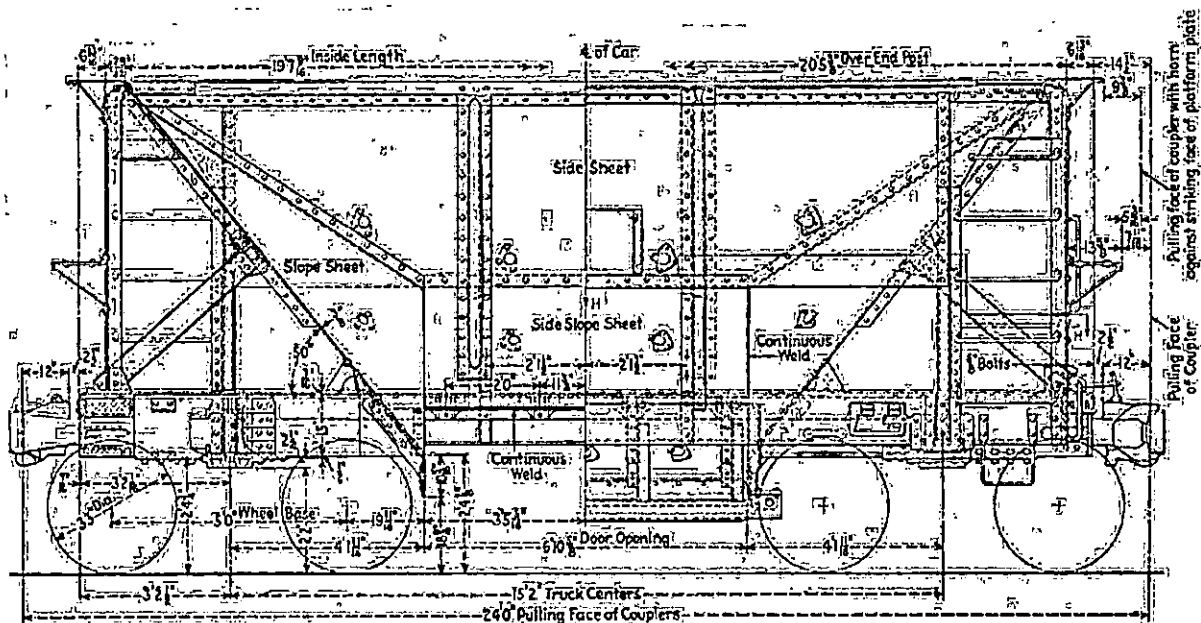


55. Top Left Drawing. In the top view (below), the left half is a sectional view that shows the structure of the lower frame or undercarriage; the upper-right quadrant shows one half of the “B end” of the car, symmetrically, along the line H-H, which the side view identifies as sectioning the ore car approximately midway between the undercarriage and the top of the car; and the lower-right quadrant shows

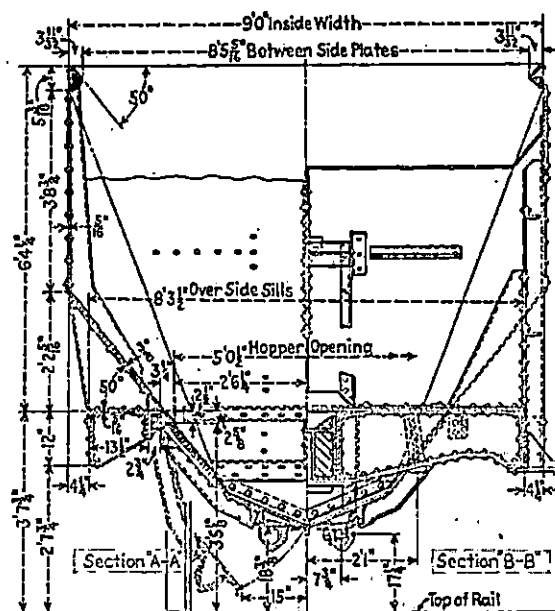
a top view from outside the car. Thus, for example, the lower-right quadrant shows half of one of the two end slope sheets.



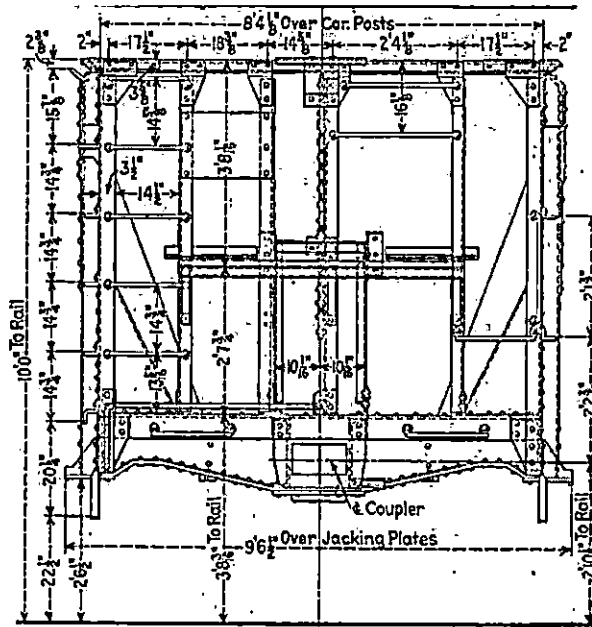
56. Bottom Left Drawing. In the side-view (below), the left half is a vertical-longitudinal sectional cut that shows the inside the hopper, and the right half shows a side view from outside the car. Thus, for example, the left half shows the interior surfaces of the sidewall positioned farther from the reader. The right half shows the exterior surfaces of the sidewall positioned closer to the reader.



57. Top Right Drawing. In the end section views (below), the left half shows a section along the line A-A and the right half shows a section along the line B-B, both of which are identified in the top view.



58. Bottom Right Drawing. The final drawing is a simple rear view, though with certain hidden features shown in dashed lines.



59. The NSC ore car can be accurately depicted in these half or quarter views including because a POSITA would understand that the depicted structure is symmetrical about its longitudinal and lateral axes. In these drawings, dashed lines indicate structure hidden behind other structure.

V. SPECIFIC PROPOSED GROUNDS FOR UNPATENTABILITY

A. Ground 1: Claims 1–2 are obvious over Hart and the 1906 Cyclopedia

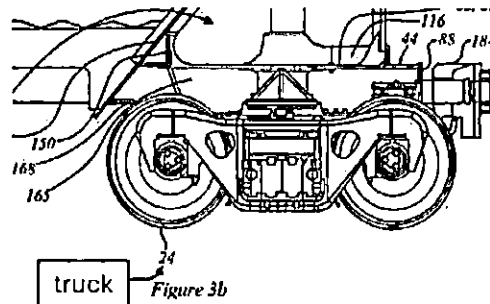
1. Independent Claim 1

- a. [1a] "A railroad hopper car for carrying particulate material, said hopper car comprising: a hopper; first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction; said hopper being suspended between said first and second end sections,"

60. U.S. Patent No. 992,192 was awarded to Harry S. Hart in 1911.

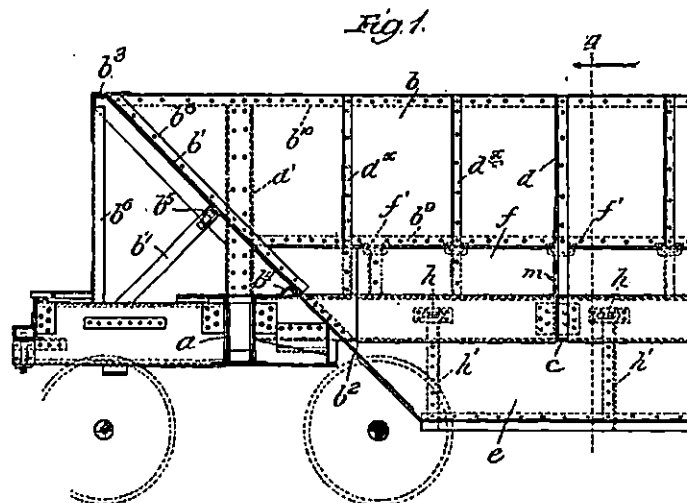
(EX1008) ("Hart"). Hart describes a railway hopper car that he refers to as a "dump

car.” EX1008 at 1:105 (“car with hopper portions”). Regarding the claimed trucks, the car of the ’515 patent has two trucks, one at each end of the rail car; the patent explains that “car 20 may have a car body 22 that is carried on trucks 24 for rolling operation along railroad tracks.” EX1001 at 12:55-57. One truck 24 is shown below.



EX1001, Fig. 3b.

61. As shown below, Hart’s Figure 1 illustrates one of the claimed “end sections” and two of the four wheels of the truck that supports that end of the car.

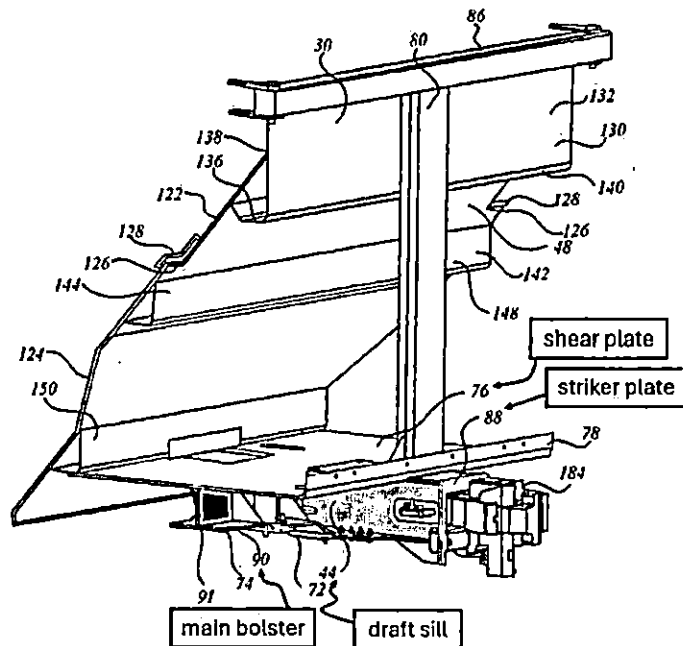


EX1008, Fig. 1.

62. Hart teaches a hopper comprising a central hopper portion and two lateral hopper portions. EX1008 at 1:58-108. Although Hart's Figure 1 shows only one end of the rail car, the written description refers to the "the ends of the car" in the plural. *See, e.g., id.* at 2:46-47, 59. The longitudinal ends of the hopper are formed by "the inclined ends of the car" *b'* and the "inclined ends of the hopper bottom" *b*². *Id.* at 2:46-62. Based on this disclosure, a "POSITA" would have understood that Hart's hopper is suspended between two end sections.

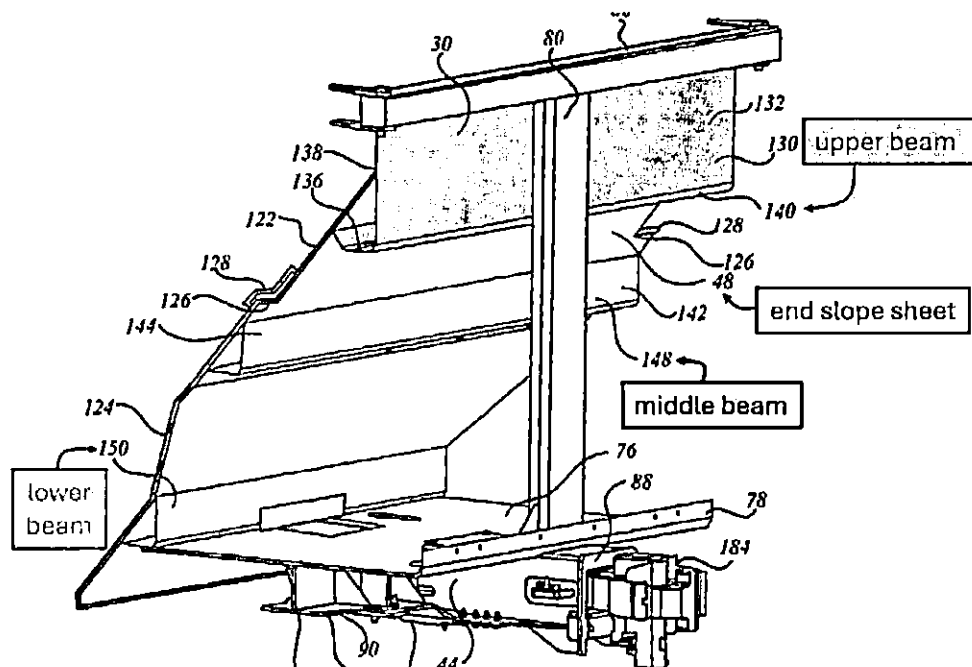
- b. **[1c] "said first end section including a draft sill extending in the longitudinal direction, a main bolster extending crosswise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;"**

63. The '515 patent contains an express definition of "draft sill": "In the terminology of the industry, the portion of the center sill 44 (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center ... may also be referred to as the draft sill." EX1001 at 14:36-39. Figure 3a of the '515 patent illustrates a longitudinally oriented draft sill, a main bolster extending crosswise to the draft sill, and a shear plate mounted on the draft sill and bolster.



Id., Fig. 3a.

64. Although not discussed in the patent, Hart shows a shear plate (colored yellow in Figs. 1 and 3). Hart's shear plate extends a certain distance along the draft sill, as shown in Fig. 3 below. In addition, Hart states that "Fig. 3 is a plan view of a portion of our car, certain parts being removed to show the construction of the underframe." EX1008 at 1, 21–24. A POSITA would understand that Fig. 3 shows only one half of the plate, and that the shear plate is attached to each side sill ^{b20} and extends from side to side.

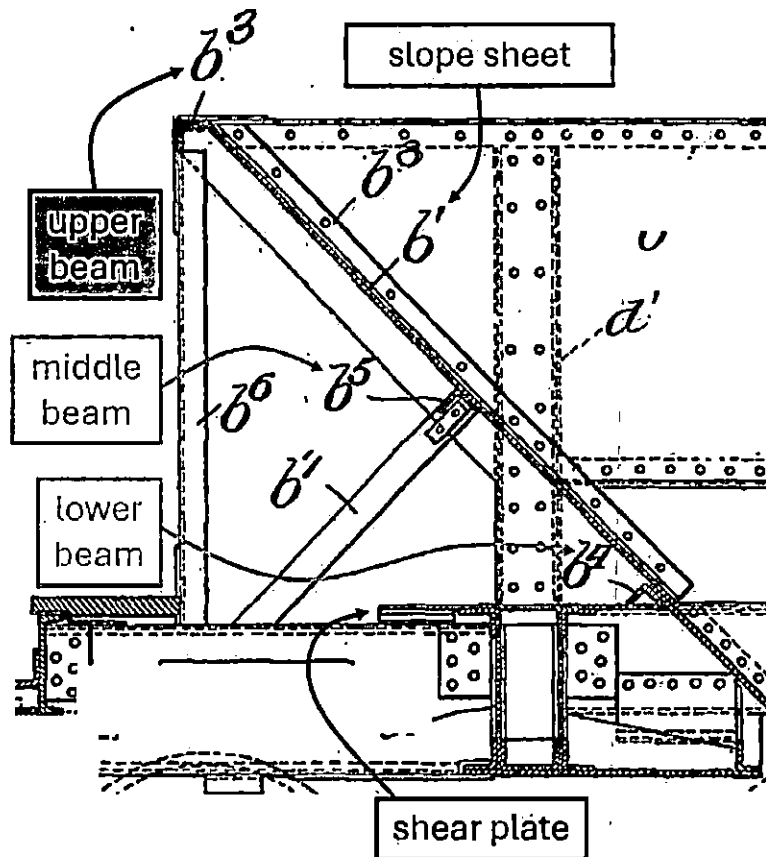


EX1001, Fig. 3a.

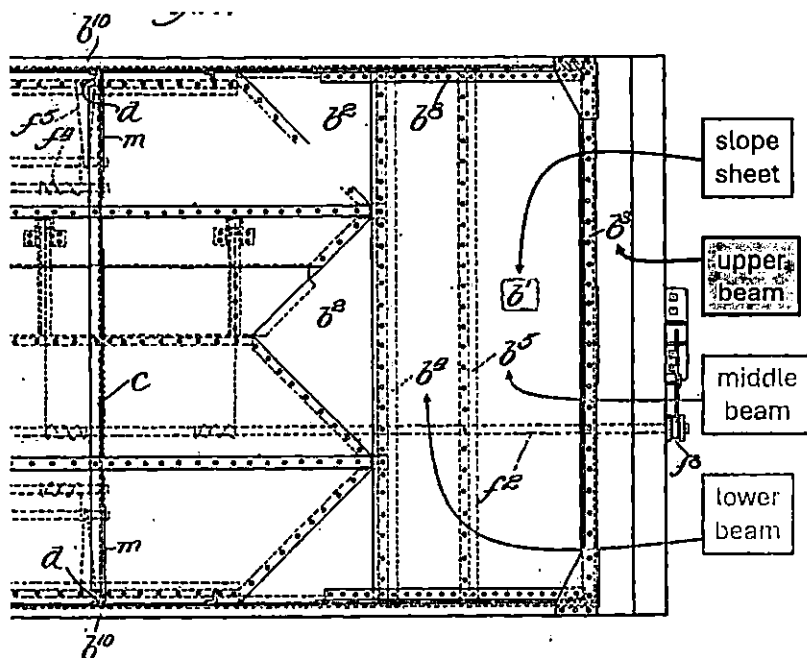
66. Because limitation [1e] should be interpreted to cover the only embodiment disclosed in the '515 patent, the reinforcement beams shown in Fig. 3a do not prevent the '515 patent's hopper car from satisfying the "being free of primary structure" clause of limitation [1e].

67. Hart also discloses reinforcement beams that extend crosswise along the underside of the slope sheet. As with the '515 patent, Hart's reinforcement beams do not prevent it from satisfying the "being free of primary structure" requirement of limitation [1e].

68. As shown below, Hart's slope sheet is supported by beams that extend crosswise along the underside of the slope sheet. EX1008, Figs. 1, 2.



Hart Fig. 1

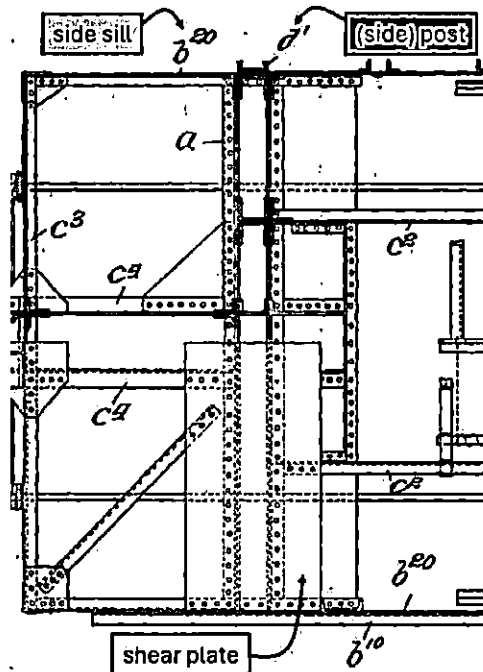


Hart Fig. 2

69. Hart's slope sheet is not supported by elephant ears (e.g., triangular longitudinal plates, struts, transverse plates, or any other primary structure directly above the shear plate and below the slope sheet. This can be seen in Figs. 1–2 above. Those figures show three other structures at the end of the rail car: (corner) post b^6 , (side) post d' , and inclined brace b^7 . See *id.*, Fig. 1. However, none of these structures is in the claimed location.

70. Corner post b^6 is not directly above the shear plate, but longitudinally outboard of the shear plate at the corner of the railcar, as shown in Fig. 1 above. *Id.*, Fig. 1.

71. Side post d' is mounted on the outside of side sill b^{20} , laterally outboard of the shear plate, as shown in Fig. 2 below. As the figure shows, the shear plate is attached to a flange that is laterally inward of the side sill, while (side) post d' is laterally outward of the side sill.

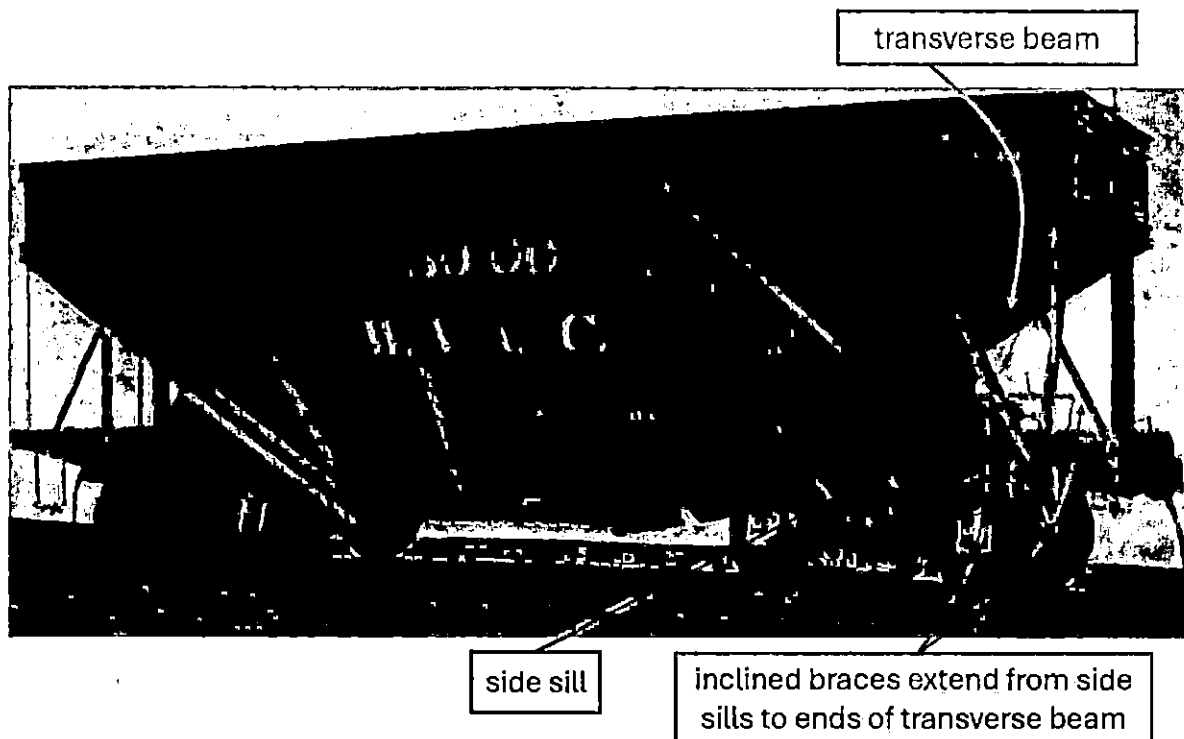


Hart Fig. 2

EX1008, Fig. 3.

72. Inclined brace b^7 is mounted to the side sill and extends upwards in a vertical plane, without extending laterally inward into the machinery space or above the shear plate. First, if inclined brace b^7 extended laterally inward, it would be visible in Fig. 2, an upper plan view of the hopper car. *Id.* But it is not shown there.

73. Second, inclined braces such as brace b^7 were often used to support the ends of a transverse beam, just as brace b^7 supports the ends of beam b^5 . *Id.* In such cases, the lower end of the inclined brace is mounted to the side sill, and no part of the inclined brace extends laterally inward of the sill. *Id.* The 1906 Car Builder's Dictionary, a handbook for train manufacturers ("the 1906 Cyclopedia"), contains a photograph of a railcar manufactured by the Cambria Steel Co. ("the Cambria Steel car") with this sort of inclined brace for supporting the ends of a transverse beam:



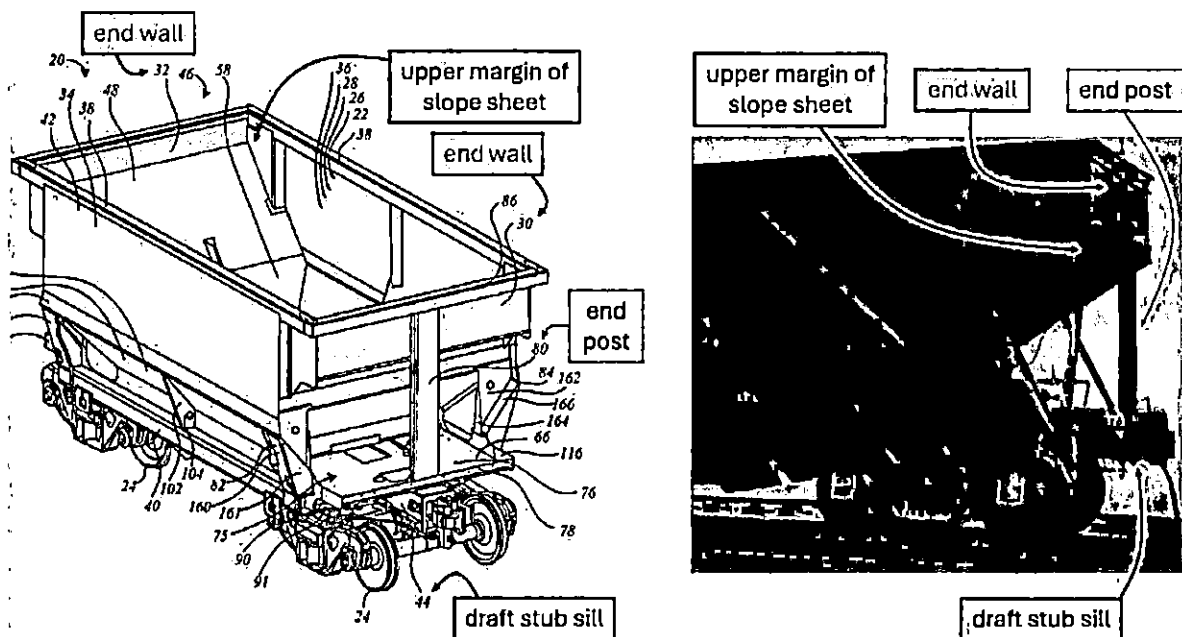
EX1009 at 13, Fig. 53.

74. Thus, like the '515 patent, Hart teaches supporting the slope sheet with transverse beams, without relying on primary structure directly over the shear plate or in the machinery space. Hart therefore discloses limitation [1e].

75. Even if Hart did not disclose that its inclined brace is laterally outboard of the shear plate, it would have been obvious to mount the brace to the outside of the side sill, as in the 1906 Cyclopedia, so that it would not be directly above the shear plate or in the machinery space. Additionally, separating the braces as far apart as possibly offers the most resistance to warping and tortional distortion. A POSITA would have been motivated to do this to create a strong base for the braces.

- d. [1f] “one of: (a) said first end slope sheet has an upper margin and said hopper car includes an end post extending upwardly from said draft sill to said upper margin of said first end slope sheet; and (b) said first end slope sheet has an upper margin terminating at an end wall, and said hopper car includes an end post extending upwardly from draft stub sill¹ to said end wall;”

76. The 1906 Cyclopedia’s Cambria Steel car discloses option (b) of this limitation, as shown below.



EX1001, Fig. 1; EX1009 at 13, Fig. 53

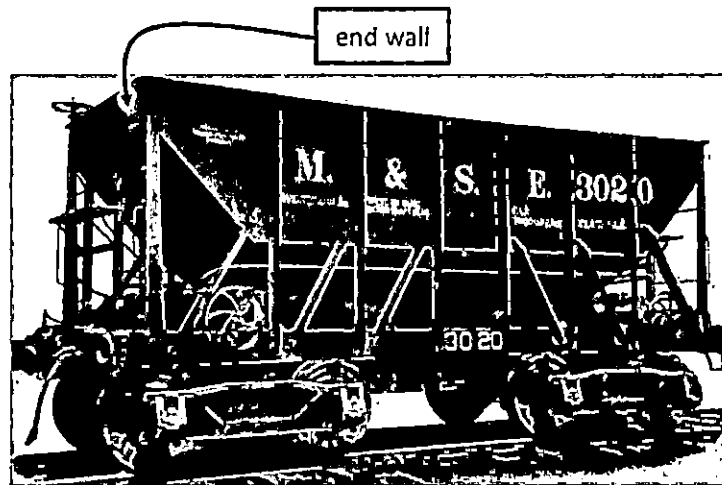
77. It would have been obvious to modify Hart to add an end wall supported by an end post, as in the Cambria Steel car. The modification could be made either (i) by leaving the end slope sheets in place and increasing the overall height of the

¹ The '515 patent uses “draft sill” and “stub sill” interchangeably. EX1001 at 17:32–33 (“draft sill (i.e., the stub sill)”).

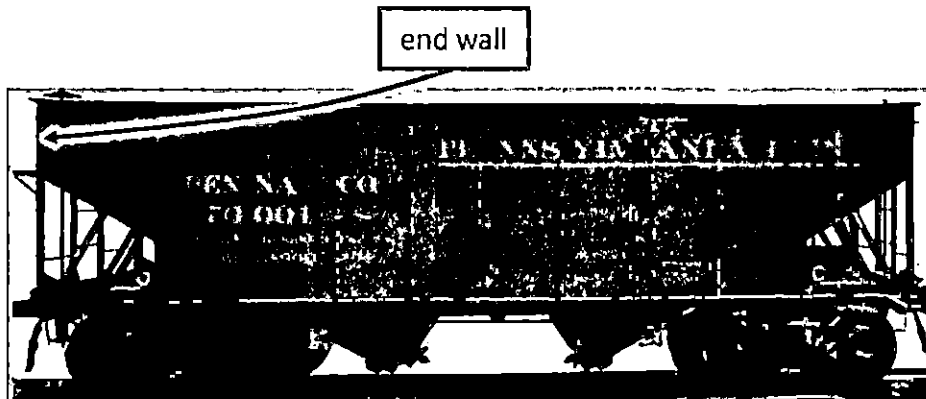
hopper; or (ii) by reducing the inclination of the slope sheets so that their outboard ends terminate at a lower height (*i.e.*, lower along the end wall).

78. A POSITA would have had reason to modify Hart to incorporate an end wall supported by an end post extending upward from the draft sill, as in the Cambria Steel car. First, doing so would increase the hopper's volume without increasing the rail car's length or width (or even its height, if the end wall is added by lowering the slope sheets).

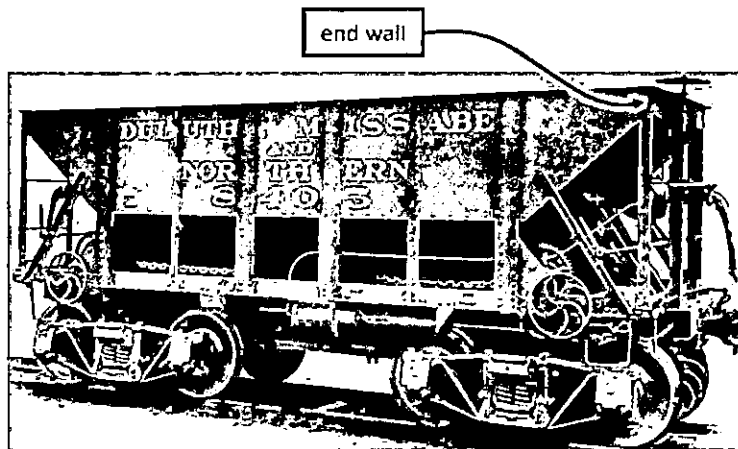
79. Second, by 2009, end walls were common and well-known optional features of hopper cars. Indeed, end walls were common and well-known even by 1906, a century before the '515 patent application, as demonstrated by the many examples below of hopper cars with end walls shown from the 1906 Cyclopedia. Each of the examples below has at least one end post supporting the end wall, either a single end post extending upward from the center of the draft sill, or two posts extending from the left and right sides of the draft sill.



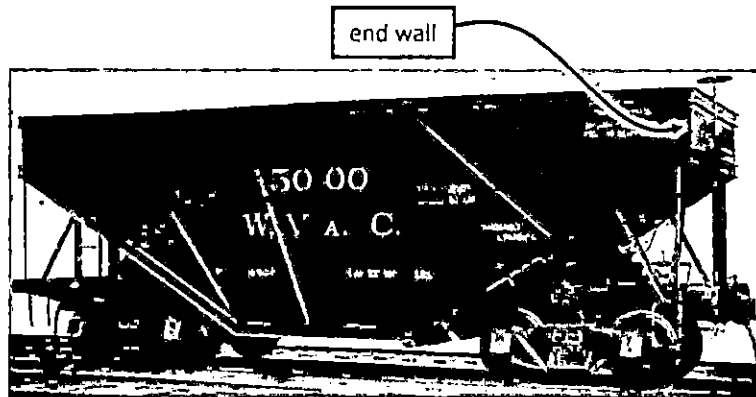
EX1009 at 14, Fig. 54.



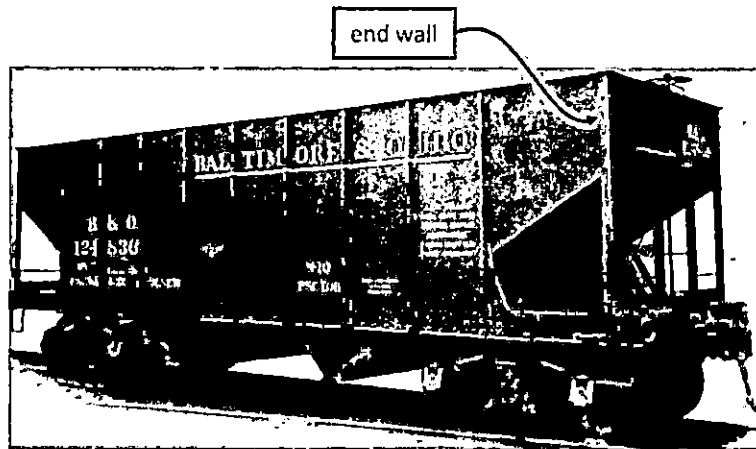
Id. at 13, Fig. 52.



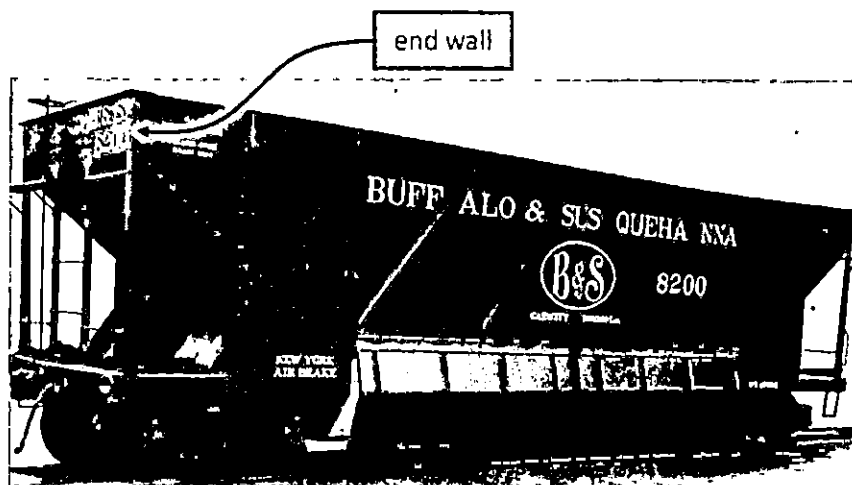
Id. at 14, Fig. 55.



Id. at 13, Fig. 53.



Id. at 13, Fig. 50.



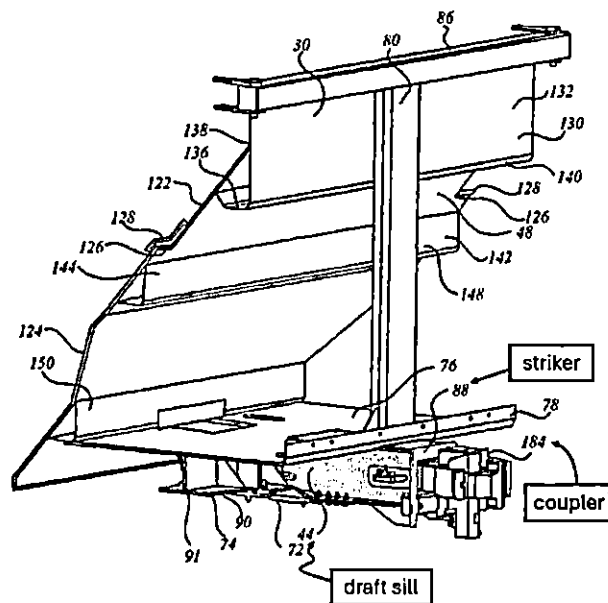
Id. at 14, Fig. 56.

80. Third, incorporating an end wall and post (as in the Cambria Steel car) in Hart's design would have been obvious to a POSITA because it is one of a finite number of well-understood options for the end of a hopper car, *i.e.*, (i) incorporating an end wall or (ii) extending the slope sheet to the top cord. The routine design choice between these two options is governed by balancing well-understood considerations, *e.g.*, maintaining the desired maximum exterior dimensions of the railcar, maximizing the capacity of the hopper, supporting the loads carried by the slope sheet and hopper doors, and maximizing the car's efficiency in discharging its intended lading.

81. Because end walls had been commonplace for a century before 2009, a POSITA would have had a reasonable expectation of success in incorporating an end wall in Hart's design.

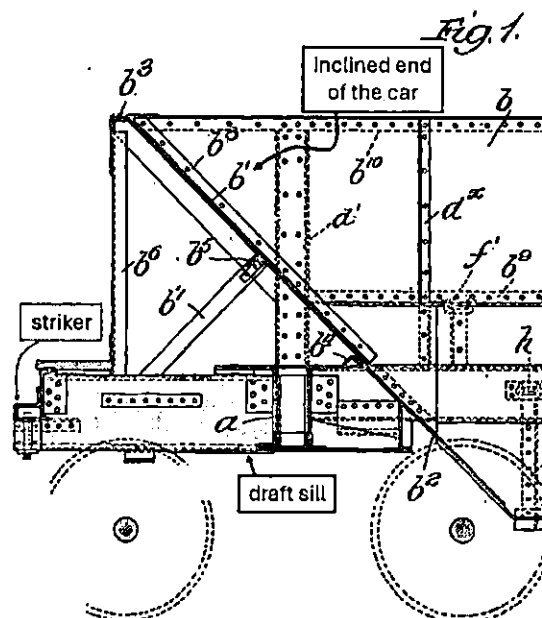
- e. **[1g] "said shear plate has a longitudinally outboard margin and said draft sill has a striker located outboard of said longitudinally outboard margin of said shear plate, and said end post is one of: (a) rooted to said draft sill adjacent to said striker; (b) rooted to said shear plate adjacent to said longitudinally outboard margin of said shear plate;"**

82. Strikers or "strike plates" are plates mounted on the outward end of a draft sill to protect the rail car from impact with the coupler that connects the adjacent rail car. Strikers are standard components on rail cars, and the distance between the strikers is a common measure of a rail car's length. The '515 patent discloses a striker 88 at the end of draft sill 44, as shown below.



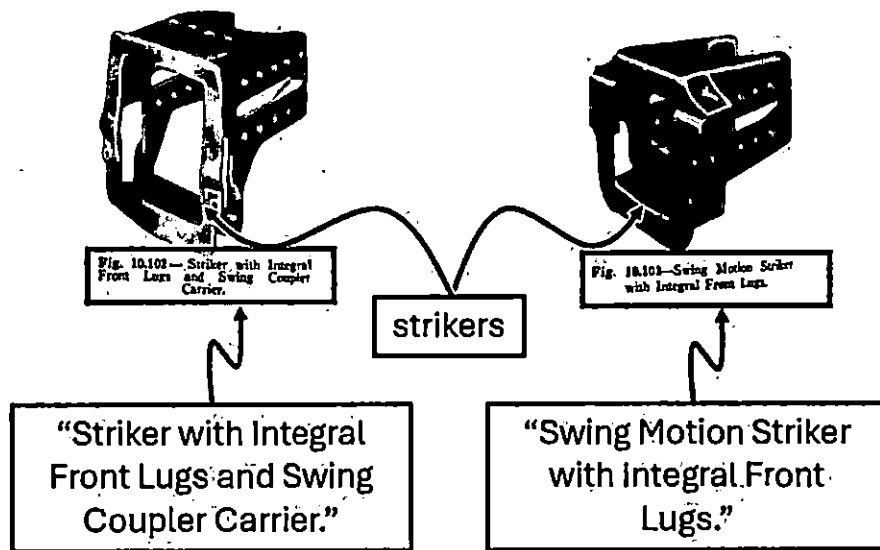
EX1001, Fig. 3a.

83. Hart discloses a structure attached to end of its draft sill, as shown below.

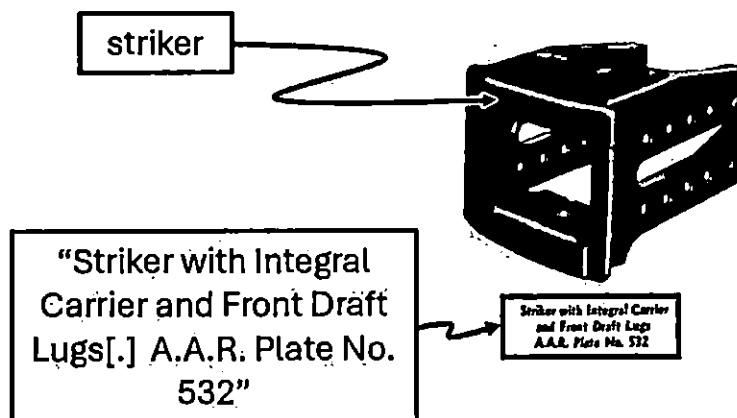


EX1008, Fig. 1. A POSITA would understand that the structure attached to the end of the draft sill is a striker.

84. Strikers were standard features on rail cars for decades before the critical date in 2009. The 1946 Cyclopedia defines “striker” and “striking plate” to mean: “A member placed on the ends of the center sills of freight cars against which the horn of the coupler strikes, preventing damage to the draft gear and center sills.” Ex1004 at 62. The reference shows many examples of strikers, including the following:



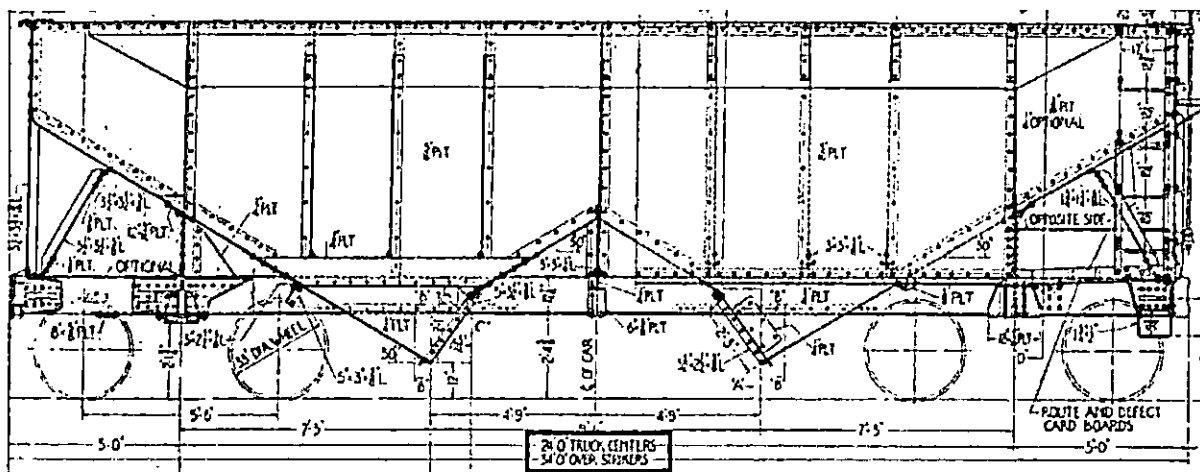
Id. at 972.



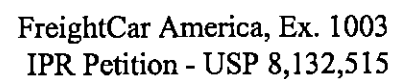
Id. at 973; *see also id.* at 1136.

85. As the definition suggests, strikers protect the rail car from impact with the couplers that connect adjacent rail cars. For this reason, strikers are typically placed at the end of the center sill (in this case, the draft sill), which is longitudinally outboard of the longitudinally outboard margin of the shear plate. A POSITA would have wanted to use a striker in its customary position outboard of the shear plate to protect the draft sills from damage.

86. As shown below, the 1946 Cyclopedia frequently identifies strikers when calling out the longitudinal length of cars “over strikers” or “over striking plates.”

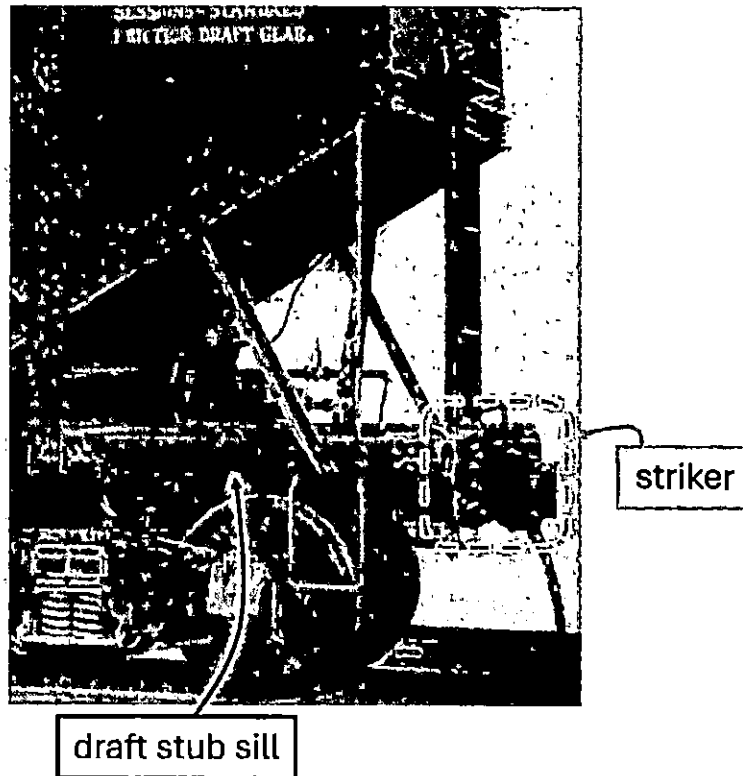


Id. at 254. *See also* 262, 276, 280. Because strikers protect the rail car from impact with the couplers that connect adjacent rail cars, they are typically placed at the end of the draft sill and therefore longitudinally outboard of truck center.

[illegible]

Id. at 294.

88. The 1906 Cyclopedia's Cambria Steel car also discloses a striker at the end of the draft sill, as shown below.



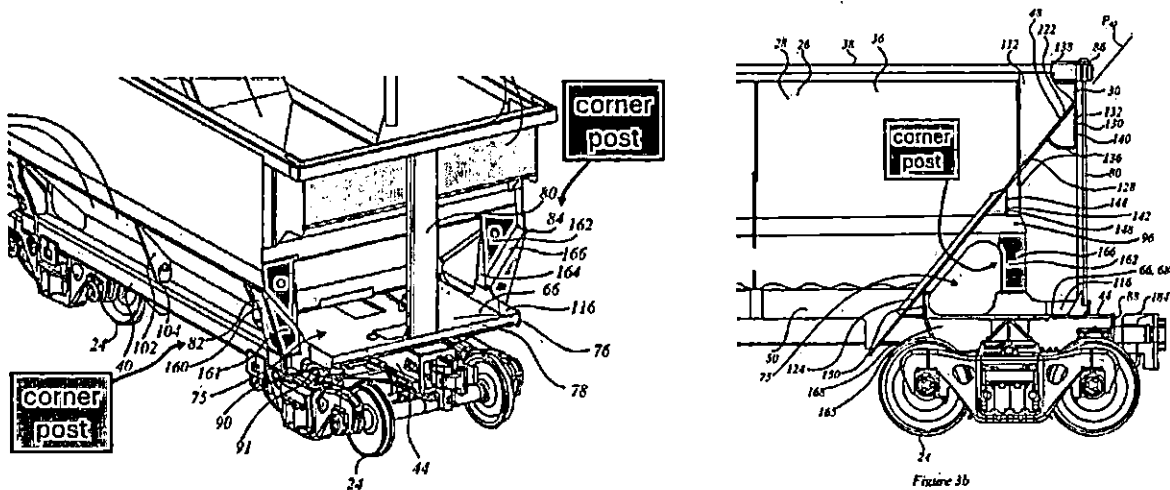
EX1009 at 13, Fig. 53. As the photograph shows, the striker plate is attached to the end of the draft sill with rivets.

89. Even if Hart did not expressly disclose a striker at the end of its draft sill, it would have been obvious to add one, as in the Cambria Steel car. A POSITA would have been motivated to do so because a striker is a standard component that protects the rail car from damage. Adding a striker plate is a simple matter that would have posed no challenge to a POSITA in 2009.

90. Finally, as discussed above in connection with limitation [1f], it would have been obvious to modify Hart to add an end wall supported by an end post extending from the draft sill, as in the 1906 Cyclopedia's Cambria Steel car. EX1009 at 13, Fig. 53. That end post would be "rooted to said draft sill adjacent to said striker," as recited in limitation [1g].

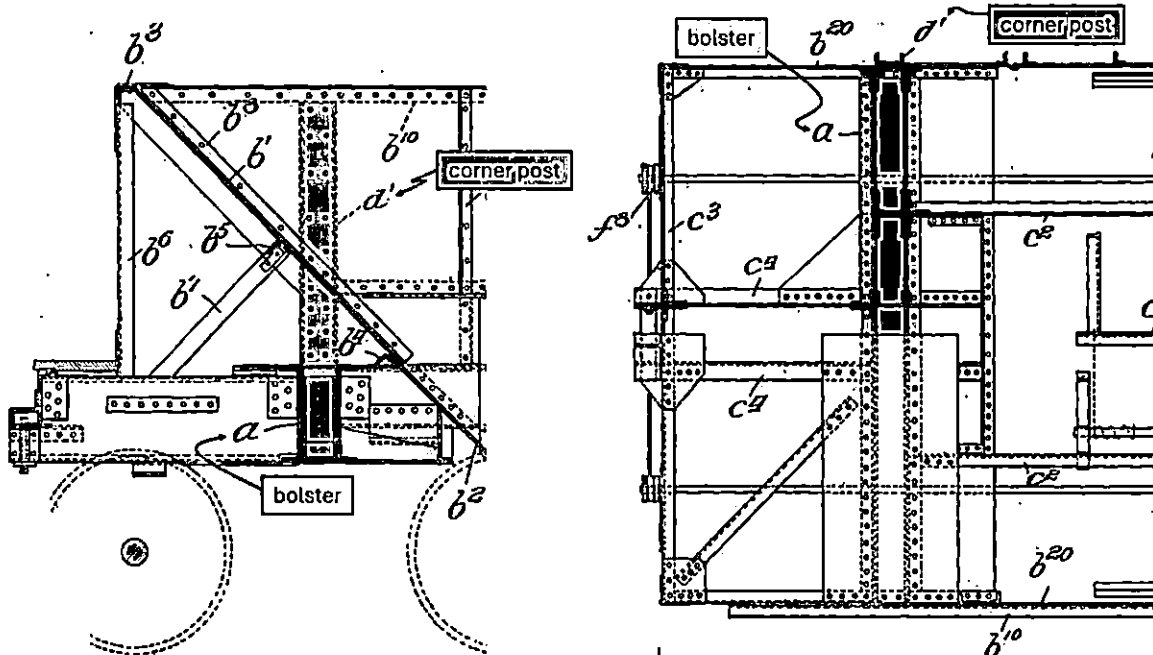
- f. [1h] "said bolster has first and second laterally outboard distal ends, and said hopper car has corner posts extending upwardly from said distal ends of said bolster to said first end slope sheet; and"

91. The '515 patent figures show corner posts extending upward generally from the longitudinal position of the bolster:



EX1001, Figs. 1, 3b.

92. Hart discloses corner posts, denominated "supporting post *d'*," that extend upward from the ends of the bolster, as shown below.



See EX1008, Figs. 1, 3.

- g. [1i] “said hopper car has a machinery space bounded by (a) said first end slope sheet; (b) said shear plate of said first end section; (c) said end post; and (d) said corner posts, and said machinery space is free of any other primary structure.”

93. Hart discloses this limitation. Hart’s hopper car has no primary structure within the the area defined by the shear plate, slope sheet, corner posts and end post. As discussed in connection with limitation [1e], Hart discloses transverse beams extending along the underside of the slope sheet, just like the ’515 patent. *See supra*, at § V.A.1.c. Hart also discloses inclined braces and true corner posts that are at the sides of the car, rather than in the machinery space, just like the corner posts of the ’515 patent. *Id.* Further, modifying Hart to add an end post, as discussed

above, would not add any structure to the machinery space, which is longitudinally inward of the end post.

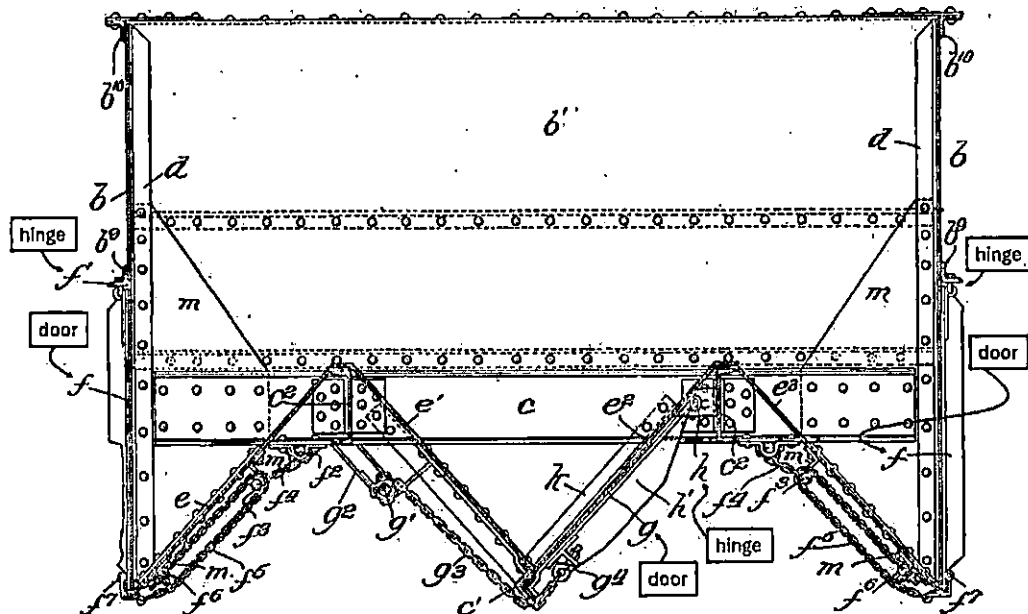
94. Finally, even if one of these structures were deemed to slightly impinge upon the machinery space, they would be no different than the '515 patent's transverse beams, which extend slightly below the slope sheet. If Claim 1 is construed so that it covers the preferred embodiment, as it should be, then a machinery space is free of primary structure even if primary structure at the perimeter of the machinery space extends a *de minimis* amount into that space. Alternatively, it would have been obvious to shift Hart's true corner posts or inclined braces slightly outward, or the above-bolster corner posts *d'* inward, as the precise positions and points of attachment of these structures is a matter of design choice.

B. Ground 2: Claim 3 is obvious over Hart, the 1906 Cyclopedia and Schuller.

- 1. Dependent Claim 3: "The railroad hopper car of claim 1 wherein: said hopper car has at least one longitudinally hinged discharge door, said discharge door being movable cross-wise between open and closed positions; and a longitudinally acting pneumatic actuator is at least partially lodged in said machinery space directly above said draft sill."**

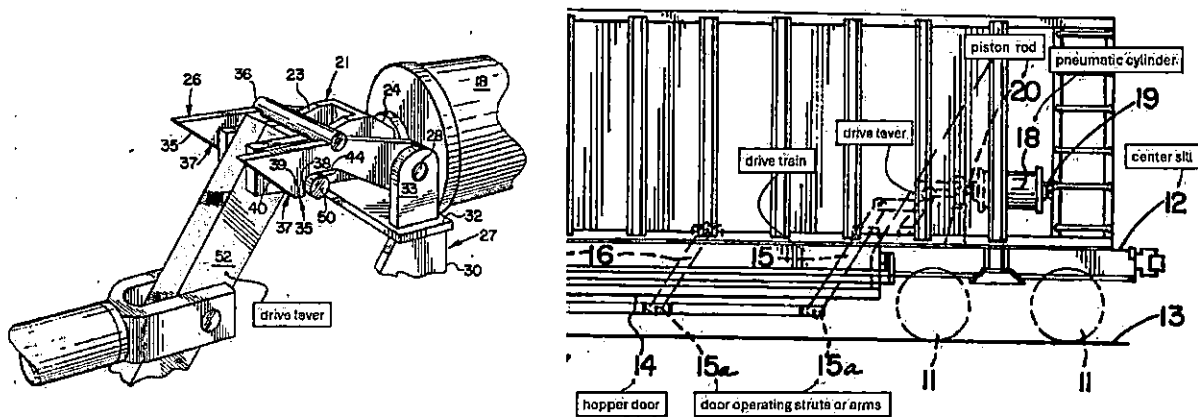
95. Hart teaches "longitudinally hinged" discharge doors that are "movable cross-wise between open and closed positions," as claimed. In Hart, "[t]he central hopper is provided with doors *g* provided upon their under sides with braces *h'*."

EX1008 at 1:72–77. “Suitably hinged, as at f' to the sides of the car, are doors f so hinged as to swing outwardly when released.” *Id.* at 1:88–91.



Id., Fig. 4. To operate the doors, Hart uses longitudinal shafts (e.g., f^2, f^3, g') and chains (f^4, f^5, g^3). *Id.* at 2:11–62.

96. Schuller also discloses longitudinally hinged discharge doors: “Hopper doors 14 are pivoted on a longitudinal axis and open downward to discharge lading.” EX1014 at 1:53–54. Schuller teaches using a “pneumatic cylinder means operative upon a door opening lever mechanism for opening and closing of pivoted discharge doors” *Id.*, claim 1. As shown below, Schuller’s pneumatic actuator acts longitudinally by moving lever 52 longitudinally, which in turn moves other components of the drive train longitudinally in order to open or close the hopper doors.



EX1014, Figs. 1, 5. Finally, as Fig. 1 shows, Schuller's pneumatic cylinder 18 is mounted in a machinery space. It is also directly above the draft sill. *Id.* at 2:7-9 (supporting means 27, shown directly below the pneumatic cylinder in Fig. 5, is "attached to the top 29 of the center sill 12").

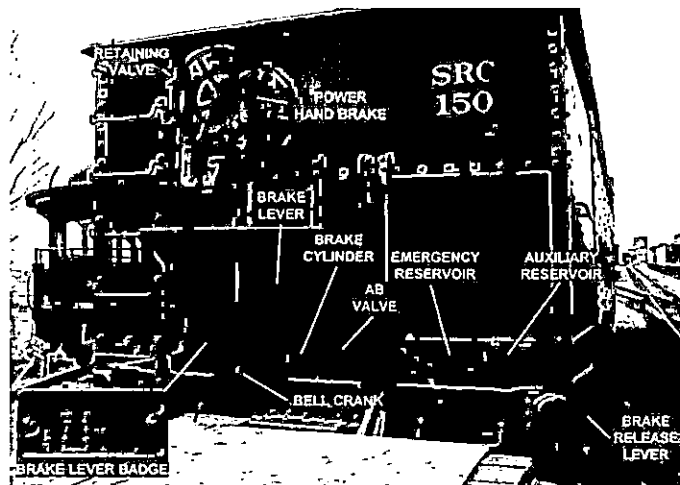
97. It would have been obvious in 2009 to replace Hart's longitudinally hinged doors and door-opening mechanism with doors and a door-opening mechanism like Schuller's. In 2009, a POSITA would have wanted to update Hart's century-old, manually operated door-opening mechanism by at least partially automating the door-opening process, to reduce the manual labor required and the risk of injury. In addition, in 2009, a POSITA would not have needed Hart's side doors *f*, because by 2009 virtually all railyards were arranged to facilitate discharge through the bottom center of the rail car, as taught by Schuller. A POSITA therefore would have been motivated to use Schuller's conventional hopper doors and

automated door-operating mechanism. With this obvious modification, Hart would satisfy claim 3.

C. Ground 3: Claim 4 is obvious over Hart, the 1906 Cyclopedia, Schuller and Karig.

1. **Dependent Claim 4: “The railroad hopper car of claim 3 wherein a brake reservoir is also at least partially lodged in said machinery space.”**

98. Lodging the brake reservoir in the machinery space has been conventional for decades. For example, Karig discloses multiple hopper cars with this conventional configuration. *See, e.g.*, EX1016 at 127, 129. One such example is shown below.



Id. at 129 (annotations in the original).

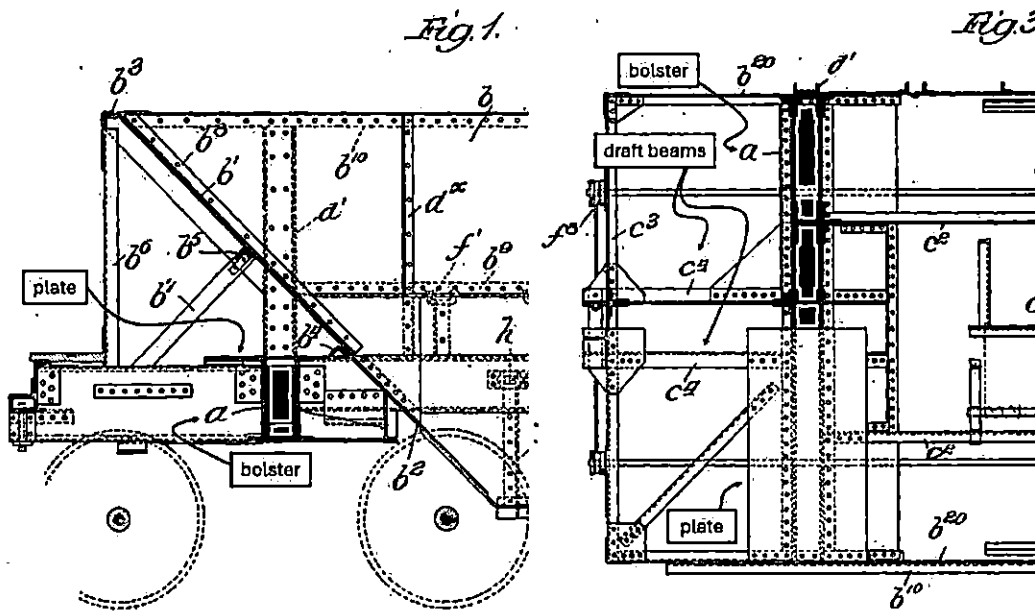
99. By 2009, it would have been obvious to use a conventional air brake system in Hart's design, and to lodge the brake reservoir in the conventional place, *i.e.*, in the machinery space at one end of the rail car. So modified, Hart's design would embody the limitation of claim 4.

D. Ground 4: Claims 5-6 are obvious over Hart, the 1906 Cyclopedia and Campbell '652.

1. Dependent Claim 5

- a. [5a] "The railroad hopper car of claim 1 wherein: said shear plate is mounted above, and to, said main bolster and defines an upper flange thereof;"

100. Hart discloses this limitation, as shown below.



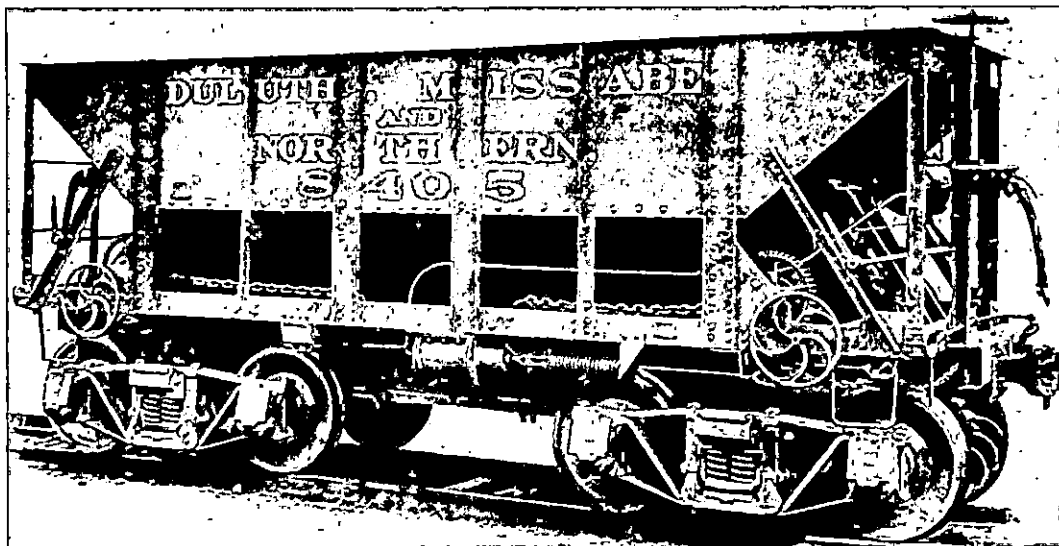
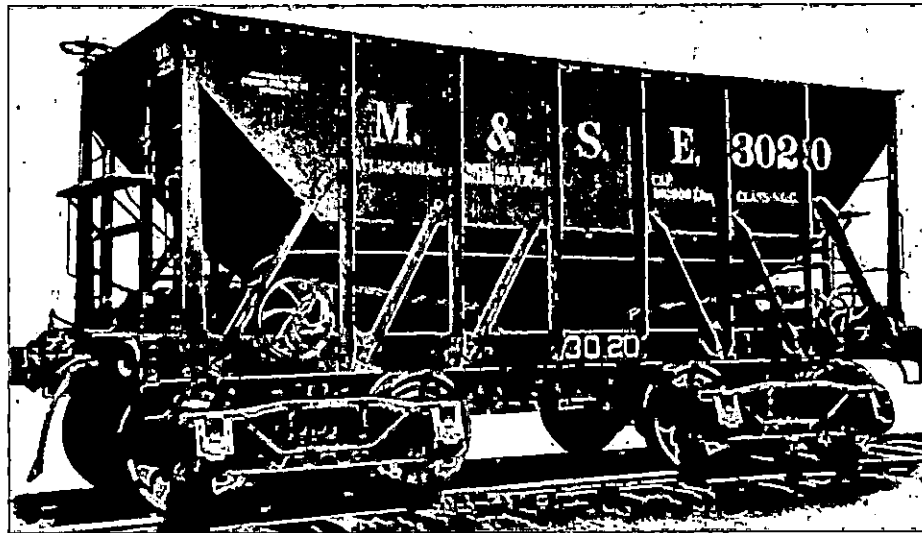
EX1008, Figs. 1, 3.

- b. [5b] "said main bolster has a lower flange downwardly spaced from said upper flange, said lower flange terminating at respective distal end portions at either side of said car;"

101. Hart discloses this limitation. Fig. 1 below shows that Hart's bolster has upper and lower flanges, and Fig. 3 above shows that Hart's bolster extends from one side of the rail car to the other.

modifier “short” in “short side sill” to refer to the side sill’s height in the vertical direction.

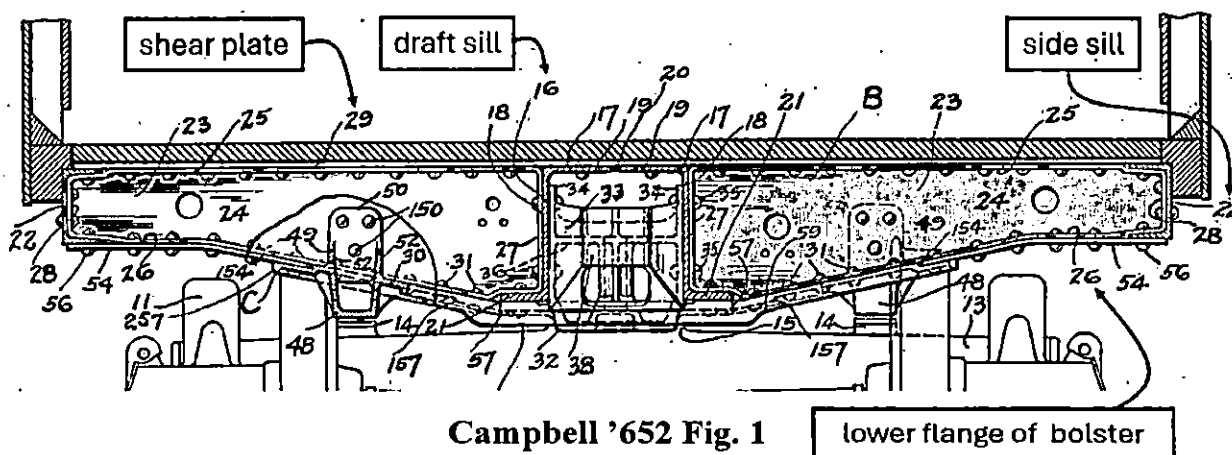
103. Even if Hart did not disclose side sills that extended from one end section to another, such side sills were commonplace long before 2009. This is reflected in the 1906 Cyclopedia, which contains many examples of hopper cars with such side sills, including the following:



EX1009 at 14, Figs. 54, 55. A POSITA would have been motivated to modify Hart to include such side sills, because doing so would provide greater strength to the undercarriage or base of the hopper car.

- d. [5d] “said side sill has an upper flange, said upper flange of said side sill being substantially co-planar with, and connected to, said shear plate; and”

104. As shown in Fig. 1 above, Hart discloses an undercarriage design in which the shear plate is substantially coplanar with the upper flange of the bolster. Hart’s figures do not show the vertical position of the flanges of the side sills. However, as shown below, Campbell ’652 teaches a side sill whose upper flange is substantially coplanar with and connected to the shear plate.



EX1013, Fig. 1 (detail). It would have been obvious to make Hart’s side sill flanges, shear plate, bolster flanges and draft sill substantially coplanar with one another, as in Campbell ’652, to facilitate their interconnection to form a single strong undercarriage structure.

- e. **[5e] “said side sill has a lower flange, said lower flange of said side sill being substantially co-planar with a respective one of said distal end portions of said lower flange of said main bolster.”**

105. As discussed above in connection with limitation [5d], it would have been obvious to select and position side sills such that Hart’s side sill flanges, shear plate, draft sill and bolster flanges are substantially coplanar with one another, as in Campbell ’652.

E. Ground 5: Claims 7–16, 20–23, 24–28, and 30–31 are obvious over Hart in view of the 1906 Cyclopedia and Wong.

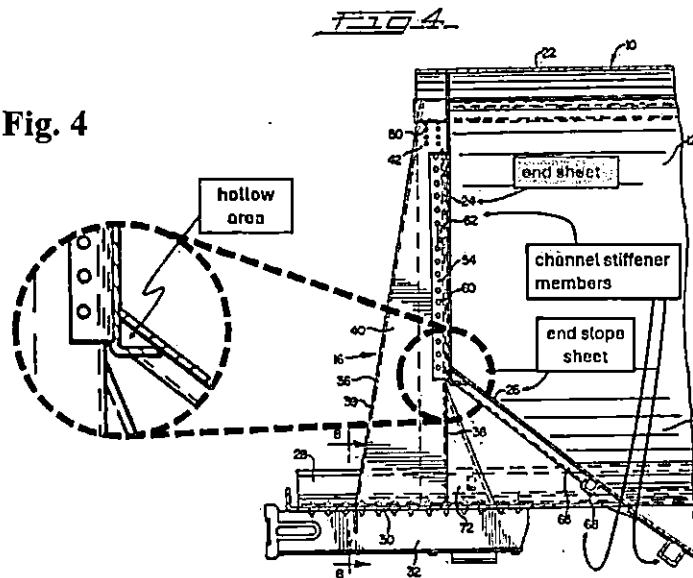
1. Independent Claim 7

- a. **[7h] “said hopper car has a first end wall member running cross-wise between said first and second side walls; said first end slope sheet has an upper margin that meets said first end wall member at a first junction; said first end wall member extends upwardly from said first junction; said first end wall member has a lower portion extending downward of said first junction; said lower portion of said first end wall member and said upper margin of said first end slope sheet co-operate to define portions of the cross-section of a second hollow section beam extending cross-wise across said hopper car between said first and second side walls.”**

106. As discussed above in connection with limitation [1f], it would have been obvious to modify Hart to add an end wall supported by an end post extending from the draft sill, as in the 1906 Cyclopedia’s Cambria Steel car.

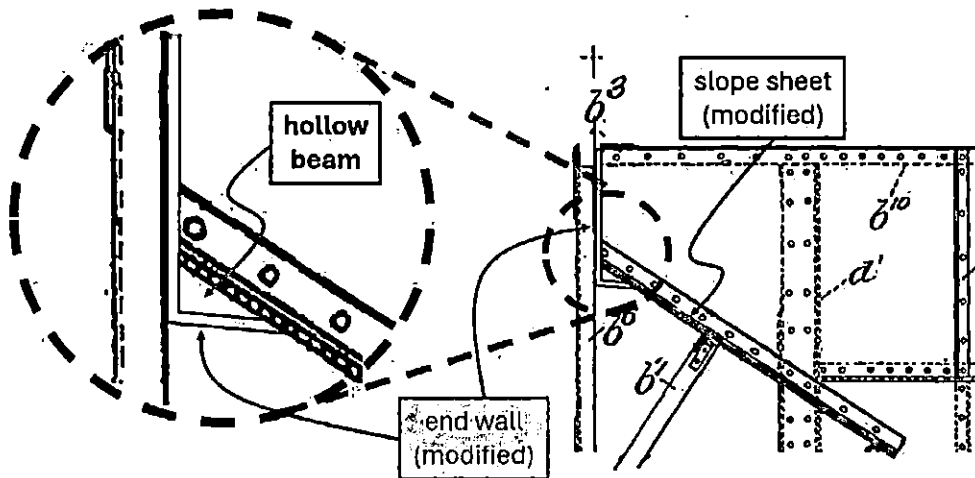
107. Wong discloses an end wall and a hollow section beam defined by the lower portion of the end wall and the slope sheet, as shown below.

Wong Fig. 4



EX1006, Fig. 4.

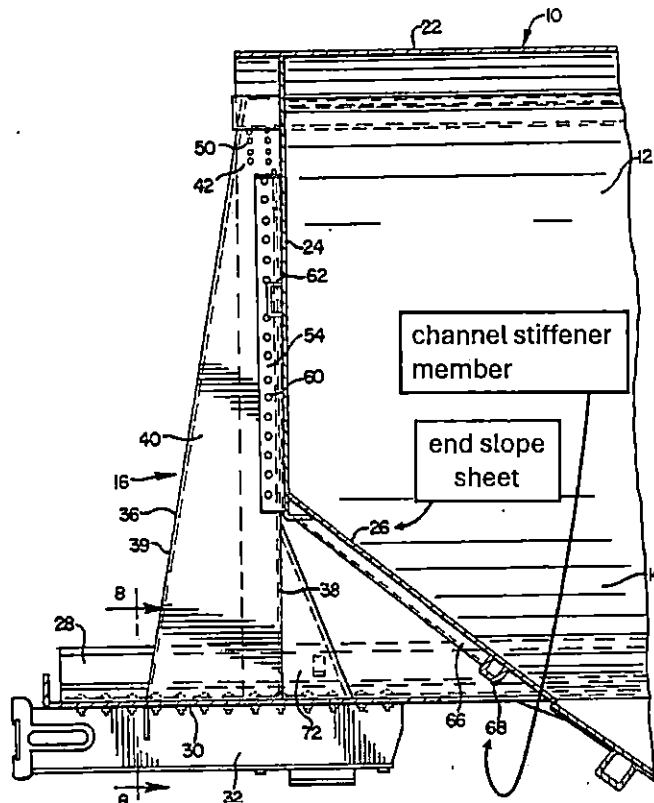
108. It would have been obvious to modify Hart to further support the upper, outboard end of the slope sheet with a cross-wise, L-shaped beam as in Wong. A POSITA would have been motivated to make the modification because Wong and the Hart are in the same field, and because a POSITA would have understood the benefits of reinforcing the slope sheet at its upper end, where its connection with another structure creates a stress concentration. In addition, the fact that Hart had a transverse beam for supporting the upper end of the slope sheet, before the modification to add an end wall, would have suggested supporting the upper end of the modified design with a transverse beam. A POSITA would have had a reasonable expectation of success in making this modification because it would be a straightforward addition of a simple structure, as shown below.



EX1008, Fig. 1 (detail) (modified).

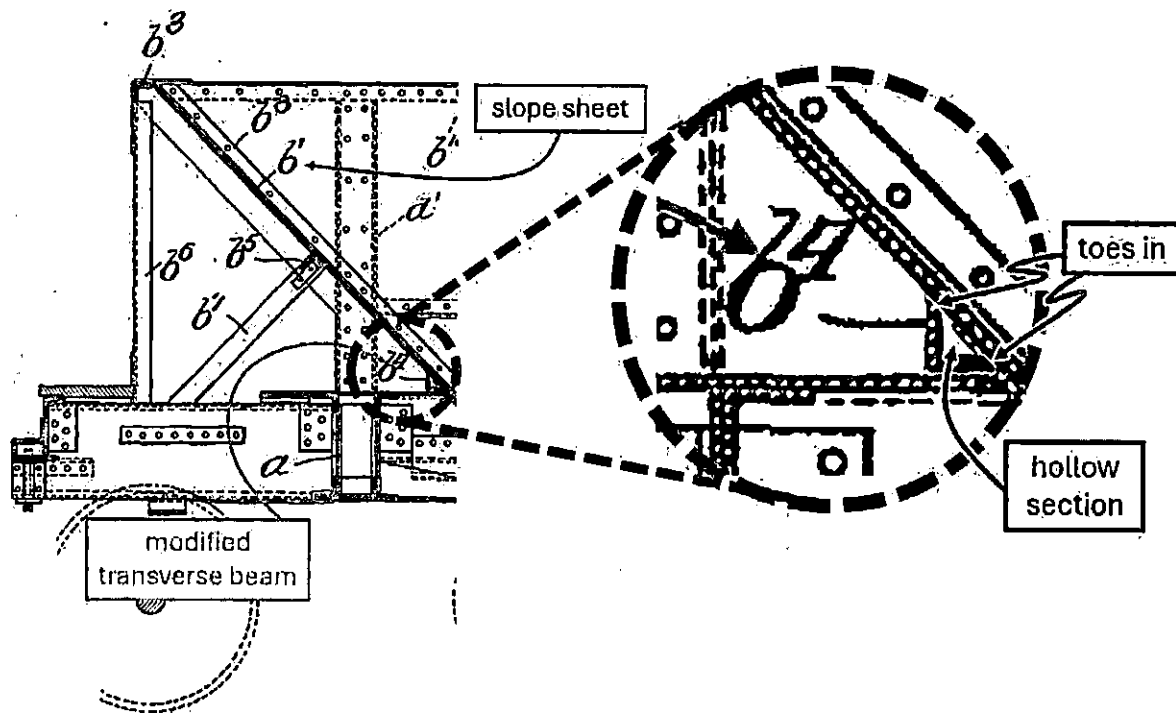
2. **Dependent Claim 9: “The railroad hopper car of claim 7 wherein said laterally extending member has a pair of first and second spaced apart toes, and said laterally extending member is mounted toes-in against said first end slope sheet, whereby said first hollow section beam is defined by said laterally extending reinforcement and said first end slope sheet.**

109. Hart’s transverse brace member b^4 is an angle iron mounted “toes-in” against the shear plate. However, Wong discloses a hollow beam (“channel stiffener member 68”) mounted “toes-in” along the underside of the slope sheet, as shown below.



EX1006, Fig. 4.

110. A POSITA would have found it obvious to rotate Hart's lower beam so that its toes were oriented toward the slope sheet instead of the shear plate. A POSITA would have considered the orientation of the support beam to be a matter of design choice, and would have thought to try the claimed orientation because there are only a finite—and very limited—number of ways to orient an L-shaped beam such as Hart's lower support beam. The POSITA would have had a reasonable expectation of success, because the modification is very simple. It involves simply re-orienting the angle iron, as shown below.



See EX1008, Fig. 1 (detail) (modified).

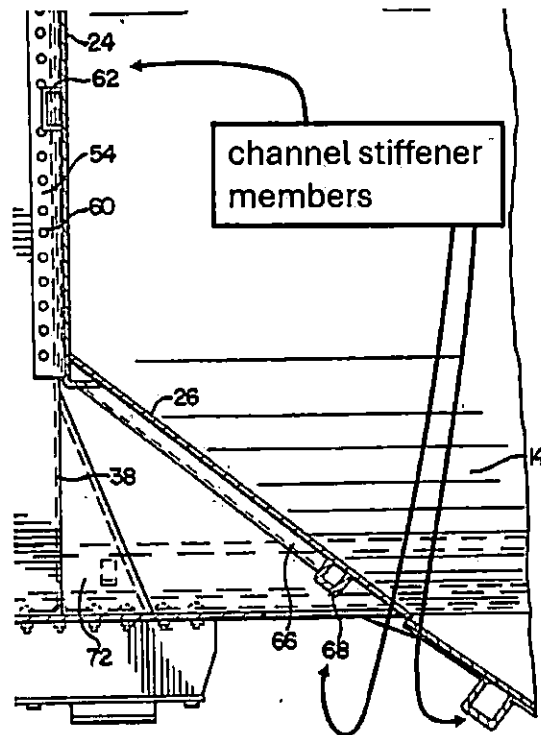
3. **Dependent Claim 11: “The railroad hopper car of claim 10 wherein said laterally extending reinforcement is an angle iron mounted toes-in to said first end slope sheet.”**

111. The written description of the '515 patent never uses the term “angle iron.” EX1001. However, a POSITA would understand the term to refer to “a piece of structural steel rolled with an L-shaped section” (quoting Merriam Webster).² Applying this definition, or any reasonable definition, Hart’s lower support beam satisfies the limitation of Claim 11.

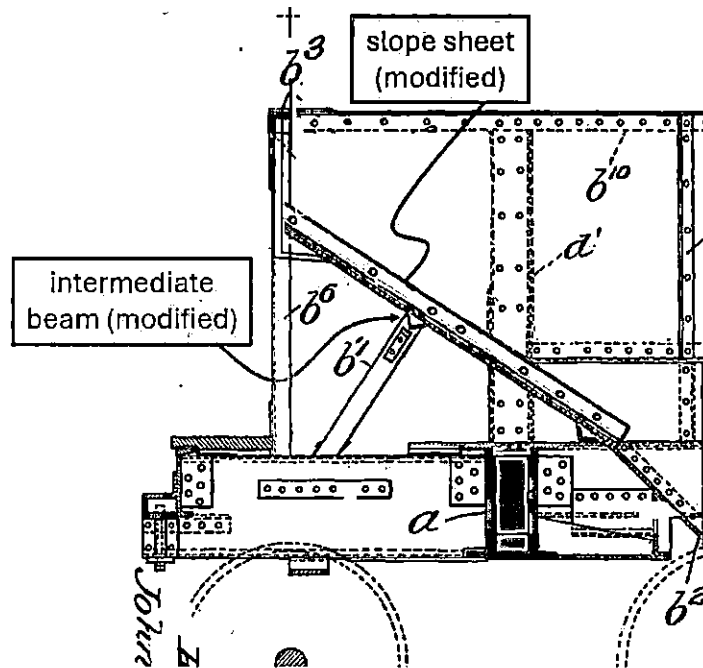
² The definition is available at www.merriam-webster.com/dictionary/angle%20iron.

4. **Dependent Claim 16: “The railroad hopper car of claim 15 wherein said intermediate beam includes a cross-wise extending structural member mounted toes-in against said first end slope sheet to define a closed hollow section.”**

112. Wong’s “channel stiffener members” are mounted to the slope sheet “toes-in,” as shown below.



EX1006, Fig. 4. It would have been obvious to a POSITA in 2009 to mount Hart’s intermediate beam “toes-in,” as in Wong, to obtain the greater strength and weight savings afforded by a hollow beam structure, and because there are only a finite number of orientations the beam can have with respect the slope sheet. A POSITA would have a reasonable expectation of success in making this modification because of its simplicity. The modified version of Hart is shown below.

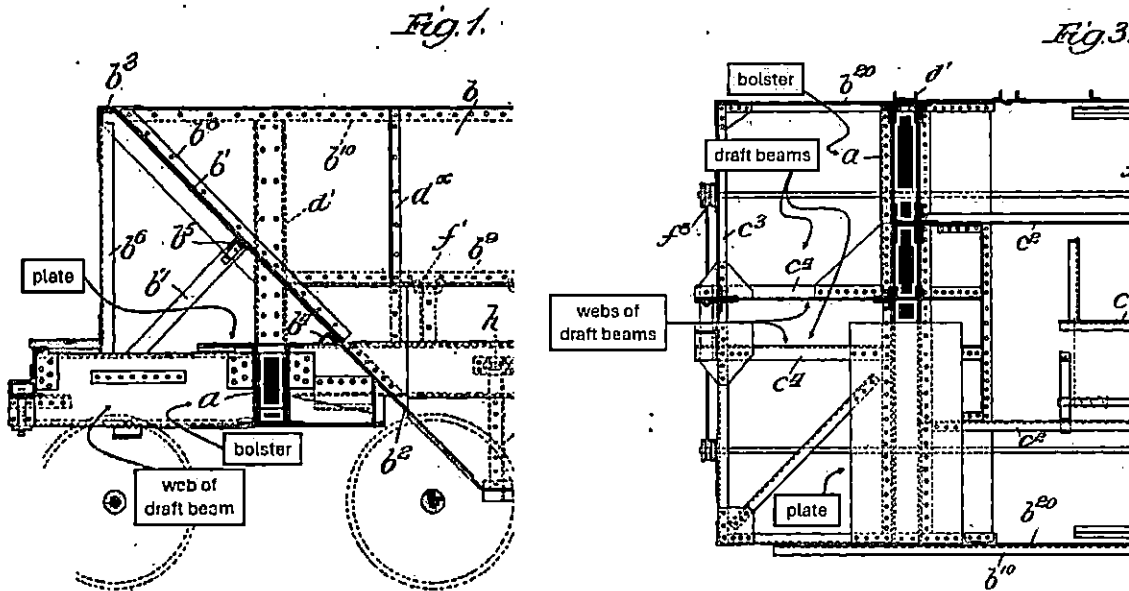


EX1008, Fig. 1 (modified).

5. Independent Claim 24

- a. 24[g] “said draft sill having longitudinally extending draft sill webs;”

113. The '515 patent states that “the draft sill has a pair of vertically oriented, longitudinally running spaced apart side webs.” EX1001 at 10:16-17. Hart states that “draft beams c^4 are connected to the end sill and to the bolster.” EX1008 at 1:101-03. Those beams have vertical webs:

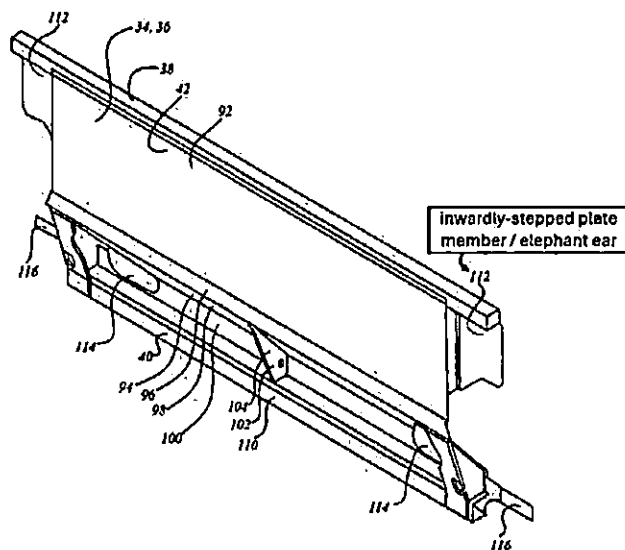


Id., Figs. 1, 3.

F. Ground 6: Claims 17–19 are obvious over Hart in view of the 1906 Cyclopedia, Wong and Campbell '051

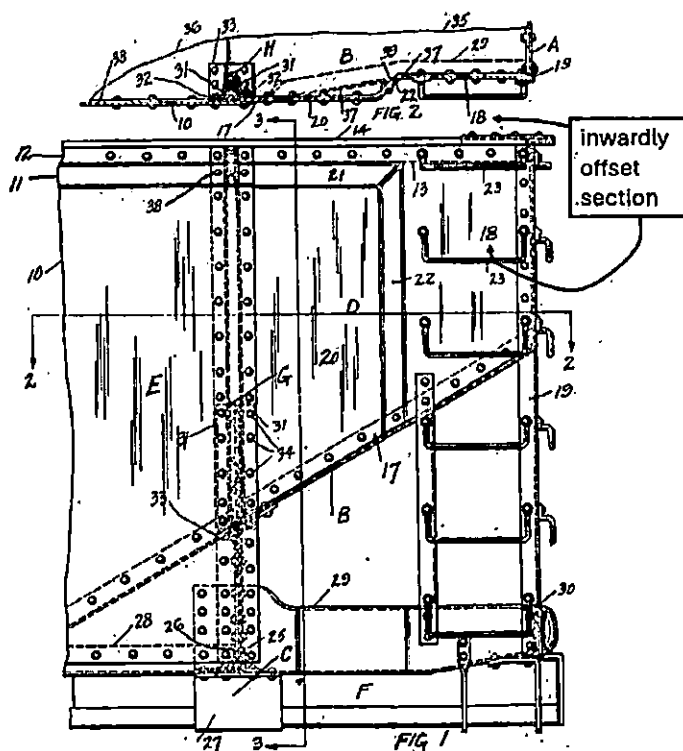
1. **Dependent Claim 17: “The railroad hopper car of claim 7 wherein said first and second side walls of said hopper car define sidewalls of said hopper, and said first and second side walls include end portions that are stepped laterally inboard, and said second hollow section beam extends between said end portions of said first and second side walls that are stepped laterally inboard.”**

114. The '515 patent illustrates side walls with end portions that are stepped laterally inboard:



EX1001, Fig. 2a. However, stepped side walls were well known long before 2009.

As shown below, they were disclosed by Campbell as early as 1925.

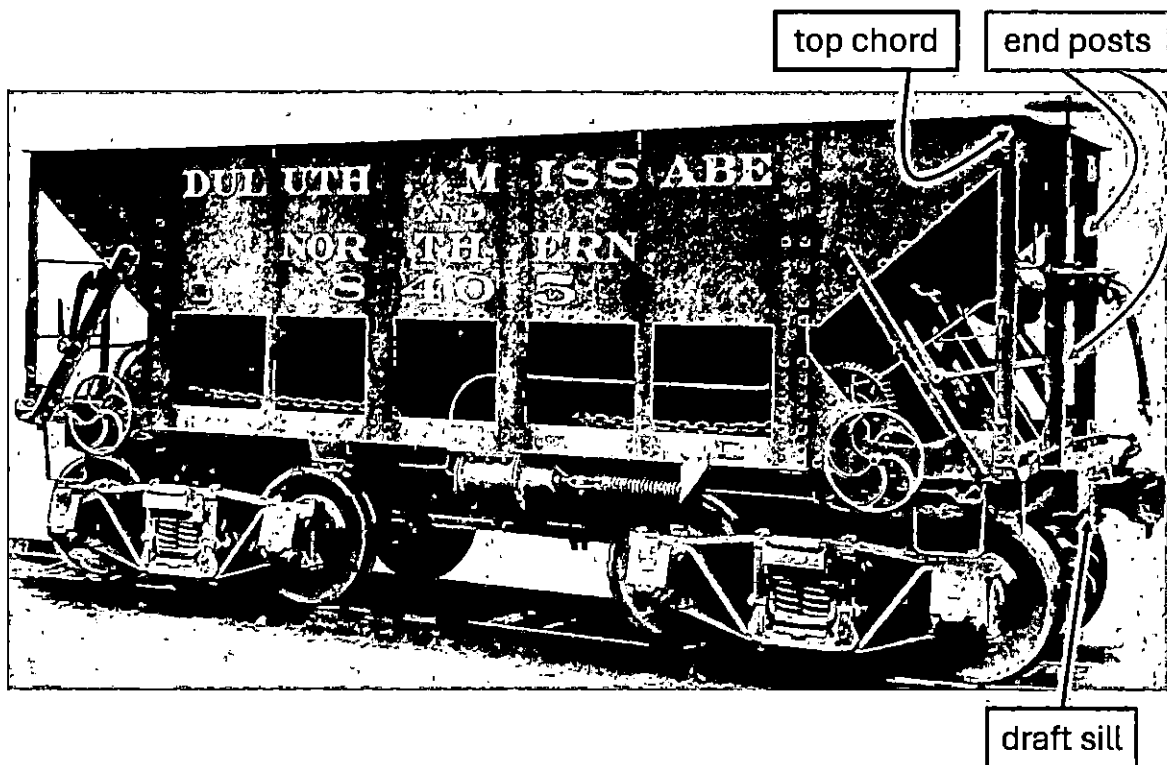


EX1012, Figs. 1, 2. Campbell '051 explains that the purpose of the stepped design
 "is to provide a car . . . having the maximum over-all width possible," *id.* at 1:14—

23, while also having an “offset section 18 for the purpose of accommodating the usual ladder rungs 23 within the permissible overall width of the car,” *id.* at 1:90–94. A POSITA in 2009 would have been motivated to modify Hart to provide stepped end portions of the side walls, in order to obtain these benefits, and would have had a reasonable expectation of success in making this simple modification.

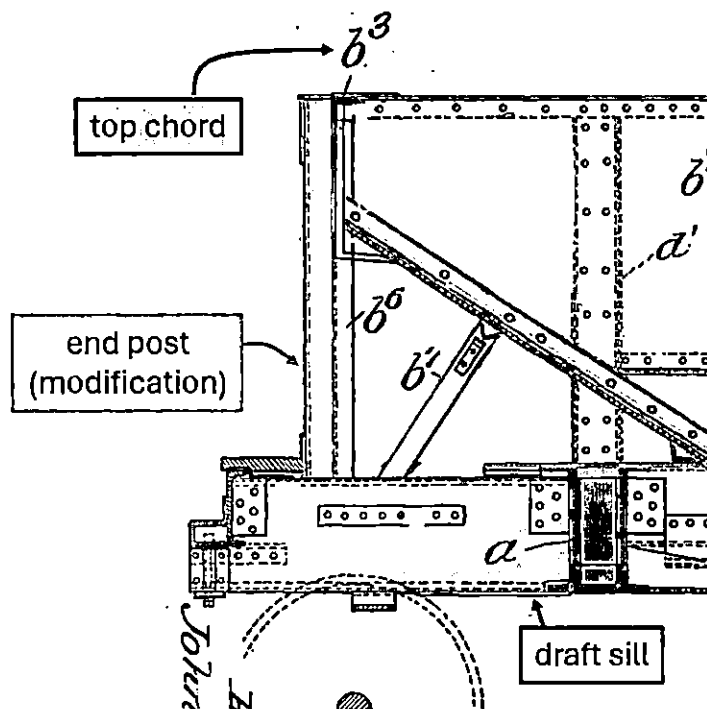
2. **Dependent Claim 19: “The railroad hopper car of claim 18 wherein: there is an end wall that extends from sidewall to sidewall; said end wall has an upper portion that has an upper margin terminating at a top chord of said end wall; said first end slope sheet has an uppermost margin, said uppermost margin of said first end slope sheet meeting said end wall along a first juncture; said end wall has a lower portion extending below said first juncture, said lower portion being bent to define a portion of said second hollow section beam; and said end post extends past said second hollow section beam along said end wall to mate with said top chord of said end wall.”**

115. As discussed above in connection with limitation [1f], it would have been obvious to modify Hart to add an end wall supported by an end post extending from the draft sill, as in the 1906 Cyclopedia’s Cambria Steel car. The end post of the Cambria Steel does not extend all the way to the top chord of the end wall. EX1009 at 13, Fig. 53. However, as shown below, the 1906 Cyclopedia also shows a hopper car made by the Standard Steel Car Co. (“the Standard Steel car”) that has two end posts extending from the left and right sides of the draft sill. *Id.* at 14, Fig. 55. These end posts extend all the way to the top chord.



Id.

116. A POSITA would have been motivated to extend the end post in the modified Hart design to the top chord because the chord is a secure and logical structure for attaching the upper end of the end post. In addition, a POSITA would have thought to attach the end post to the top chord because end posts are typically attached either to the top chord or, if the rail car has an end wall, to the lower portion of the end wall. Choosing one of these two common options is a simple design choice that would immediately occur to a POSITA. Finally, a POSITA would have a reasonable expectation of success in attaching the upper end of the end post to the top chord. The modified Hart design, shown below, would embody Claim 19.



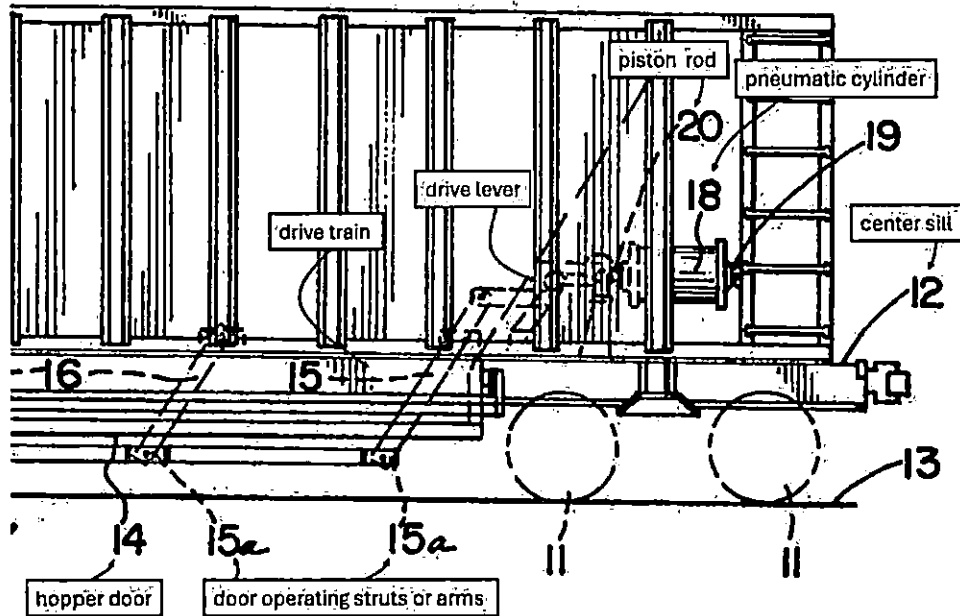
EX1008, Fig. 1 (detail) (modified).

G. Ground 7: Claims 21–22 and 29 are obvious over Hart in view of the 1906 Cyclopedia, Wong and Schuller.

1. **Dependent Claim 21: “The railroad hopper car of claim 20 wherein: said hopper has a movable door by which egress of lading is governed; said hopper car has an actuator and a drive train, said drive train being connected between said actuator and said door, said actuator being operable to move said door; and said actuator is mounted in said machinery space.”**

117. As discussed above in connection with Claim 3, it would have been obvious in 2009 to replace Hart’s longitudinally hinged doors and door-opening mechanism with doors and a door-opening mechanism like Schuller’s. Claim 21 also requires (i) a drive train that connects the actuator and the hopper doors, and (ii)

that the actuator be “mounted in,” rather than “at least partially lodged in,” the machinery space. Schuller discloses both of these claim elements, as shown below.



EX1014, Fig. 1. A POSITA would have understood that Schuller’s pneumatic actuator, used with Hart’s design, should be mounted in Hart’s machinery space.

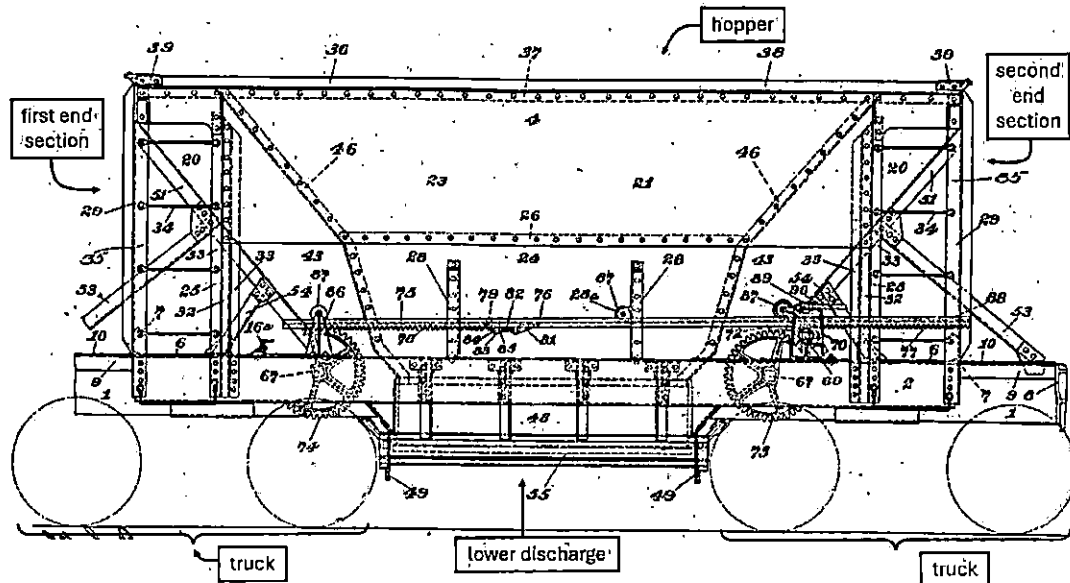
H. Ground 8: Claims 32–34 are obvious over Lindström in view of Wong, Ratcliffe 1 and Hart.

1. Independent Claim 32

- a. [32a] “A railroad hopper car, said hopper car comprising: a hopper; first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction; said hopper being suspended between said first and second end sections,”

118. U.S. Patent No. 1,321,928 was granted to Charles A. Lindström on Nov. 18, 1919. EX1005 (“Lindström”). Lindström discloses a “dump car,” a

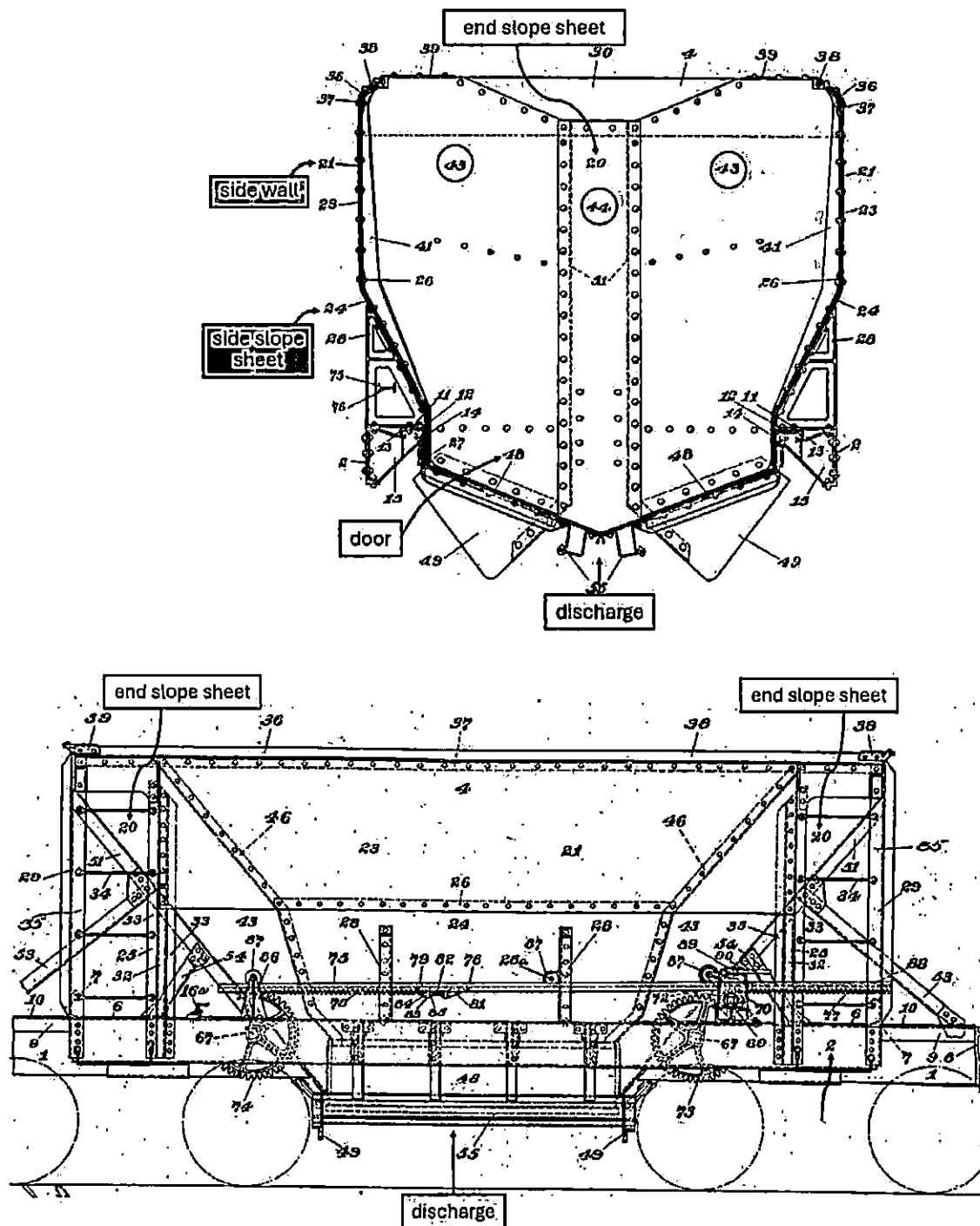
railroad hopper car that discharges lading through “discharge doors 48.” *Id.* at 3:123–25 (“referring to “track rails”), 4:64 (“discharge doors 48”), 2:56–59 (the car permits “the free discharge of the lading through the single central unobstructed discharge opening 22”). Lindström discloses limitation [32a], as shown below.



Id., Fig. 2.

- b. [32b] “said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;”

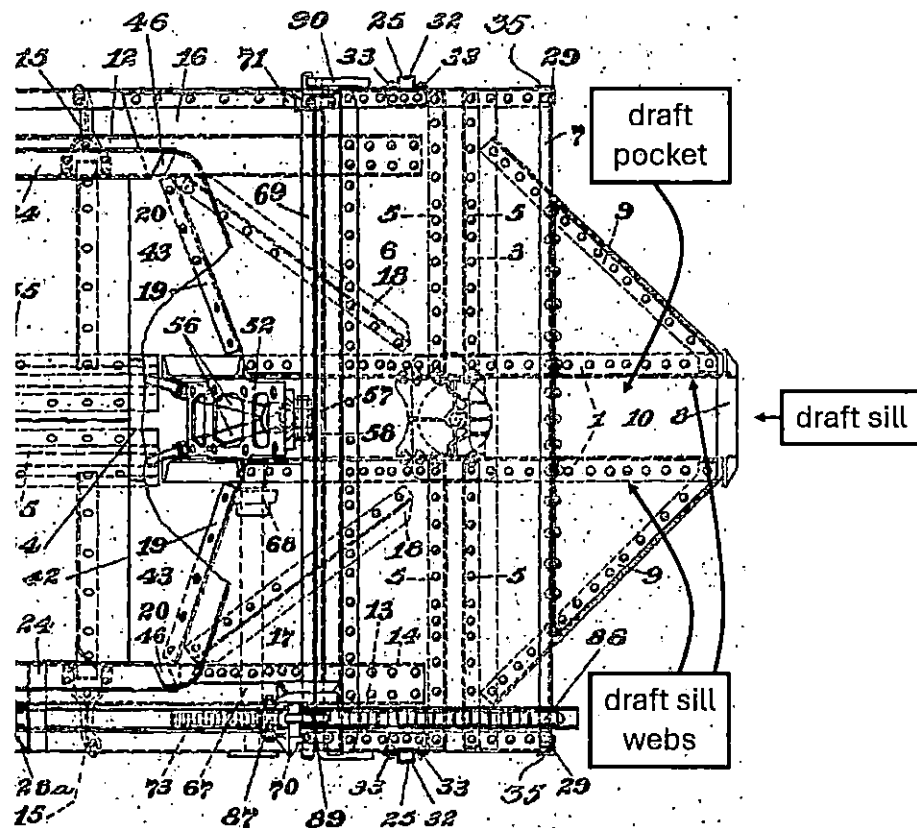
119. Lindström discloses limitation [32b], as shown below. Lindström’s slope sheet, which he calls “sloping end floor 20,” comprises a center portion 44 and two side portions 43. *Id.* at 2:52, 3:74–77. In addition, each of Lindström’s side walls (21) includes a side slope sheet denominated “sloping floor plate 24” that is also inclined toward the lower discharge. *Id.* at 2:84–89.



Id., Figs. 2, 5.

- c. [32c] “said first end section including a draft sill extending in the longitudinal direction, said draft sill having first and second spaced apart longitudinally running draft sill webs and a draft pocket defined therebetween;”

120. Lindström discloses limitation [32c], as shown below.

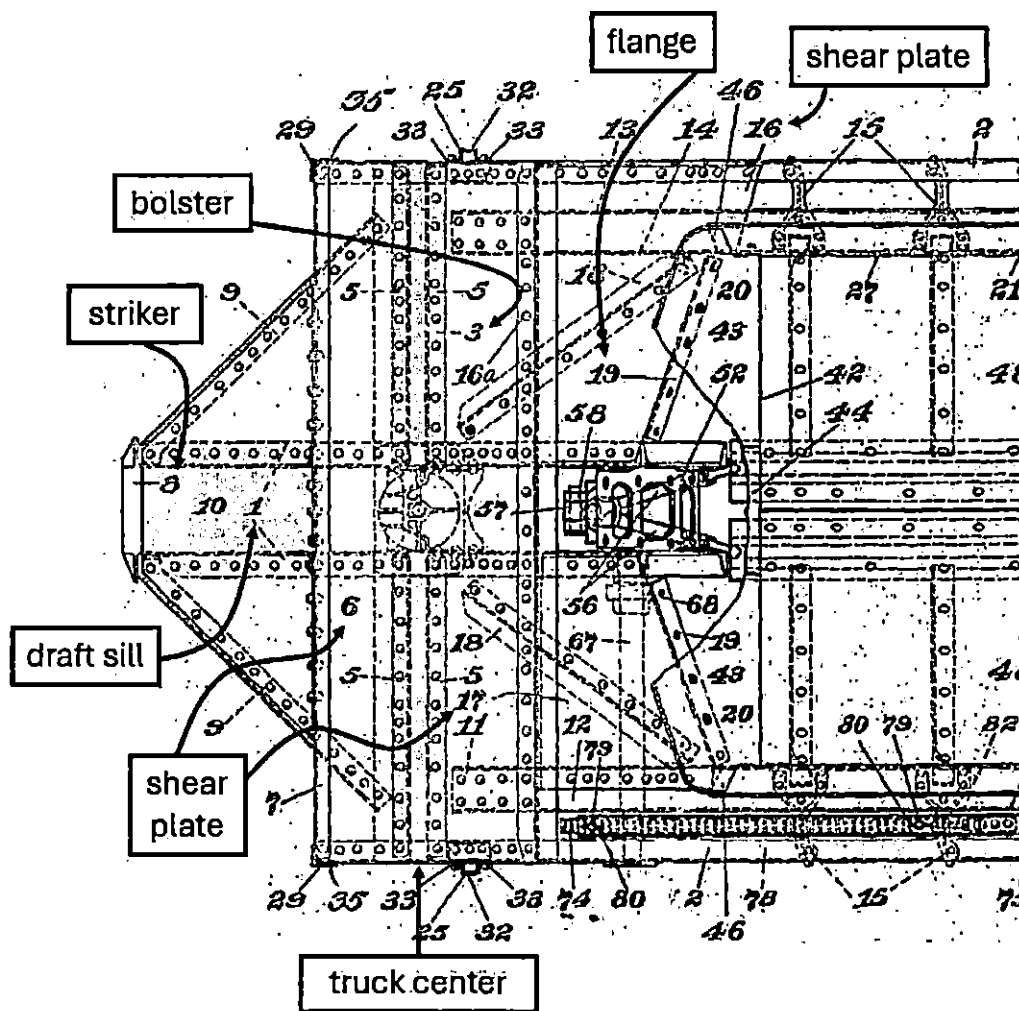


Id., Fig. 3.

- d. [32d] “said first end section including a main bolster extending cross-wise to said draft sill; said first end section having a truck center where said main bolster meets said draft sill; said draft sill having a striker end longitudinally outboard of said truck center; said first end section including a shear plate; said shear plate overlying said draft sill webs and said main bolster, said shear plate extending longitudinally along said draft sill and cross-wise from side to side of said hopper car; said shear plate having an

outboard margin running across said car distant from said truck center and proximate said striker end;”

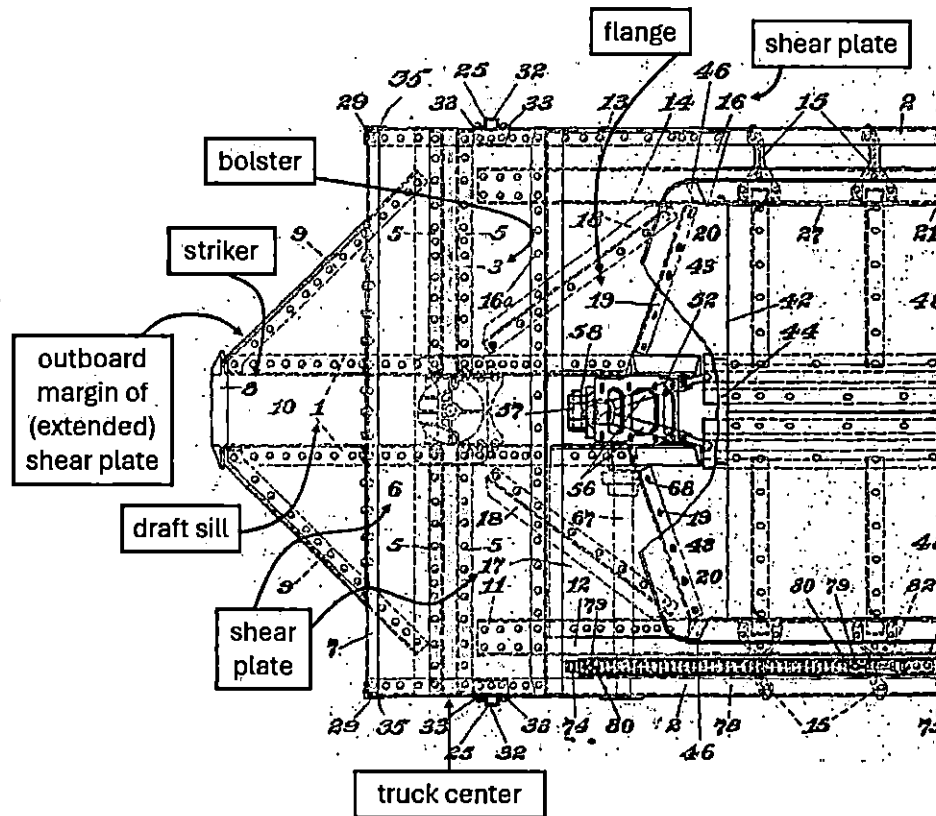
121. Lindström discloses limitation [32d]. The '515 patent discloses shear plate 76, which it describes as “defining the top cover plate” of the stub draft sill, extending “laterally from side sill to side sill,” and extending longitudinally from the slope sheet to end sill 78. EX1001 at 14:12–18. The corresponding structure in Lindström comprises three plates that together are Lindström’s shear plate: plate 6, plate 16 and plate 17. At the inboard ends of plates 16 and 17 are downwardly angled flanges 19 that are riveted to the underside of the slope sheet, specifically, to the sloping end plates of the slope sheet. EX1005 at 2:36–39, 4:29–33. As shown below, Lindström discloses the bolster, draft sill and shear plate recited in the first five clauses of limitation [32d].



EX1005, Fig. 3.

122. The final clause of limitation [32d] requires the outboard margin of the shear plate to be proximate the striker and distant from truck center. Lindström teaches that plate 10 optionally may be formed as part of plate 6, which is part of the shear plate. EX1005 at 2:4–8 (“These [draft] sills 1, 1 are further strengthened and braced by a member 10 which is preferably in the form of a flat plate. This member 10 may be a continuation or part of the horizontal plate 6.”). In this embodiment of

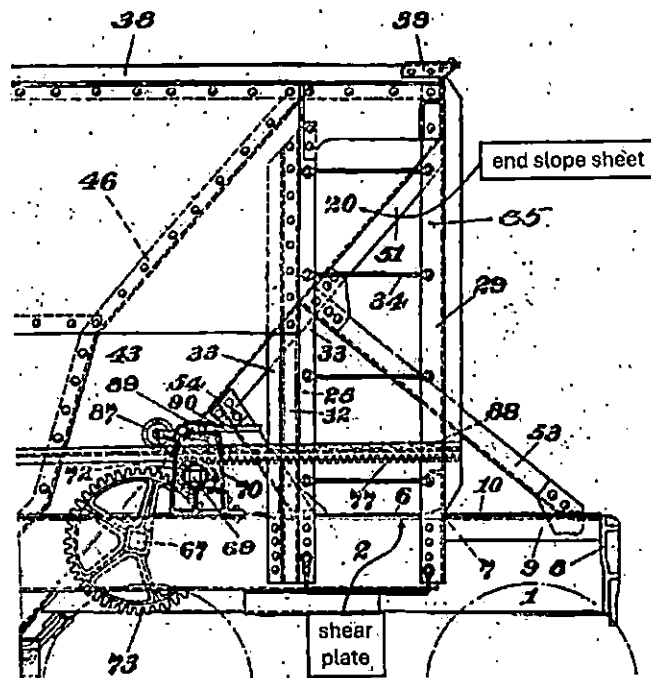
Lindstrom, shown below, the shear plate's outer margin is proximate the striker 8 and distant from truck center.



Id., Fig. 3.

- e. [32e] "said first end slope sheet over-hanging said shear plate of said first end section;"

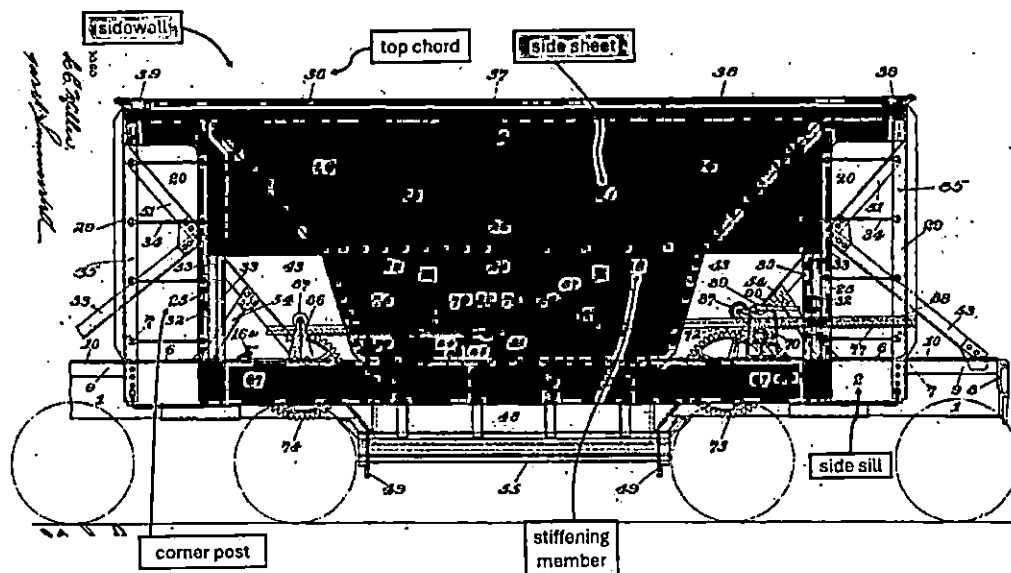
123. Lindström discloses limitation [32e], as shown below.



Id., Fig. 2.

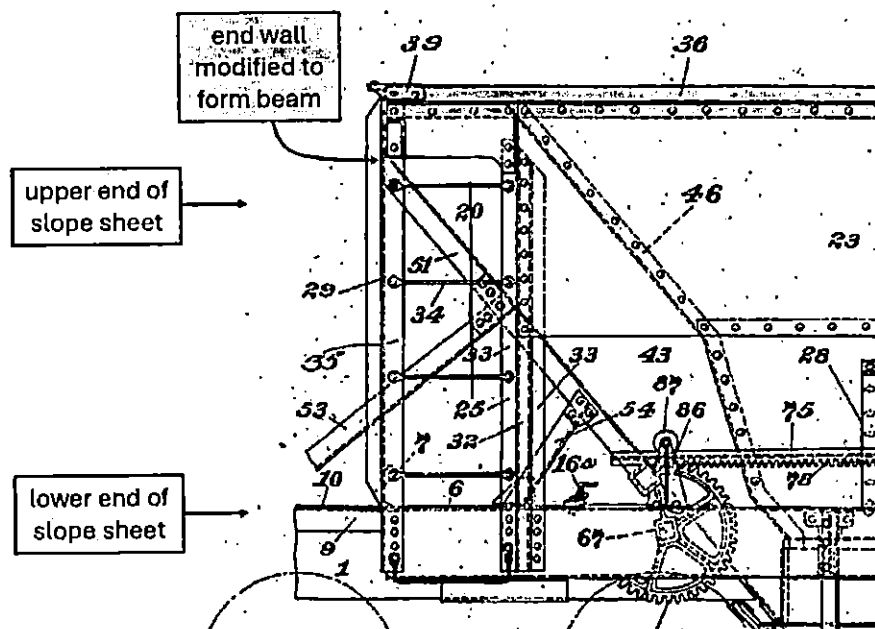
- f. [32f] first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

124. Lindström discloses limitation [32f], as shown below.



127. It would have been obvious to modify Lindström's design to support the upper margin of the slope sheet with a crosswise, hollow beam as in Wong. A POSITA would have been motivated to make the modification because Wong and Lindström are in the same field, and because a POSITA would have understood the benefits of further reinforcing the slope sheet at its upper end, where its connection with another structure creates a stress concentration.

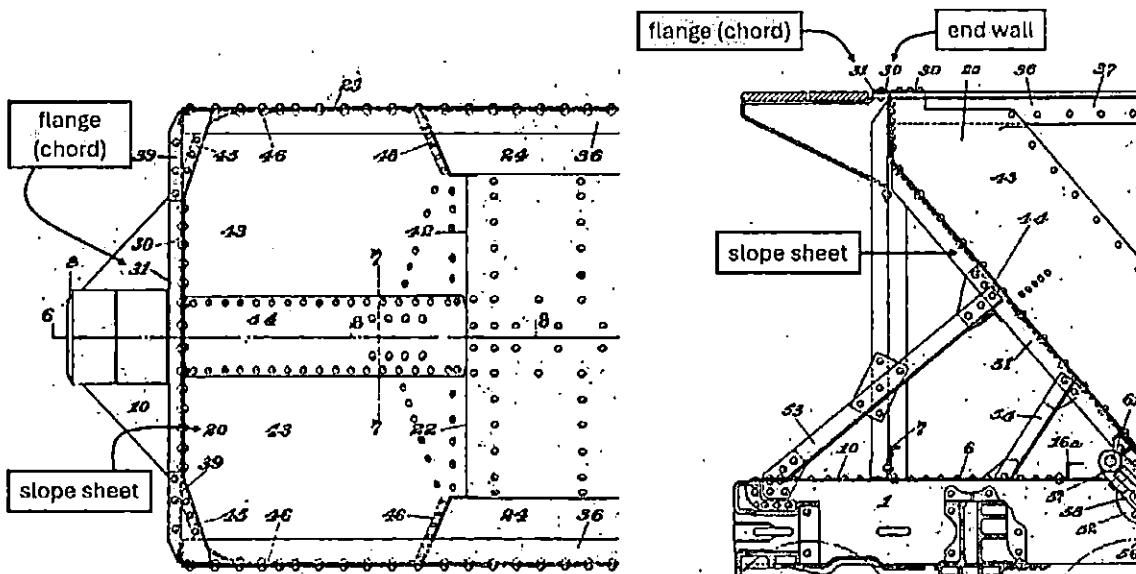
128. A POSITA would have had a reasonable expectation of success in making this modification because it is a straightforward modification of Lindström's existing end wall 30. EX1001 at 2:123–27 (plate 30 “forms an end wall of the car body”). Specifically, Lindström's end wall would have been slightly lengthened and bent inward at its lower end, as shown below.



EX1005, Fig. 2 (modified).

- h. [32h] “said first end wall is surmounted by a cross-wise running top chord; said first end wall includes a panel extending downwardly from said cross-wise running top chord;”

129. Lindström discloses this limitation, as shown below.

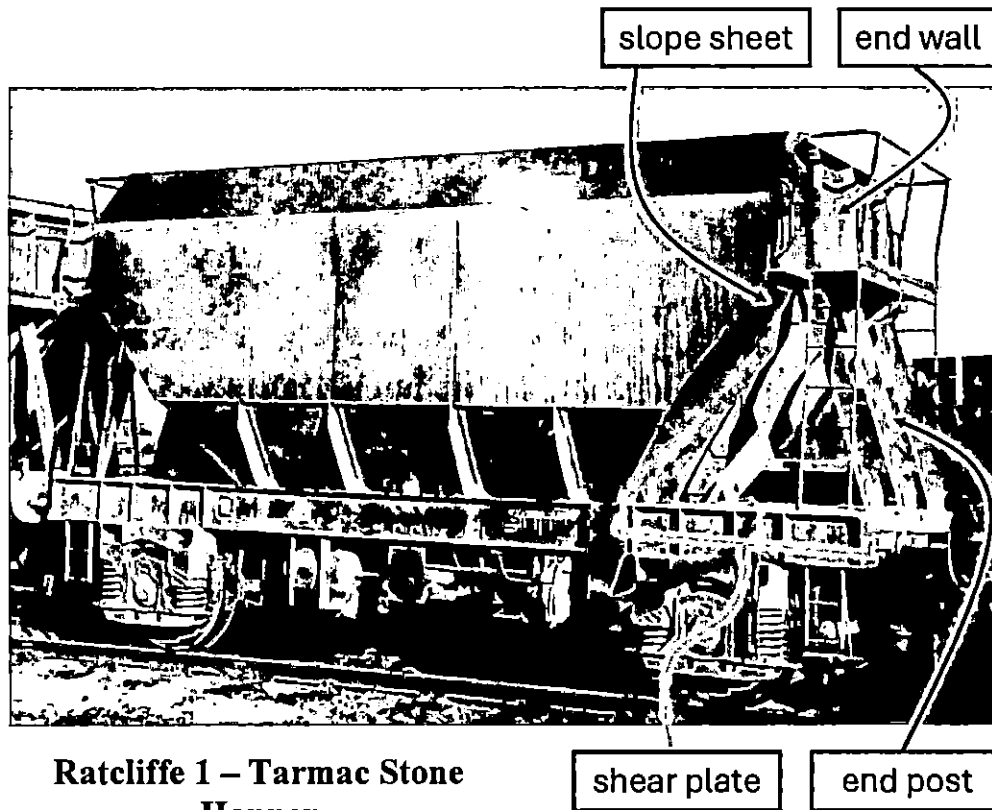


Id., Figs. 1, 6.

- i. [32i] “said first end section includes an end post extending upwardly of said draft sill, said end post being mounted above said draft sill distant from said truck center and proximate said striker end; said end post extending upwardly to meet said first beam and said top chord;”

130. Ratcliffe 1 discloses a British hopper car owned by Tarmac Roadstone which, according to Radcliffe, was manufactured by the Standard Wagon Company in 1974. EX1017 at 55. As shown below, the Tarmac Roadstone car discloses three end posts extending from the laterally outboard margin of the shear plate to the lower margin of the end wall. *Id.* Because the central post is located at the lateral center

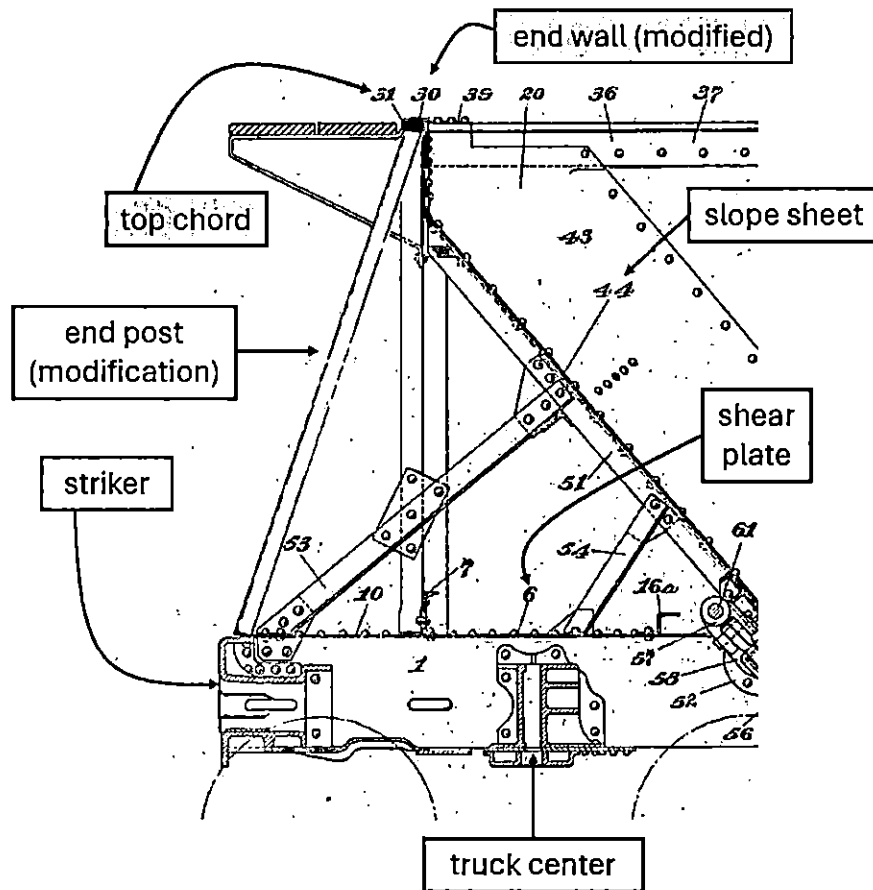
of the shear plate (and the rail car), a POSITA would have understood that the post is positioned above the draft sill.



EX1017 at 55.

131. It would have been obvious to modify Lindström to incorporate an end post like the central end post in Ratcliffe 1 (either alone or with an end post on each side) in order to support the longitudinal end of the rail car, *e.g.*, because the presence of the end wall creates extra loads at the end of the car, as compared to designs where the slope sheet extends to the end top chord. A POSITA would have been motivated to place the base of the end post as close as possible to the outboard margin of the draft sill, as in Ratcliffe 1, in order to maximize the usable space of the shear-plate

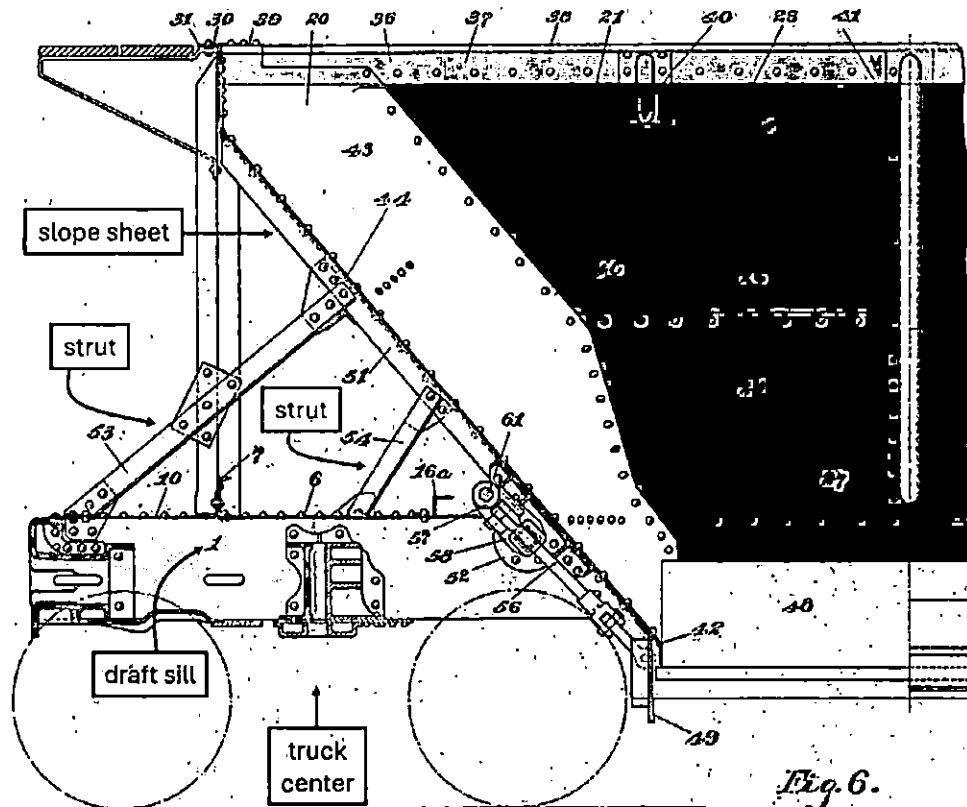
platform. In that position, the end post would be proximate Lindström's striker and distant from Lindström's truck center, as shown below.



EX1005, Fig. 6 (modified).

- j. [32j] “said first end section being free of longitudinally oriented elephant ears extending upwardly of said draft sill webs of said draft sill to meet said first end slope sheet;”

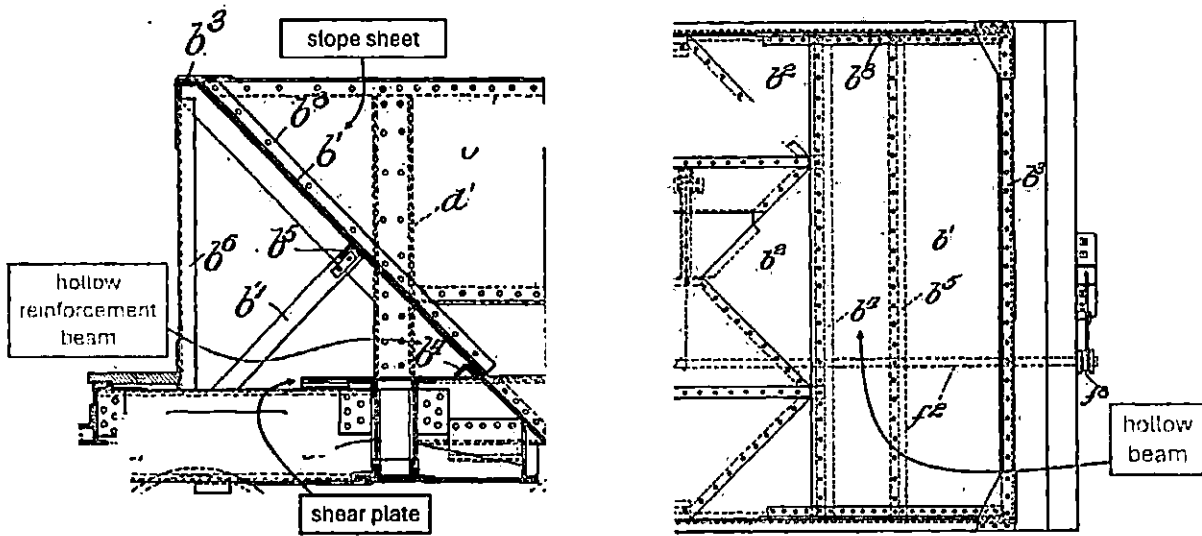
132. As discussed above, the '515 patent defines elephant ears as “large, substantially triangular planar plates.” EX1001 at 14:61-67. As shown below, Lindström's slope sheets are supported not by elephant ears, but by larger strut 53 and a smaller strut 54. EX1005 at 4:34-42.



EX1005, Fig. 6. In addition, the smaller strut does not extend between the draft sill and the slope sheet. *Id.* Thus, Lindström discloses limitation [32j].

- k. [32k] “said hopper car having a second beam extending cross-wise between said first and second side walls, said second beam being a beam of hollow section; and said second beam being connected to said shear plate.”

133. Hart also discloses a crosswise, hollow reinforcement beam (“transverse member $b^{4''}$ ”), as shown below.

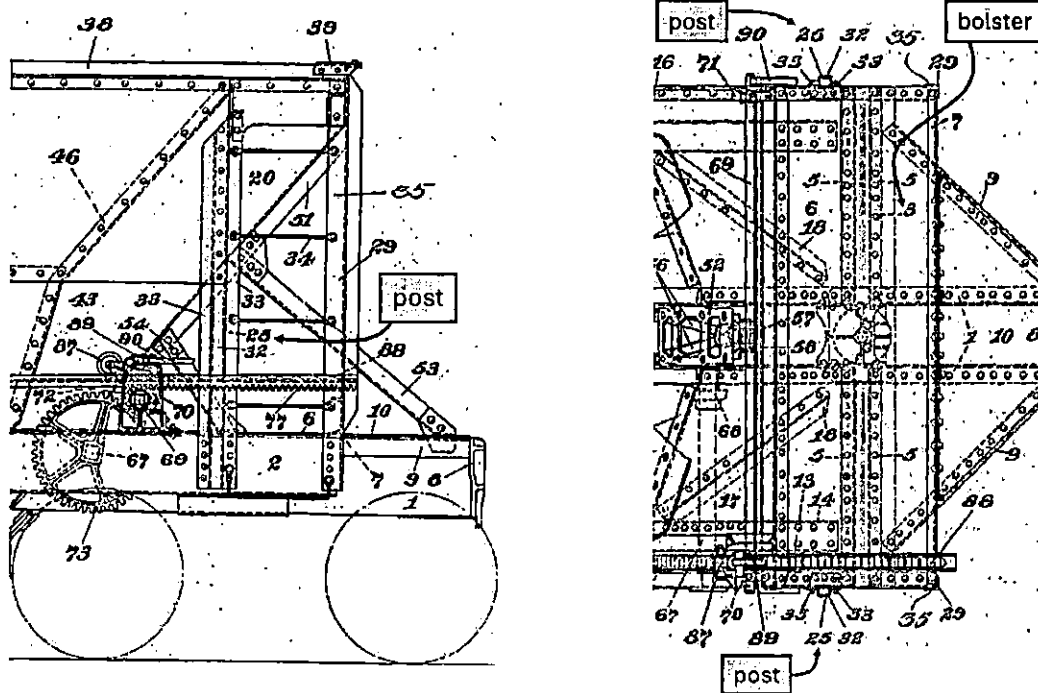


EX1008, Figs. 1–2. It would have been obvious to modify Lindström’s design to further support the lower end of the slope sheet with a crosswise, hollow beam as in Hart. The beam could be formed of two parts and placed just longitudinally outboard of the flanges 19 that connect the slope sheet and the shear plate. A POSITA would have been motivated to make the modification to further reinforce the slope sheet at its lower end, where its connection with another structure creates a stress concentration. A POSITA would have had a reasonable expectation of success in making this modification because it is a straightforward addition of a simple structure.

I. Ground 9: Claims 35–44 are obvious over Lindström in view of Wong, Ratcliffe 1, Hart and the 1946 Cyclopedia.

1. Dependent Claim 35: “The railroad hopper car of claim 32 wherein: said main bolster has first and second ends; and respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom to meet said first end slope sheet.”

135. The '515 patent discloses “corner posts” 82 and 84 that each extend up from the junction of a bolster and a side sill. EX1001 at 14:26–31. Lindström’s posts 25 are positioned immediately adjacent the bolster ends:

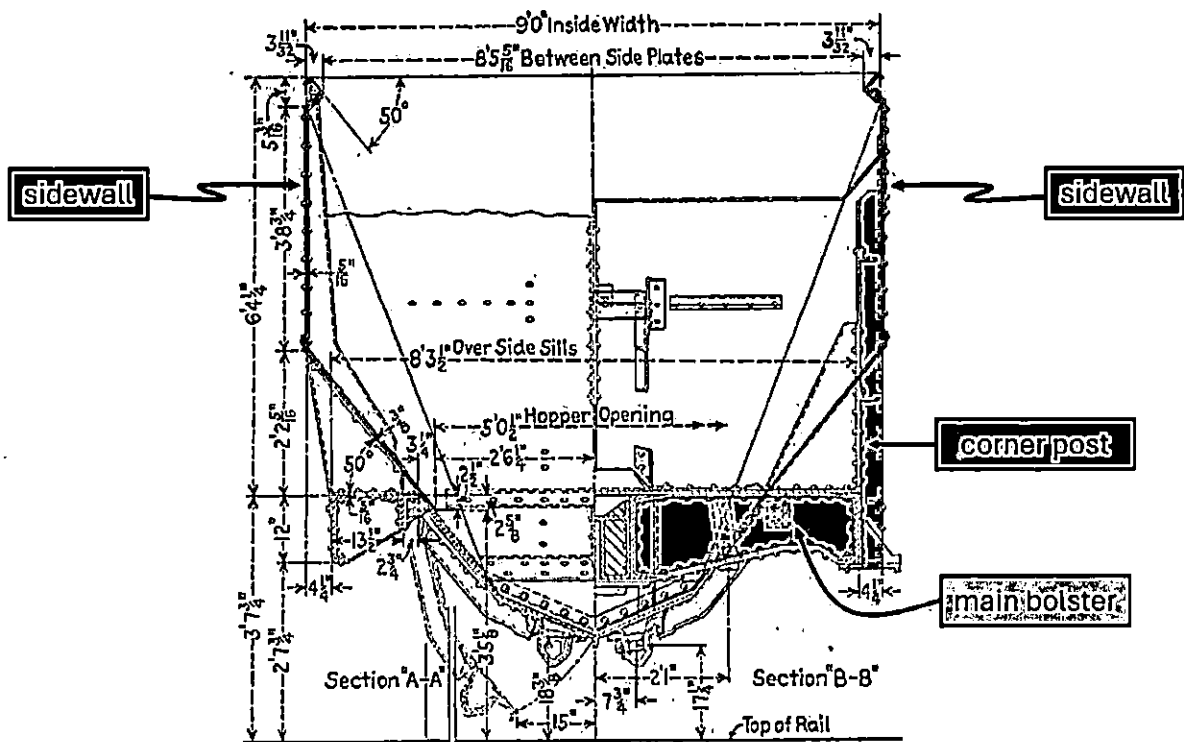
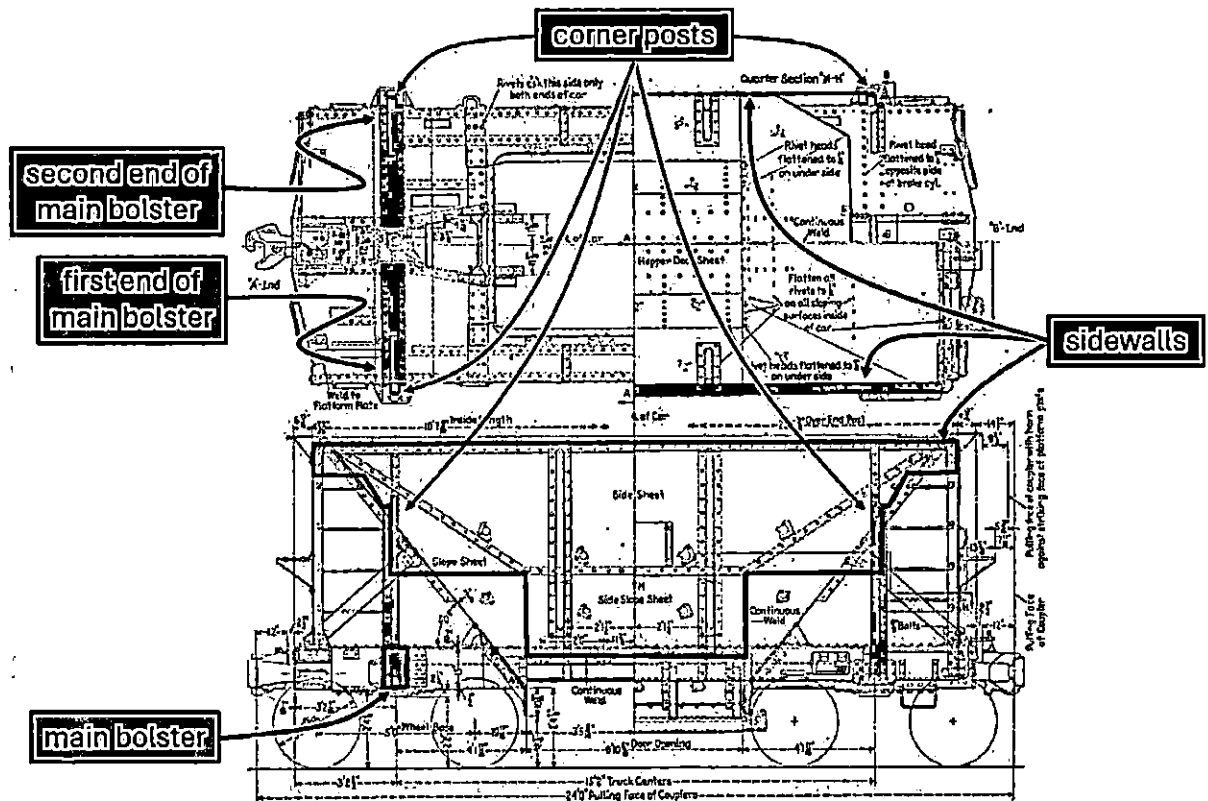


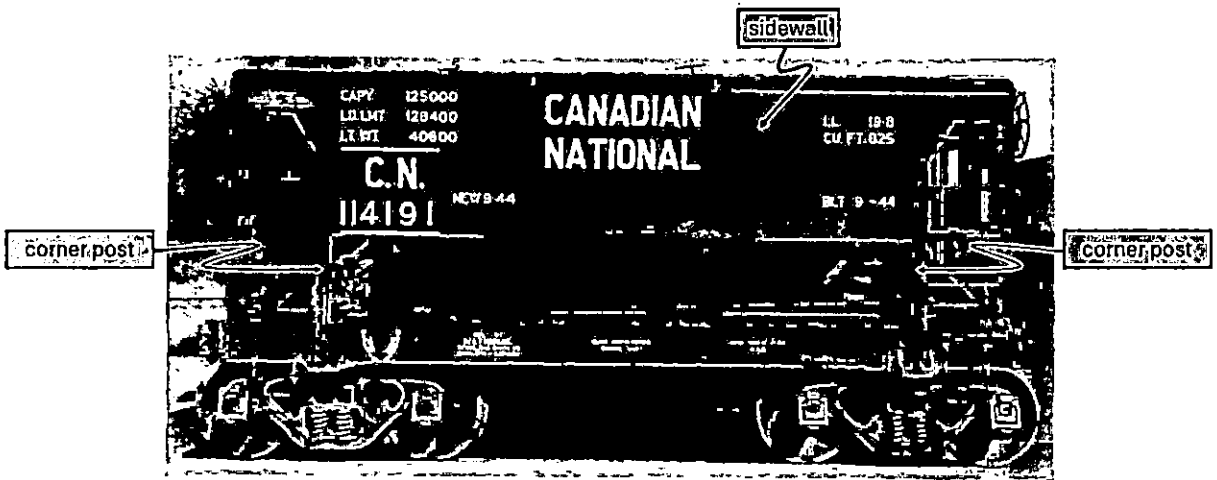
Id., Figs. 2–3.

136. Hart’s “supporting post *d'*,” shown below, extends from the end of the bolster to the end slope sheet *b'*.

138. A POSITA would consider Lindström's posts 25 to extend upwardly from the ends of the bolster, as required by Claim 11. However, at a minimum, it would have been obvious in view of Hart or the NSC ore car, to move Lindström's posts 25 slightly inward longitudinally, so that they could be more directly supported by the bolster.

139. A POSTIA would be motivated to do so to eliminate the bending moments imparted when a load is transferred from Lindström's posts 25 to its bolsters 3. A suggestion to move Lindström's posts 25 more directly over the bolster also appears in the the 1946 Cyclopedia's drawings and photograph of the NSC ore car. EX1004 at 294-95. As shown below, the NSC ore car discloses its first and second corner posts extending upwardly from the first and second ends of its main bolster to mate with its sidewalls.

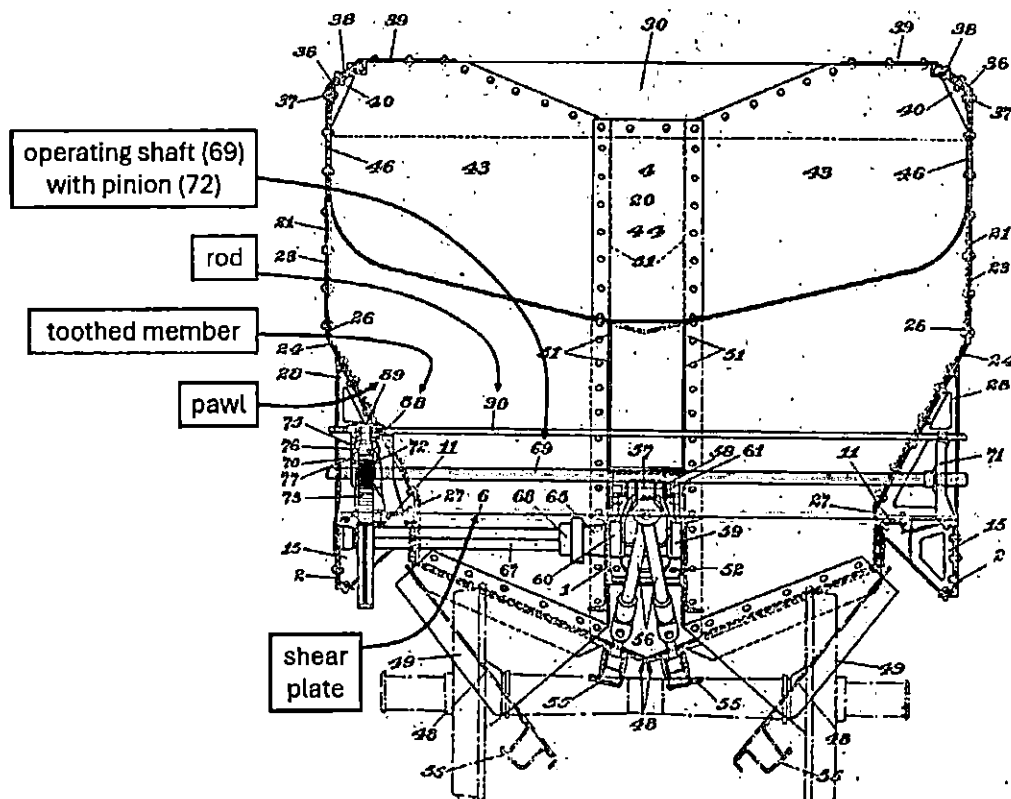
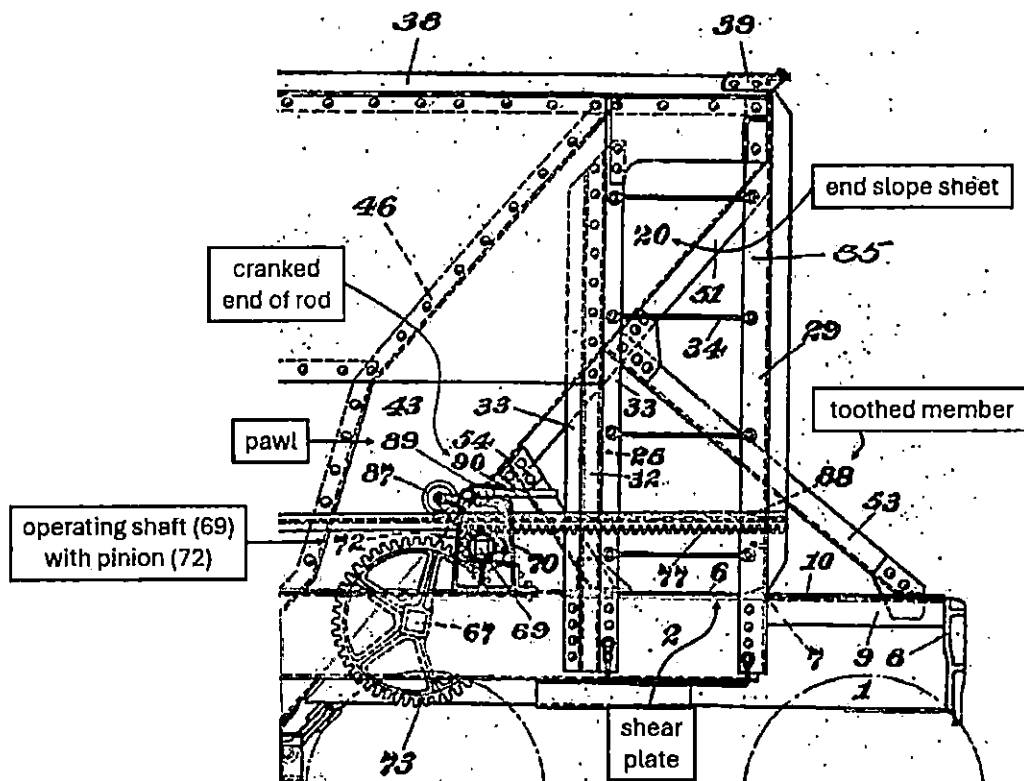




EX1004 at 294-95.

2. **Dependent Claim 36: “The railroad hopper car of claim 35 wherein: a machinery space is defined above said shear plate and under said first end slope sheet; and a door actuator is mounted above said shear plate and under said first end slope sheet.”**

140. Lindström discloses a hopper car with a machinery space over a shear plate (6) and under an end slope sheet (“sloping end floor” 20), as claimed. For opening hopper doors 48, Lindström discloses a door actuator comprising an operating shaft 69, a pinion 72, a toothed member 88, a pawl 89 and a rod 90. Lindström’s door actuator is mounted in the machinery space, above the shear plate and under the end slope sheet.

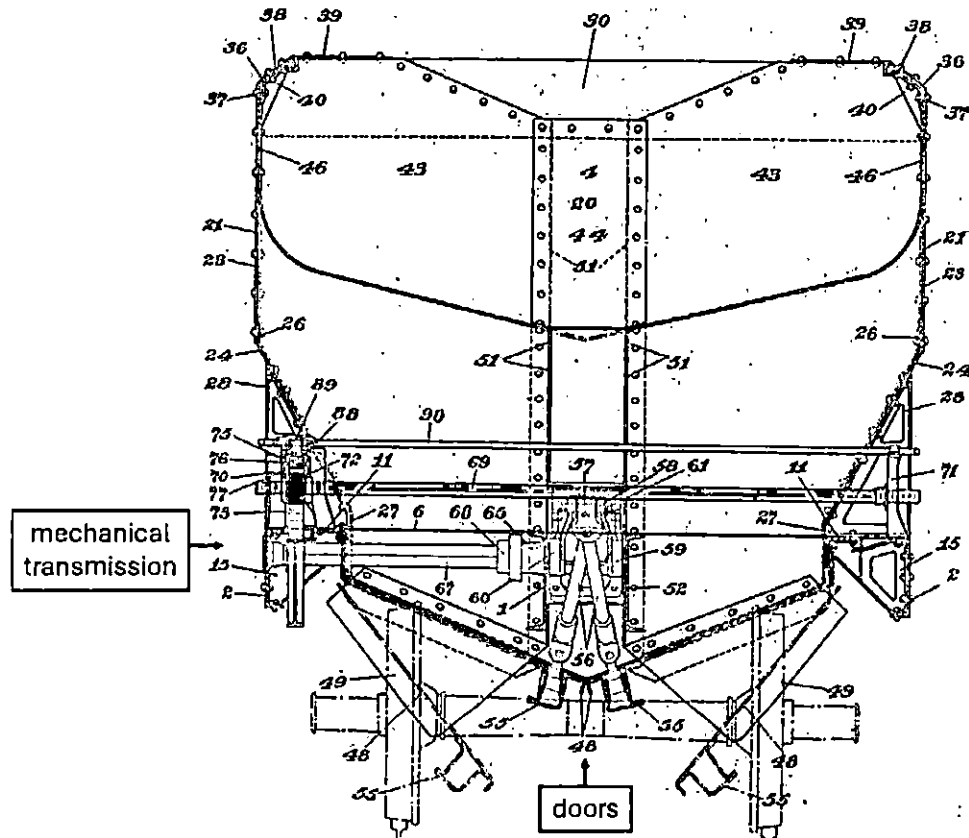


EX1005, Figs. 2, 4.

141. To open the hopper doors:

the operator grasps the rod 90 by one of its cranked ends and through its operation throws the pawl 89 out of engagement with the toothed member 88. A crank or wrench is then applied to the end of the shaft 69, which is then operated in the direction of the arrow, as shown in Fig. 2.

Id. at 5:115–122. Shaft 69 is connected to the hopper doors by a mechanical transmission that includes gears and linkages, as shown in the annotated figures below. *Id.* at 4:43–5:96.



EX1005 at Fig. 4.

142. Shaft 69 is connected to the hopper doors by a mechanical transmission that transfers force between gears and linkages as follows.

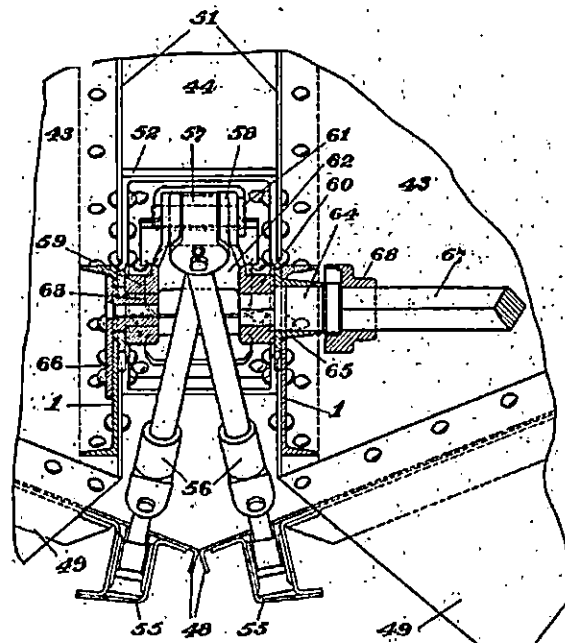
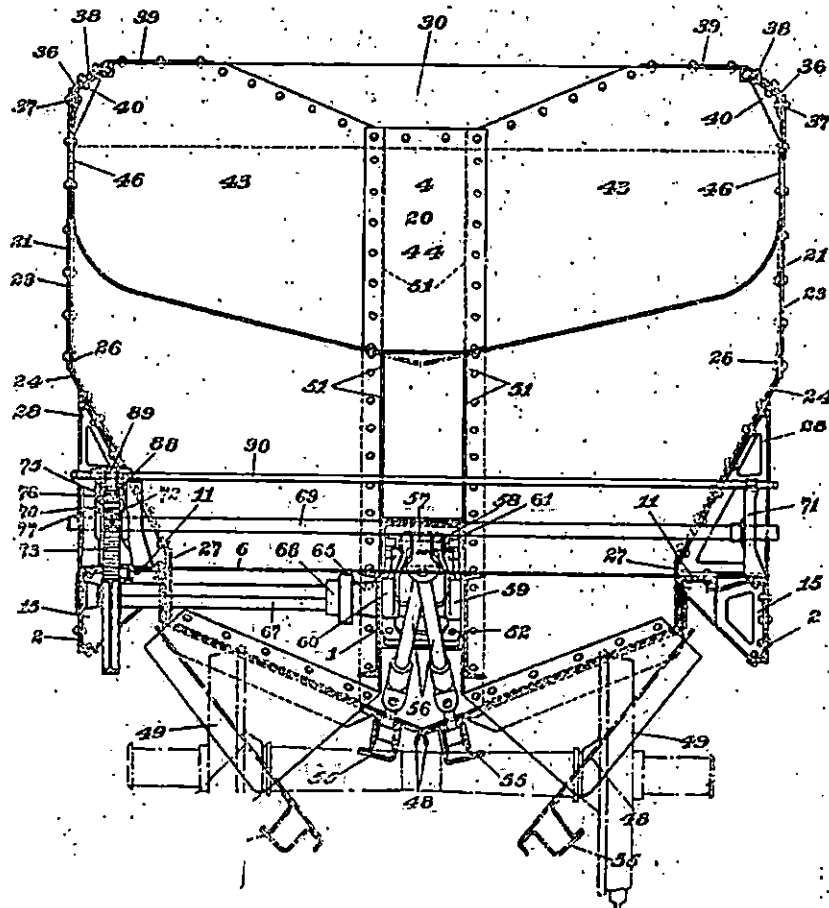


Fig. 7.

1. Shaft 69 to pinion 72 to segment gear 73 to shaft 67. *Id.* at 5:40–44 (“The shaft 69 is connected to one of the shafts 67 through the medium of a pinion 72 secured on the shaft 69, meshing with a segment gear 73 on the shaft 67”).
2. Shaft 67 to clutch member 68 to trunnion 64 (Fig. 7), which is journaled in bearing member 65 and is part of arm 60. *Id.* at 4:118–21 (“shafts 67 are provided which are secured in the outer portions of the clutches hereinafter described”), 5:5–7 (“the lug in the clutch member 68 when rotating will strike the lug on the trunnion 64 and transmit motion to such trunnion 64”), 4:105–08 (“arms 60 are provided with trunnions 64 having cylindrical outer bearing portions which are suitably journaled in bearing members 65”).
3. Arm 60 to crank pin 61 to yoke 57 to link 56 to beam 55 to door 48. *Id.* at 4:83–86 (“At the free ends of the crank arm there is carried the crank pins 61 upon which the yokes 57 are directly mounted.”), 4:74–80 (“there is a pair of links 56 at each end of the discharge doors, one end of each of said links being connected to the end of its respective beam 55, the other end of each pair of links being brought together and pivotally mounted in the yoke 57”), 4:64–65 (“Each of the discharge doors 48 is provided with a beam 55”).

143. This mechanical transmission between shaft 69 and the hopper doors 48 is described in detail in the following passage in Lindström:

For the purpose of operating the doors 48, 48 we have provided a mechanism which is similar to the mechanism shown in U. S. Letters Patent No. 1,002,856 and 1,012,260, granted to Charles A. Lindstrom, with the following improvements: Instead of locating the crank operating mechanism on both sides of the car in such a manner that the mechanism on one side operates one end of each of the doors and the mechanism on the other side operates the other end of each of the doors, in which location they are difficult to inspect without going from side to side of the car, the mechanism has been mounted on one side of the car. This improvement also reduces the number of pinion wheels from two to one, and permits the whole mechanism to be constructed more accessible and compact, and also cheaper.

The present mechanism including parts previously used and the modifications are as follows: *Each of the discharge doors 48 is provided with a beam 55*, composed of Z or other suitable section or sections extending along and under its free edge and projecting slightly on each end of the door. The ends of beams 55, 55 are connected through the medium of universally jointed links 56 to yokes 57, 57 pivotally mounted in crank frames 58, 58, which are preferably located between the sills 1, 1, and at each end of the doors. That is to say, *there is a pair of links 56 at each end of the discharge doors, one end of each of said links being connected to the end of its respective beam 55, the other end of each pair of links being brought together and pivotally mounted in the yoke 57*. Each of the crank frames which are oppositely disposed consists of a pair of crank arms 59, 60 connected together through the medium of a web 62. *At the free ends of the crank arm there is carried the crank pins 61 upon which the yokes 57 are directly mounted*. Each of the crank frames 58 is journaled, as later described, in the draft sills 1, 1 in such a position that when the discharge doors 48, 48 are closed, the links 56 and yoke 57 are on the dead center of the crank frame 58, or slightly beyond the same toward the sloping floor, so that the load on the doors tends to force the crank frame in the closing direction and thus the doors are automatically locked against opening from jars or shocks during transit. It will be noted from the drawings that the crank frames 58 are oppositely

disposed so that through the medium of the yokes 57 and the links 56 they oppose each other, which arrangement is a further safeguard against accidental opening of the doors during transit.

The arms 59 of the crank frames 58 are journaled on trunnions 63, while the *arms 60 are provided with trunnions 64 having cylindrical outer bearing portions which are suitably journaled in bearing members 65* preferably integral with the members 52 secured between the sills 1, 1. Each of these trunnions is provided with a squared inner end which fits in a square perforation in the crank arm 60 and may form a member of the safety clutch hereinafter referred to. Trunnions 63 are each provided with a flange 66 which is preferably secured to the outer face of the sill 1.

For operating the crank frames 58, *shafts 67 are provided which are secured in the outer portions of the clutches hereinafter described* by any suitable means. The shafts 67 extend transversely from the clutches to the side of the car, and are supported at their outer ends by suitable bearings. Near the outer ends of the shafts 67, segments of gears are secured thereto, connected with rack operating mechanism hereinafter described.

Safety clutches are introduced for the purpose of permitting the dropping of the doors quickly without danger to the operator. The clutch members 68 and the trunnions 64 are provided with projecting lugs, such lugs being in the same rotary plane so that *the lug in the clutch member 68 when rotating will strike the lug on the trunnion 64 and transmit motion to such trunnion 64* and, conversely, either the clutch member or the trunnion is capable of limited non-transmitting movement relative to the other. These clutches are of the same general character as described in United States Letters Patent Nos. 865,714, 865,920 and 865,921 granted to Charles A. Lindstrom. It will be noted that the crank frames 58, in dropping the doors will make about one half revolution, and this being the case, because of the interposition of the clutches, such movement will not be transmitted to the shafts 67, and hence will be independent of shafts 67 and the balance of the mechanism.

It is necessary that the two crank frames 58 operate simultaneously to prevent undue strain on either side of a door due to one crank frame

operating before the other, also that the two crank frames move away from the end sloping floors when the doors are being opened and toward the floors when the doors are being closed, which enables the placing of the crank frames closer to the floors and also allows the use of straight connections to the beams 55; further, as the load on the doors is naturally great, on account of the size of the doors as well as the nature of the lading, a power increasing mechanism is necessary. For this purpose the two shafts 67 are operatively connected to a common operating shaft 69, preferably extending transversely of the car and journaled in bearings 70 and 71. *The shaft 69 is connected to one of the shafts 67 through the medium of a pinion 72 secured on the shaft 69, meshing with a segment gear 73 on the shaft 67,* such segment gear projecting upwardly between the side sill 2 and the member 11, and shaft 69 being preferably located above the horizontal plane of the upper surfaces of the side and draft sills. The operating shaft 69 is connected with the other shaft 67 by means of a segment gear 74 on the shaft 67, the pinion 72 on the shaft 69 and toothed racks 75 meshing with and operatively connecting said segment gear 74 and pinion 72.

The rack 75 comprises a member 76 which is preferably of I form having toothed members 77 and 78 attached to its horizontally disposed web in such position as to mesh with the pinion 72 and the segment gear 74 respectively. The toothed member 78 is attached to the web of the member 76 through the medium of bolts 79 which pass through perforations in the member 78 and through slotted perforations 80 in the member 76, such bolts being held in position by nuts or other suitable means. To the member 76, intermediate the members 77 and 78, a bracket 81 is secured. Held within this bracket and extending outwardly therefrom is a threaded member 82 which is adapted to pass through a perforation in the lug 83 of the member 78. This member 82 is provided with nuts 84 and 85 which are adapted to engage the opposite faces of the lug 83 and hold the member 78 in any desired position. When for any reason it is desired to lengthen or shorten the distance between the members 77 and 78 the nuts 84 and 85 are turned to affect such adjustment.

The rack 75 is supported in operative position by means of brackets 86 and 70, projections being provided on the inner sides of the vertical portion of the sides of the brackets, on which slide the side extensions or flanges of the rack. The rack is retained in such a position, that the

teeth shall be in mesh with the teeth of the pinion 72 and segment gear 74, by means of rollers 87 which contact with the upper portions of the rack, and which are held in such position by means of pins which are passed through the upward extensions of the brackets 86 and 70. Intermediate the brackets 86 and 70 the rack is retained in position by a roller journaled between the lugs 28a which are preferably integral with one of the members 28.

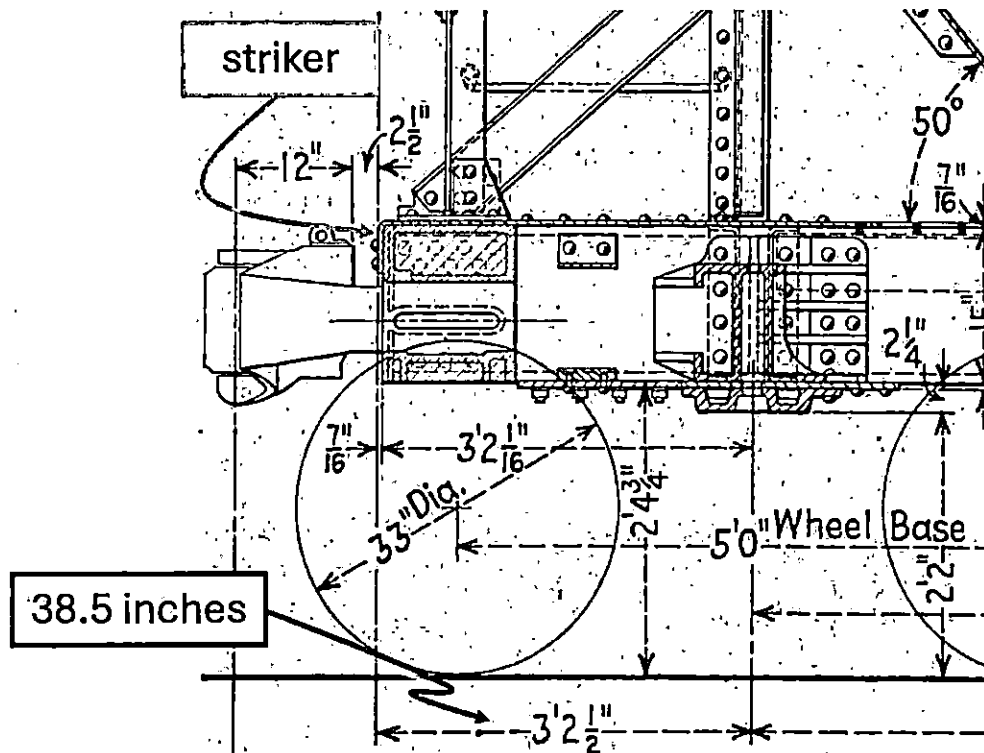
Id. at 4:43–5:96.

144. As shown in the figures and descriptions above, Lindström's door actuator is mounted above the shear plate and under the end slope sheet, as claimed.

3. Dependent Claim 39: “The railroad hopper car of claim 32 wherein said draft sill has a longitudinally outboard end, and a striker plate mounted at said longitudinally outboard end; and said draft sill has a length between said truck center and said striker plate that is less than 50 inches.”

145. Lindström discloses a striking plate 8 at the end of draft sill, but does not provide specific dimensions for these structures.

146. The 1946 Cyclopedia's NSC ore car discloses a striker whose outboard end is 38.5 inches from truck center, as shown below.

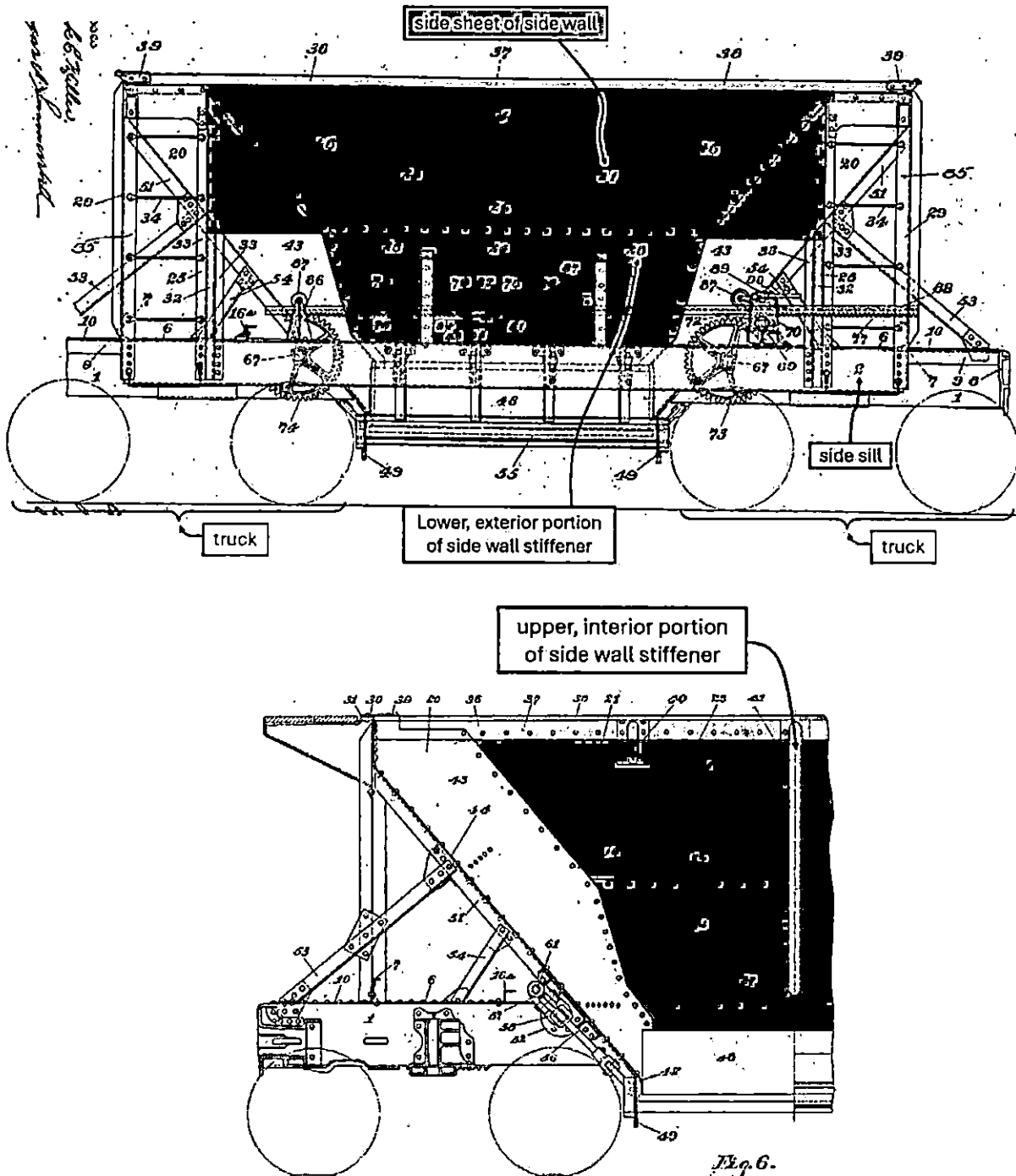


EX1004 at 294. It would have been obvious to use the NSC dimension with the Lindstrom hopper-car design, making any necessary adjustments to related structures, because the specific distance between the striker and truck center is a routine design choice.

4. Dependent Claim 40:

- a. [40c] "said first side wall has a predominantly upwardly running side wall stiffener mounted thereto, said side wall stiffener being located at a longitudinal station intermediate the trucks;"

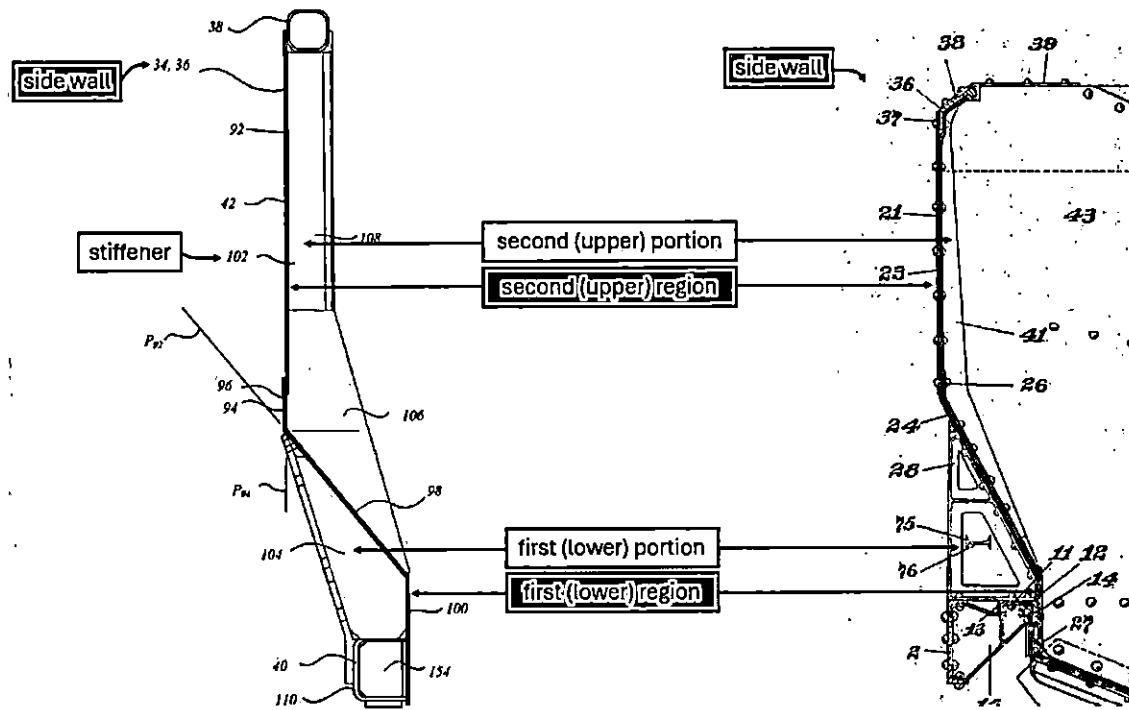
147. Lindström has a sidewall with the claimed stiffener:



EX1005, Figs. 2, 6. Lindström states: “To assist in supporting and stiffening the combined side walls and sloping floor plate 21, 21, members 28 are provided which are preferably of triangular form” *Id.* at 2:111–115. The reference further

states: “To further stiffen and strengthen the combined side walls and sloping floors 21, 21, stakes 41 are provided which are preferably of U-shape in cross section having lateral flanges.” *Id.* at 3:39–45.

148. The stiffening members are shown in the '515 patent at the left, and in Lindström at the right:



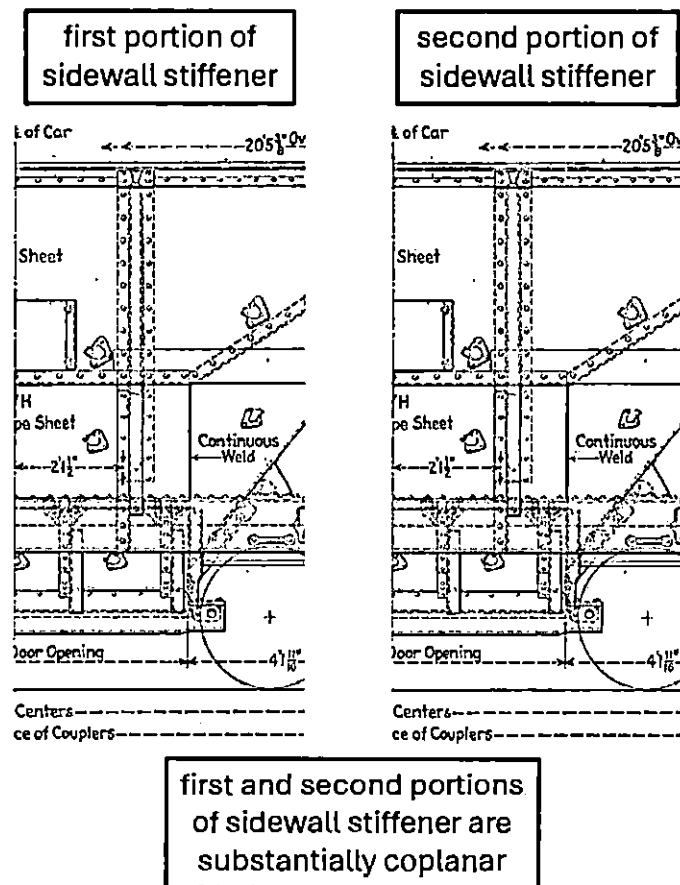
EX1001, Fig. 2c; EX1005, Fig. 5.

b. [40h] “said side wall stiffener having web continuity between said first and second portions thereof”

149. A POSITA would have understood that the two portions (outer and inner portions) of Lindström’s side-wall stiffener are arranged in the same vertical plane, and thus have web continuity, because any other arrangement would subject

the side walls to bending moments that could damage them (or would otherwise provide an inferior structure).

150. However, even if Lindström did not disclose web continuity, the 1946 Cyclopedia's NSC ore car drawings disclose two-part side-wall stiffeners with web continuity. The 1946 Cyclopedia's NSC ore car discloses outside and inside portions of a stiffener aligned in a vertical plane:



EX1004 at 294. A POSITA would have been motivated to align the portions of Lindström's side-wall stiffener in the same vertical plane, as in 1946 Cyclopedia's

NSC ore car, to avoid the bending moments discussed above, and because such side-wall stiffeners had become commonplace at least by 1946.

5. **Dependent Claim 43:** “The railroad hopper car of claim 40 wherein: said first side wall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said side wall stiffener from an inboard margin thereof to an outboard margin thereof; said hopper includes first and second sloped side sheets; and said first sloped side sheet meets said first side wall at said transition portion.”

151. The '515 patent states: “Lower portion 124 tapers in width to match the narrowing width between the *sloped side sheets* with which it mates.” EX1001 at 16:39–41 (emphasis added).

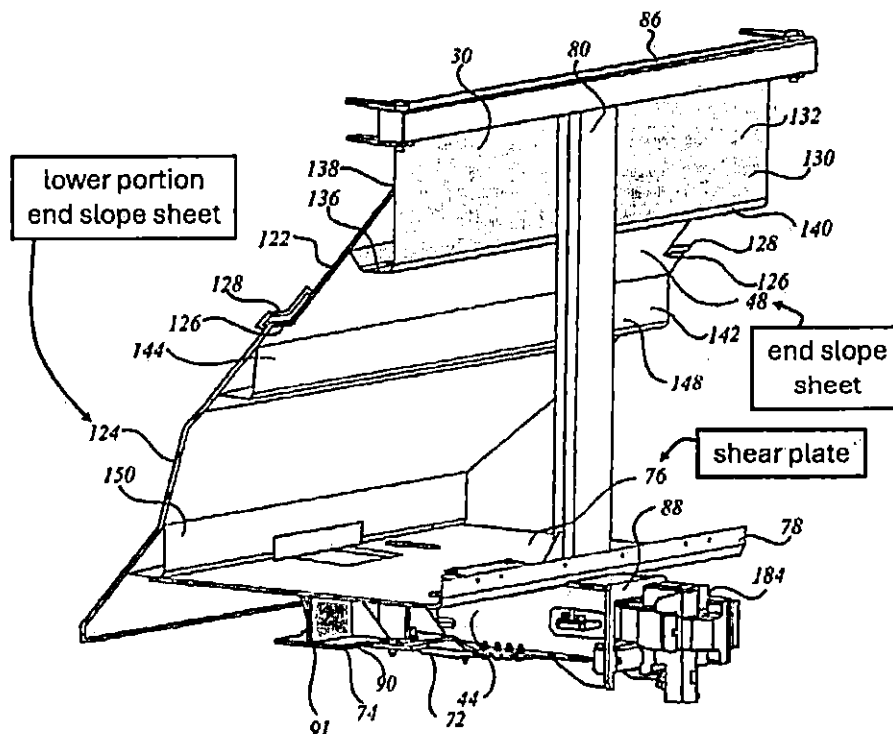
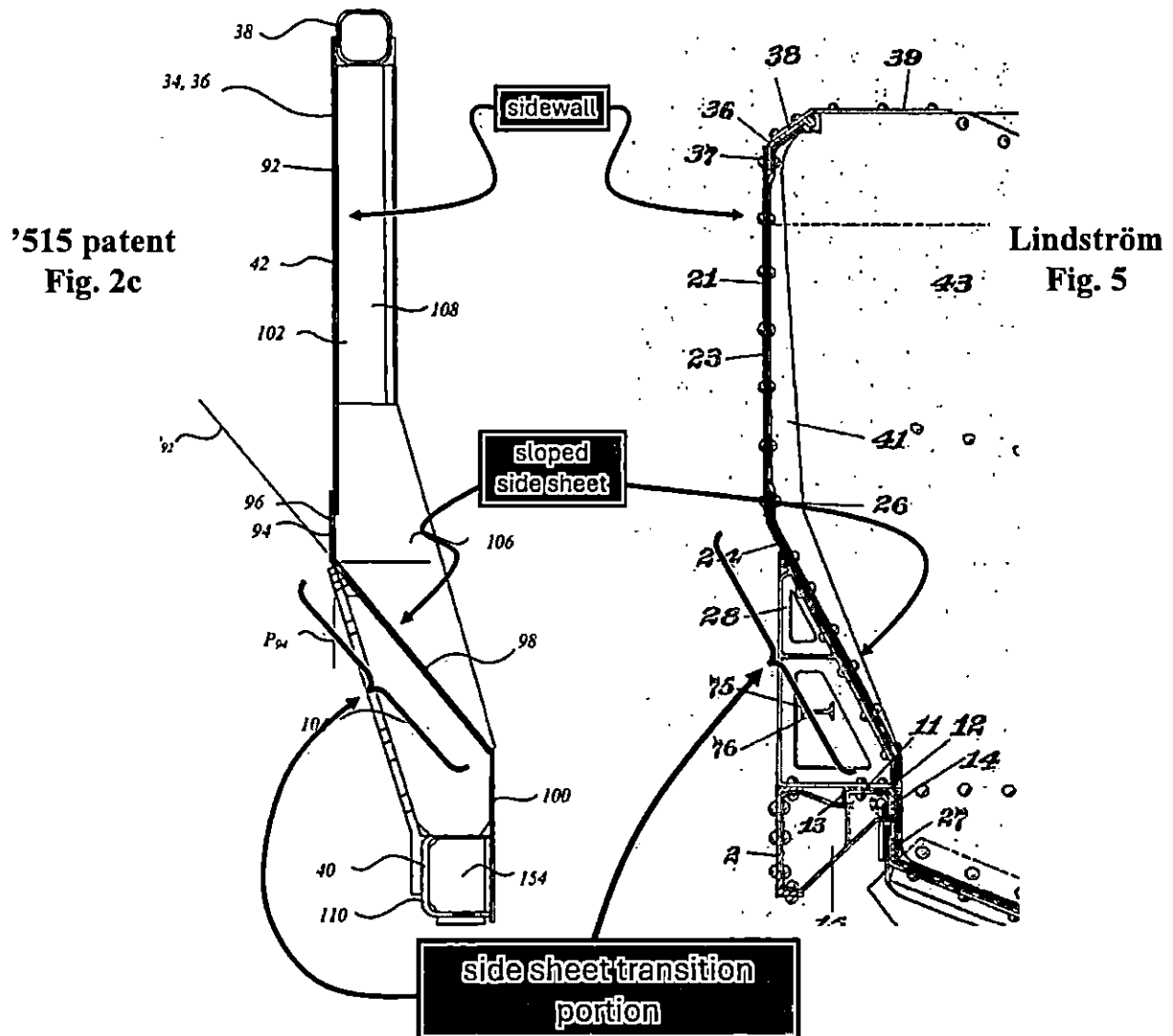


Fig. 1 is a schematic diagram of a vertical member 100. The member has a top flange 38, a main body 92, and a base 40. A shear plate 154 is shown at the base. A dashed line indicates the level of the shear plate. A sloped portion 98 of the sidewall 34, 36 is shown, spaced above the shear plate. A force P_y is applied to the sloped portion. A force P_x is applied to the base. A force P_z is applied to the base.

108

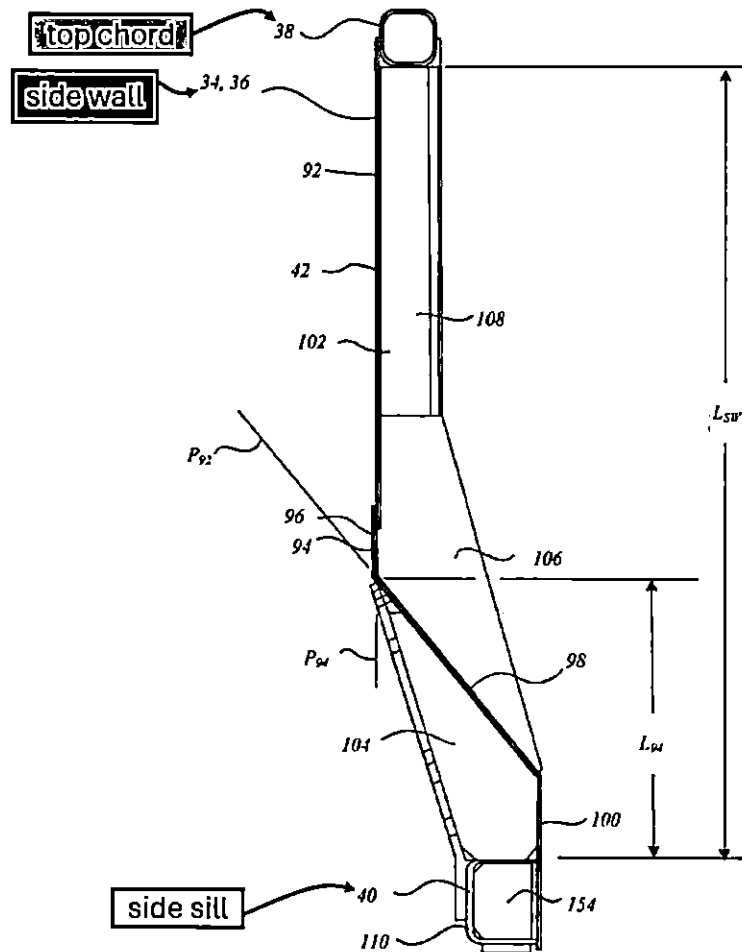


EX1001, Fig. 2c; EX1005, Fig. 5.

6. **Dependent Claim 44:** “The railroad hopper car of claim 43 wherein said first side wall has an overall height from said side sill to said top chord, L , and said transition portion is located a distance above said side sill that is in the range of $\frac{1}{4}$ to $\frac{3}{8} L$.”

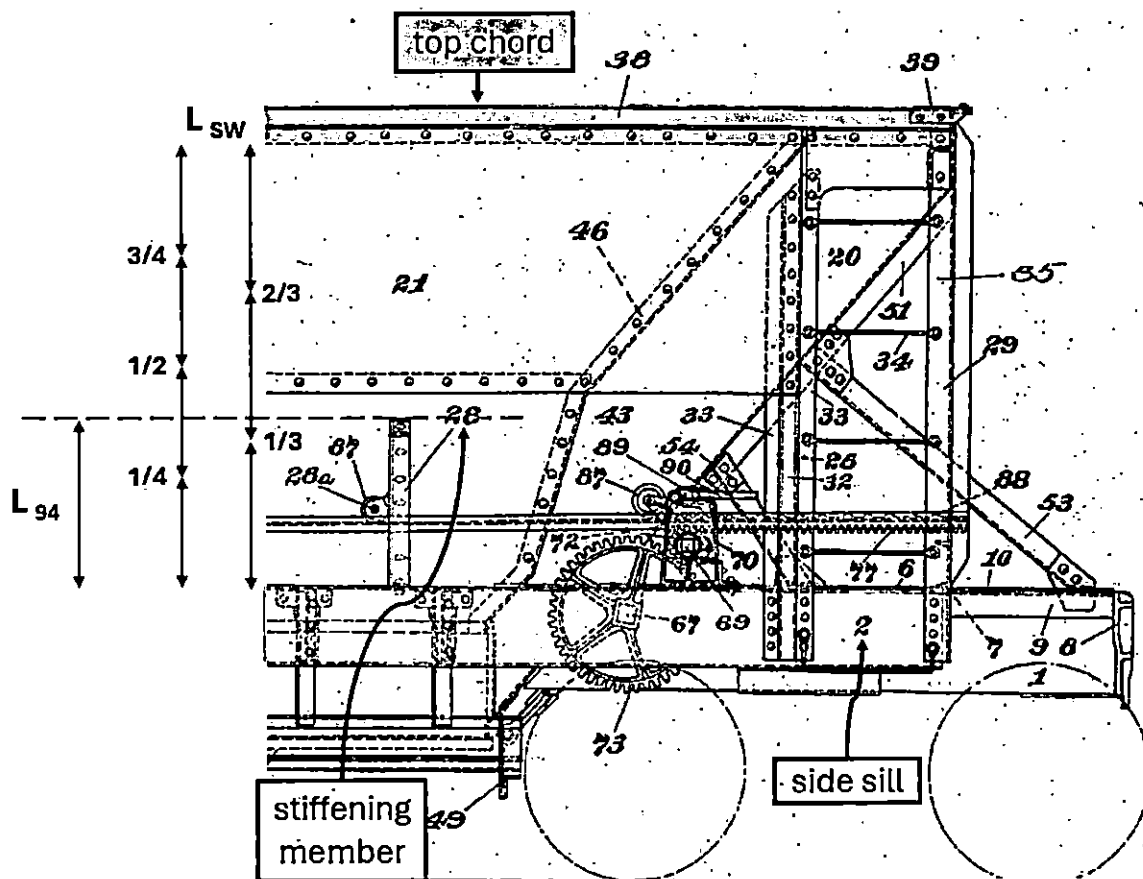
153. The '515 patent's only disclosure of this limitation is in Fig. 2c, shown below, and in the corresponding text. EX1001 at 15:63-16:1, Fig. 2c. As shown below, the '515 patent compares the height of the side wall, labeled L_{sw} , and the

distance from the side sill to the juncture of the upper vertical (second) region of the side walls and the sloped (third) region of the sidewall, labeled L_{94} . EX1001, Fig. 2c. The text states that distance L_{94} “may lie in the range of $\frac{1}{4}$ to $\frac{2}{3}$ of the distance L_{sw} .” *Id.* at 15:66-67.



EX1001, Fig. 2c.

154. As shown below, Lindström discloses that its distance L_{94} is between $\frac{1}{4}$ and $\frac{2}{3}$ of L_{sw} , as required by Claim 44.



EX1005, Fig. 2. Even if Lindström did not expressly disclose this limitation, it would have been obvious to select dimensions consistent with the Lindström's drawings and with the NSC ore car for the additional reason that the precise dimensions are a matter of design choice. A POSITA would know to modify the angle of the transversely angled portion of the side sheet—thereby modifying the location of the transition portion—based on design constraints that are standard and well-understood, including maximizing hopper capacity, supporting the loads within the hopper including those seen at the slope sheet and hopper doors, and maximizing the car's efficiency in loading and discharging its intended lading. Selecting

elements that are efficiently carry the loads from the longitudinal beam at the top of the hopper car to the still, aligning them co-planarly, spacing them properly, connecting various elements to reduce stress concentration, supporting the weights on bolsters, ... are examples of engineering practices for maximizing capacity and efficiency. A POSITA is aware of and commonly employs such practices.

VI. GROUNDS AND COMBINATIONS

155. I have reviewed all grounds and combinations of prior art references referenced in this declaration, and I agree that each ground would render obvious the relevant claims. In particular, the following combinations of prior art references would be successfully combined and modified as described. Although I have not illustrated each modification, I have considered them all as part of this analysis to reach my conclusions.

GROUND	Claims	Obviousness References
1	1–2	Hart and the 1906 Cyclopedia
2	3	Hart, the 1906 Cyclopedia, and Schuller
3	4	Hart, the 1906 Cyclopedia, Schuller and Karig
4	5–6	Hart, the 1906 Cyclopedia, and Campbell '652
5	7–16, 20–23, 24–28, 30–31	Hart, the 1906 Cyclopedia, and Wong
6	17–19	Hart, the 1906 Cyclopedia, Wong and Campbell '051
7	21–22, 29	Hart, the 1906 Cyclopedia, Wong and Schuller

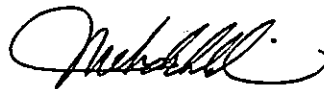
GROUND	Claims	Obviousness References
8	32–34	Lindström, Wong, Ratcliffe 1 and Hart.
9	35–44	Lindström, Wong, Ratcliffe 1, Hart and the 1946 Cyclopedia.

VII. CONCLUSION

156. I reserve the right to supplement my opinions in the future to respond to any arguments or positions that the patent owner may raise, taking account of new information as it becomes available to me.

157. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

May 27, 2025



Mehdi Ahmadian, Ph.D.

Exhibit 4



US008166892B2

(12) **United States Patent**
Forbes et al.

(10) **Patent No.:** US 8,166,892 B2
(45) **Date of Patent:** May 1, 2012

(54) **RAILROAD GONDOLA CAR STRUCTURE
AND MECHANISM THEREFOR**

(75) **Inventors:** James W. Forbes, Campbellville (CA);
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Keats, Brantford (CA)

(73) **Assignee:** National Steel Car Limited (CA)

(*) **Notice:** Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 284 days.

(21) **Appl. No.:** 12/559,065

(22) **Filed:** Sep. 14, 2009

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**

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Sep. 14, 2009 (CA) 2678605

(51) **Int. Cl.**
B61D 17/00 (2006.01)

(52) **U.S. Cl.** 105/406.1; 105/396; 105/404

(58) **Field of Classification Search** 105/199.4,
105/406.1, 413, 414, 415, 420, 247, 244,
105/250, 254, 396, 404; 213/50, 51, 56,
213/60, 61, 75 R

See application file for complete search history.

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Primary Examiner — S. Joseph Morano

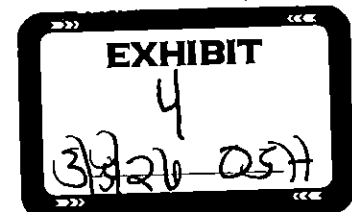
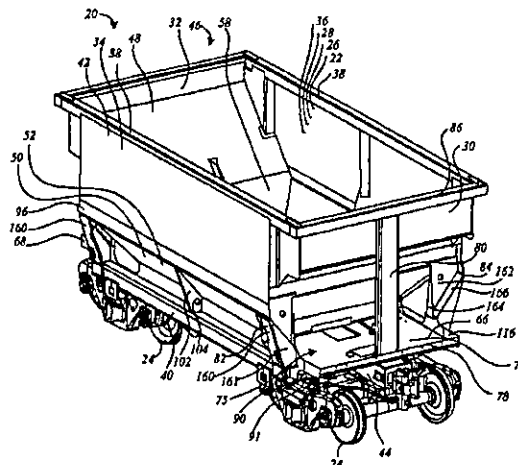
Assistant Examiner — Jason C Smith

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Michael H. Minns

(57) ABSTRACT

A railroad gondola car has a hopper carried between two trucks. The hopper has convergent end and side slope sheets that feed a bottom discharge. The bottom discharge has a pair of longitudinal doors. The door closing mechanism is a mechanical transmission that includes a set of linkages running from the door to a reciprocating pneumatic cylinder. The linkages run generally parallel to the slope sheet. The car has a very short draft installation that includes a removable coupler carrier bar, and the main shear plate has a removable draft gear installation panel. There is a machinery space above the end section shear plate. It is overhung by the slope sheet that is substantially unobstructed by any other primary structure. The pneumatic cylinder is mounted on an angle in this unobstructed machinery space, oriented longitudinally over the draft sill beneath the main drag link of the mechanical transmission, and above the main pivot of the driving input lever of the transmission. The main lever is bifurcated, and straddles the pneumatic cylinder. The mechanism includes a primary lock in the form of an over center lever arrangement, and a compact secondary lock that acts sideways rather than lengthwise. The sidewalls of the car include vertical stiffeners and side sheets. The lower portion of the side sheets lies laterally inboard of the stiffener web, while the upper portion lies laterally outboard of the stiffener web. The side slope sheet of the hopper meets the sidewall at the transition of the sidewall sheet from the inside-the-post to the outside-the-post condition.

15 Claims, 18 Drawing Sheets



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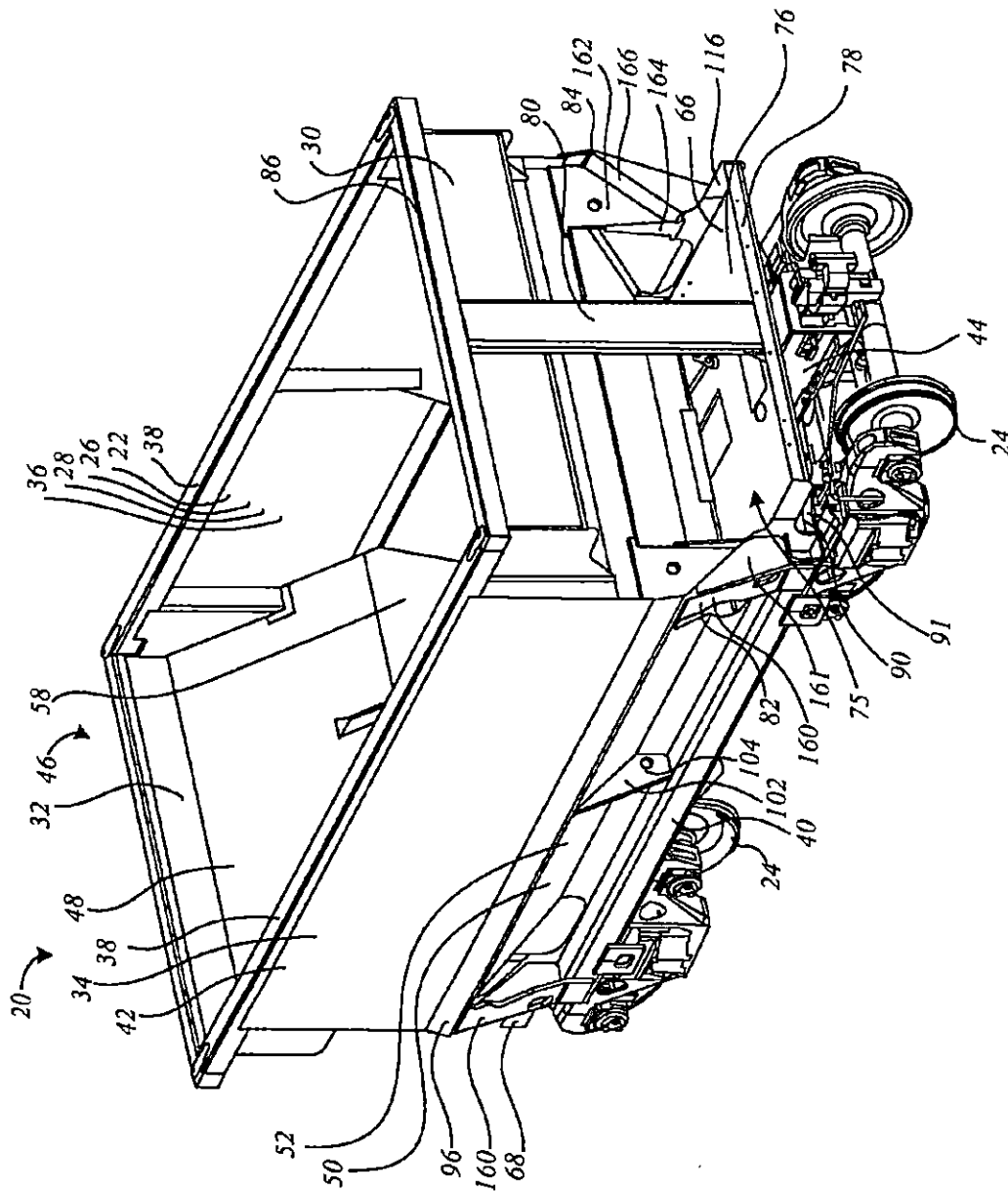


Figure 1

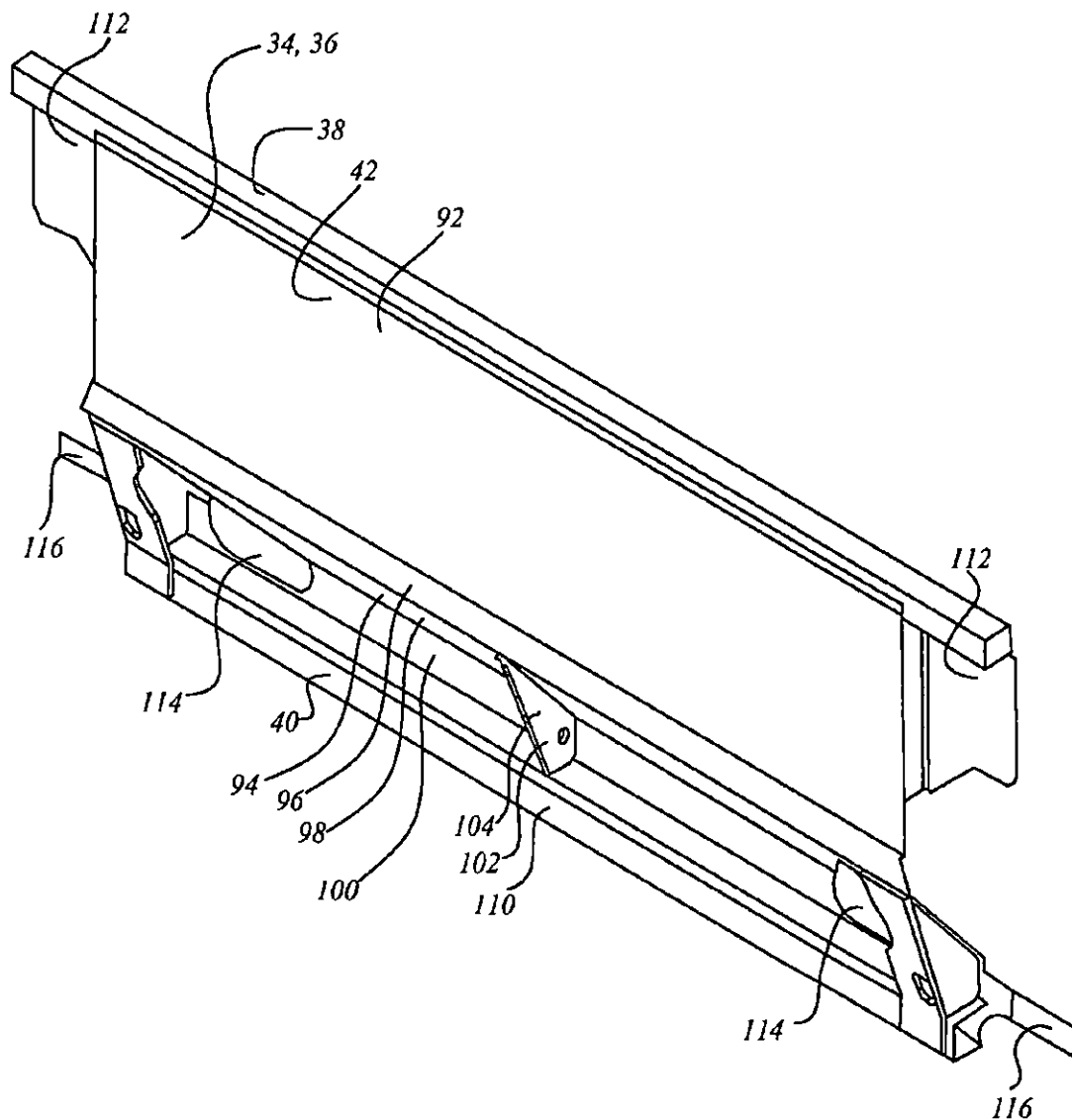


Figure 2a

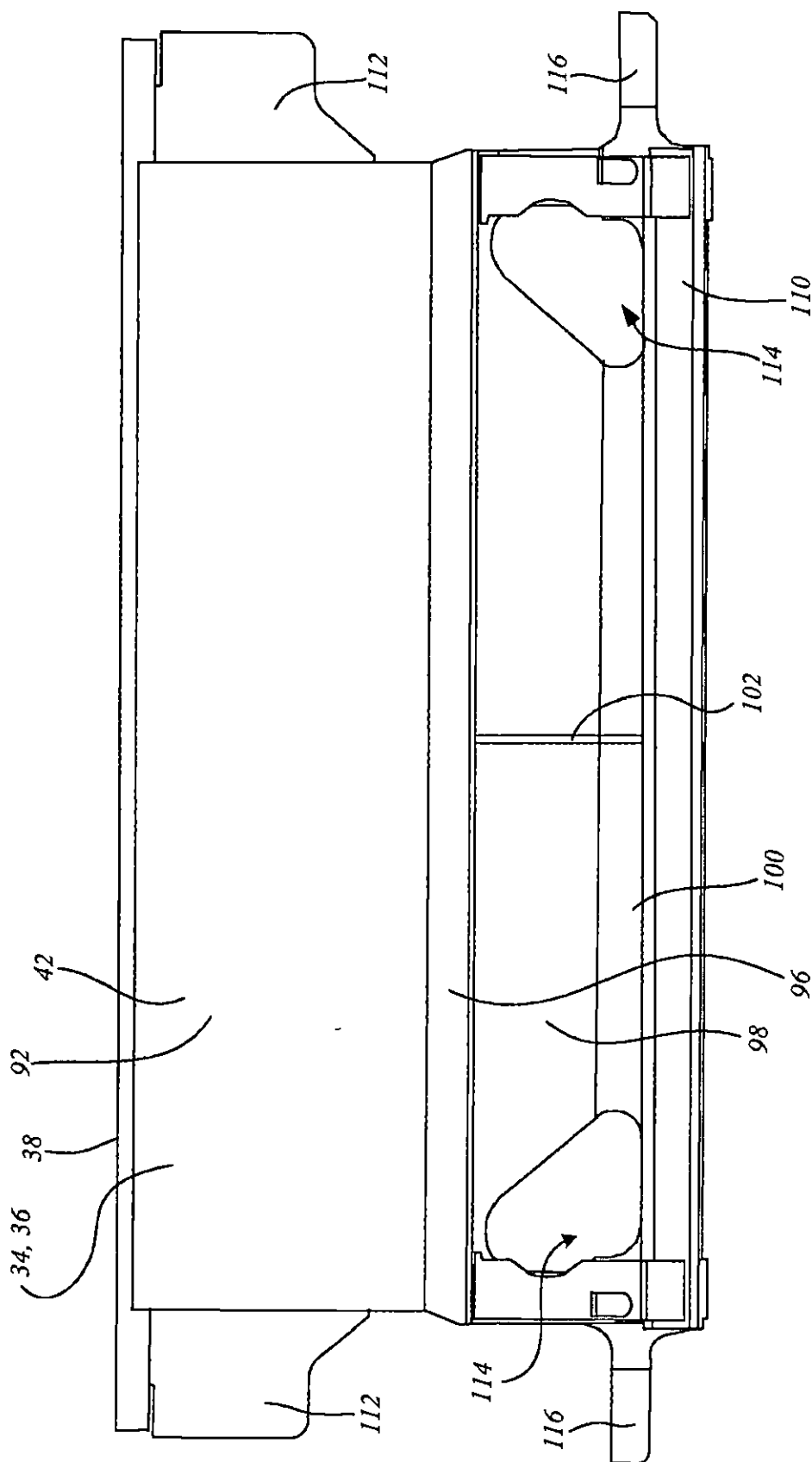


Figure 2b

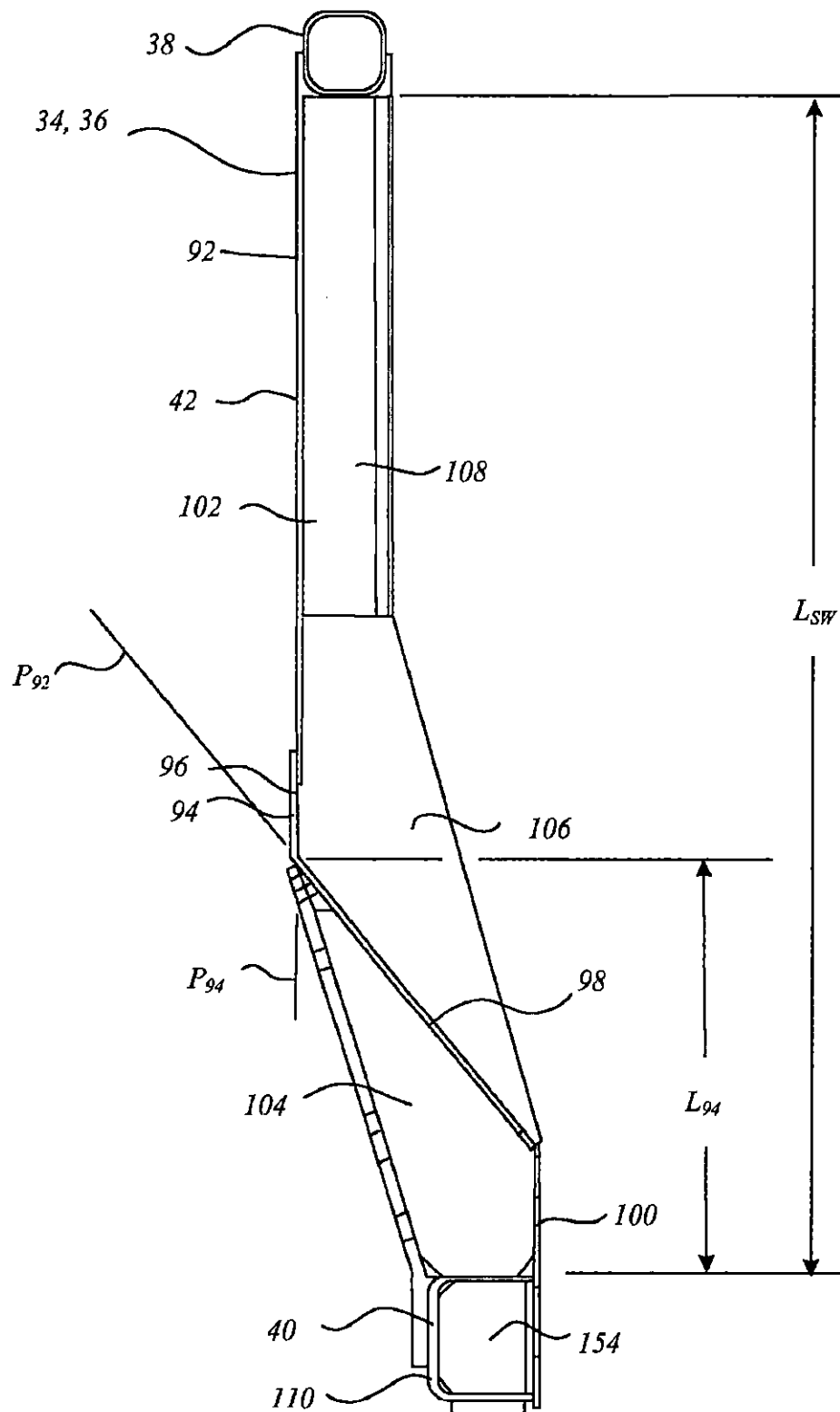
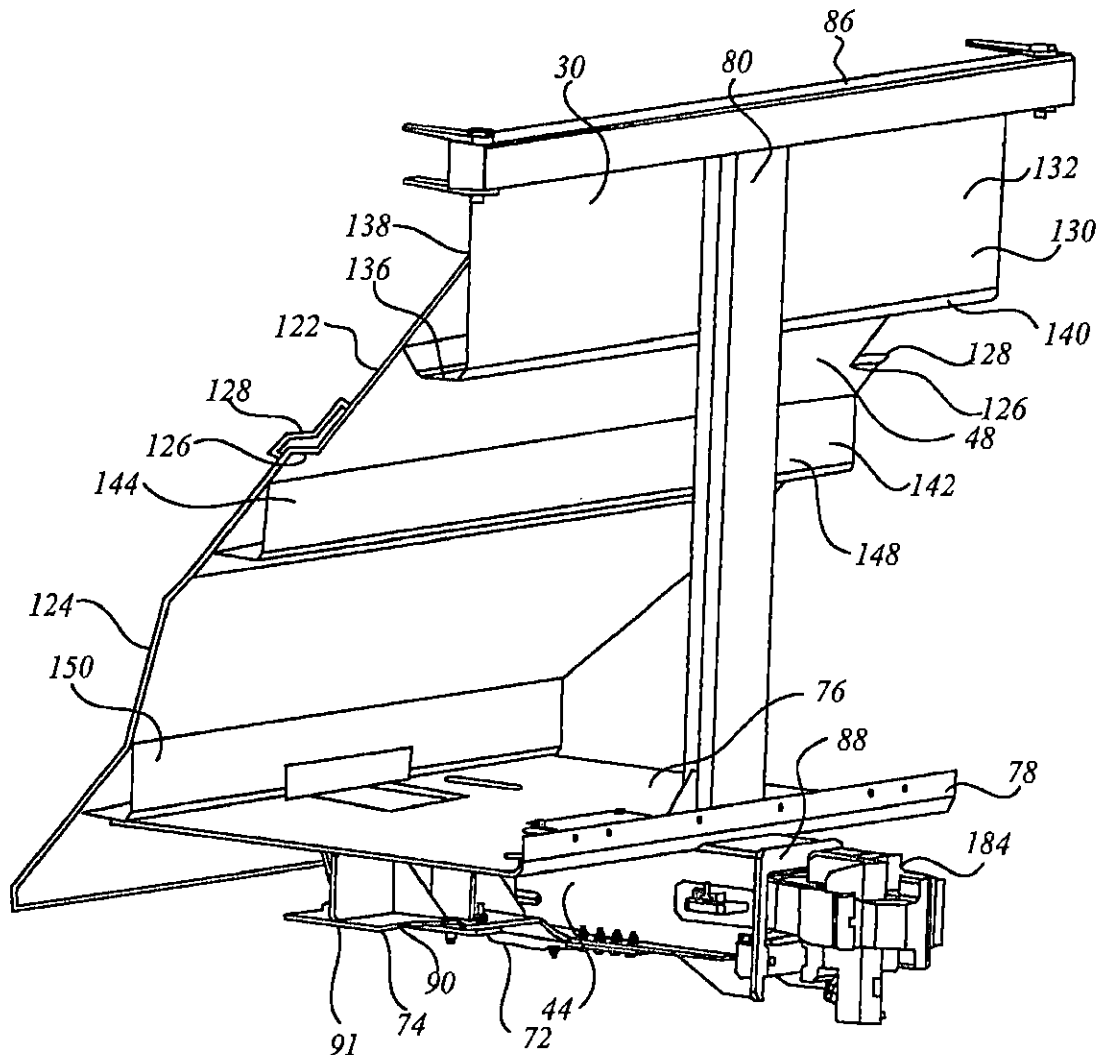


Figure 2c

*Figure 3a*

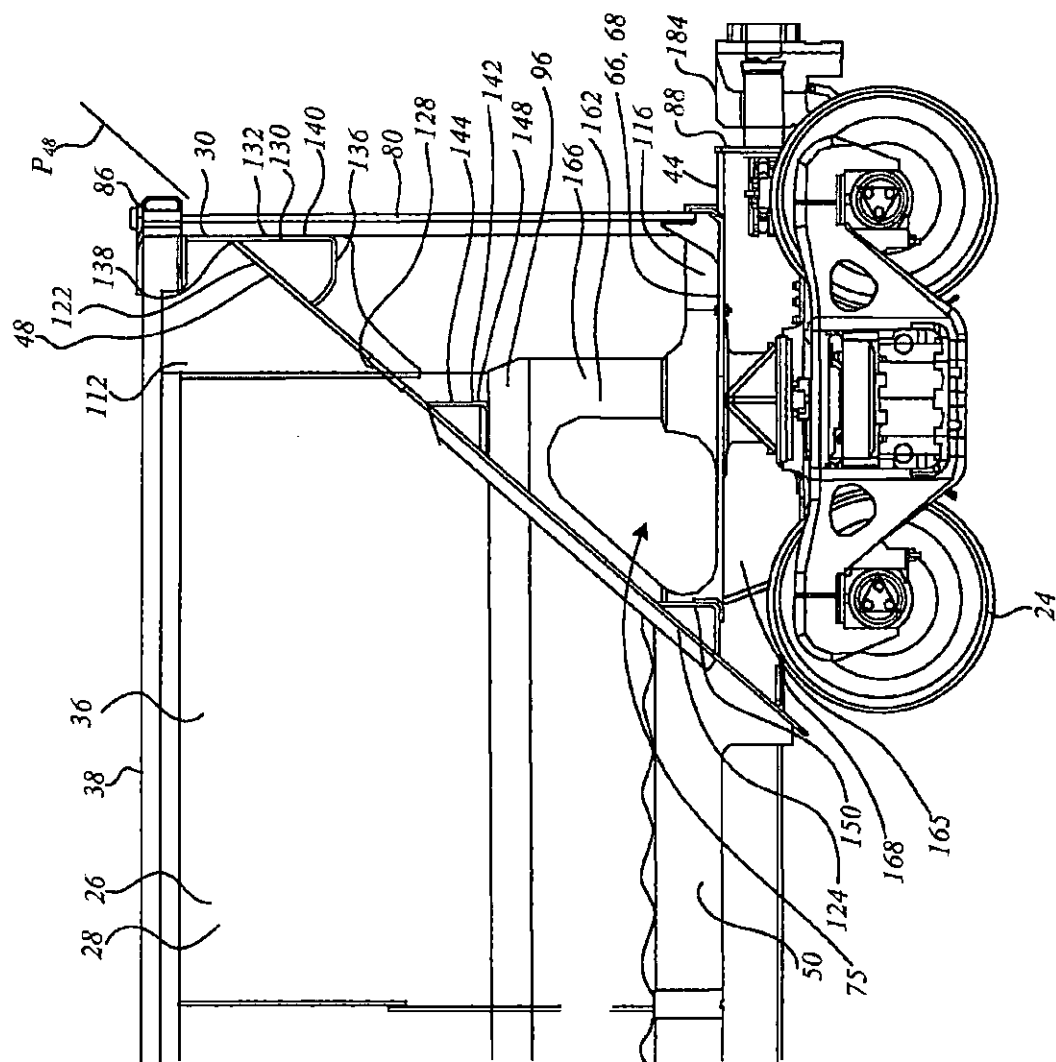


Figure 3b

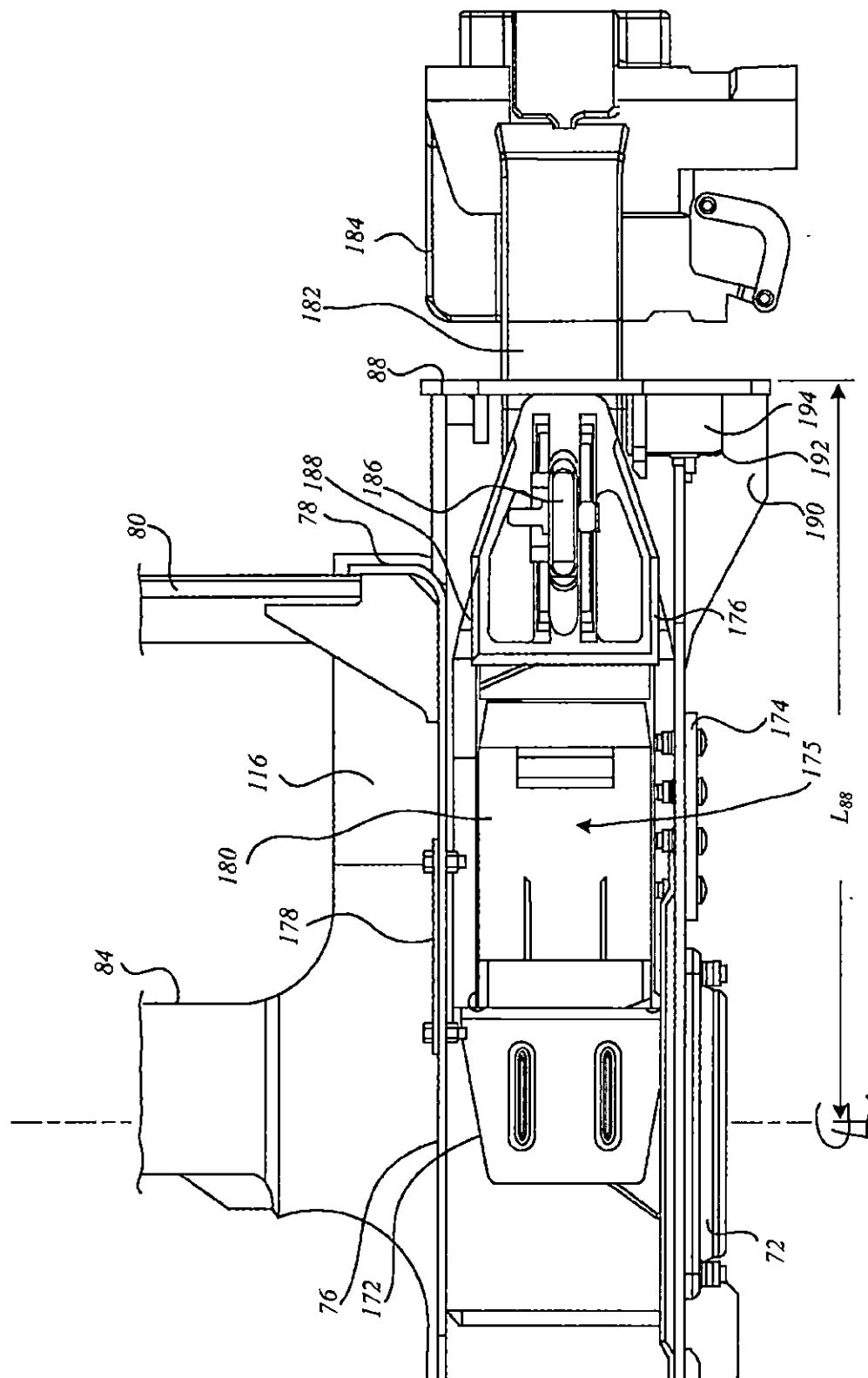


Figure 3c

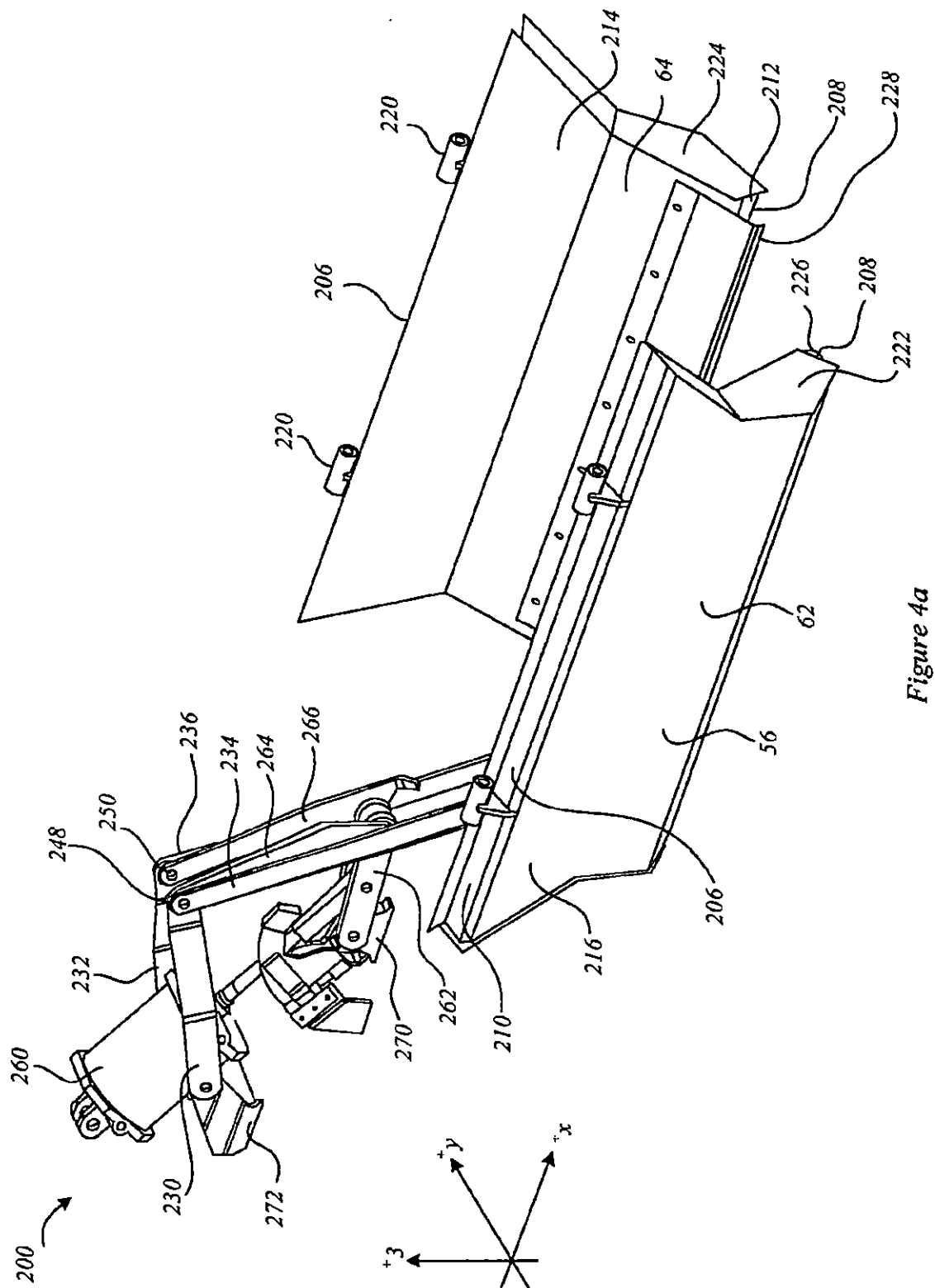


Figure 4a

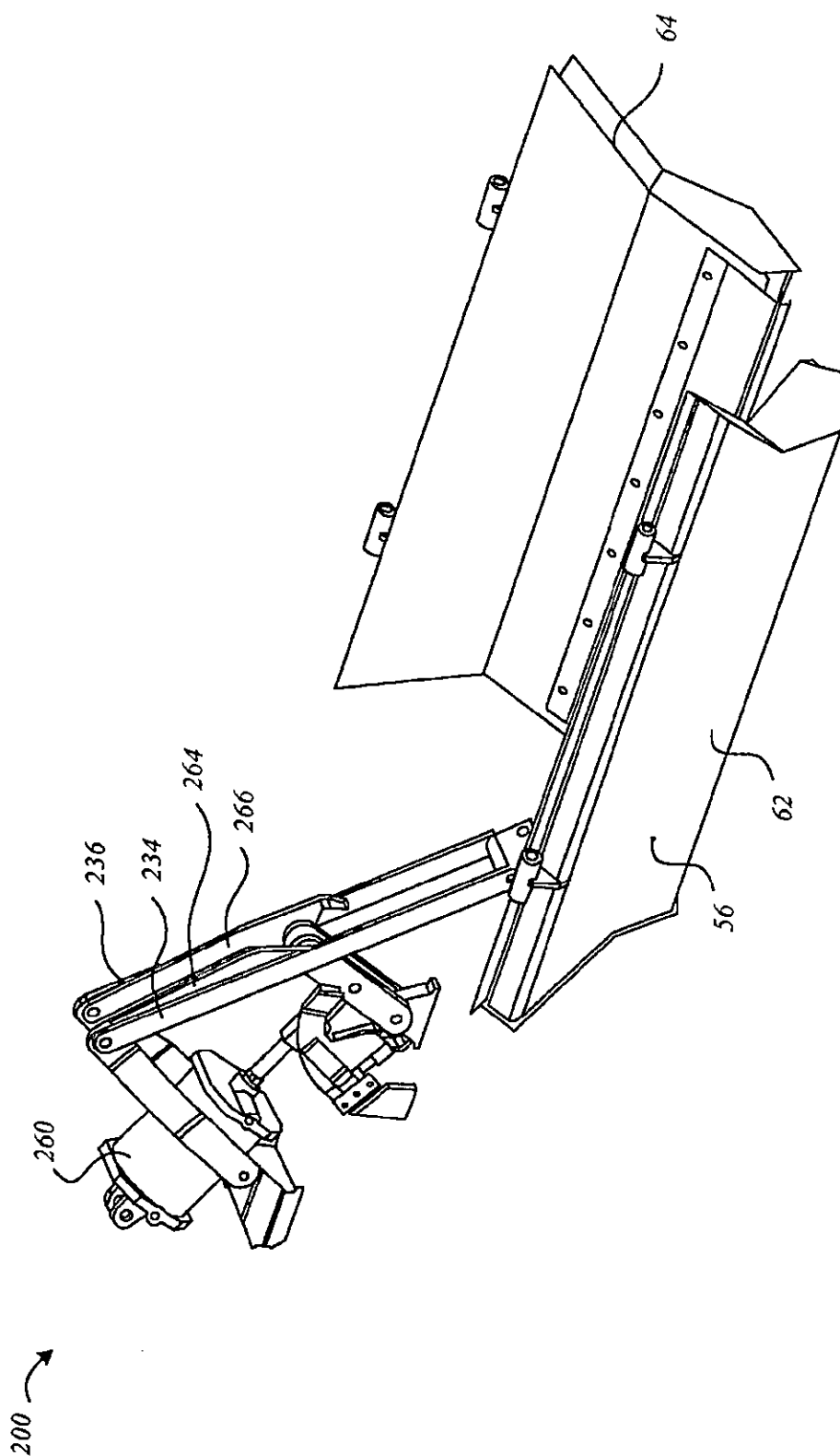


Figure 4b

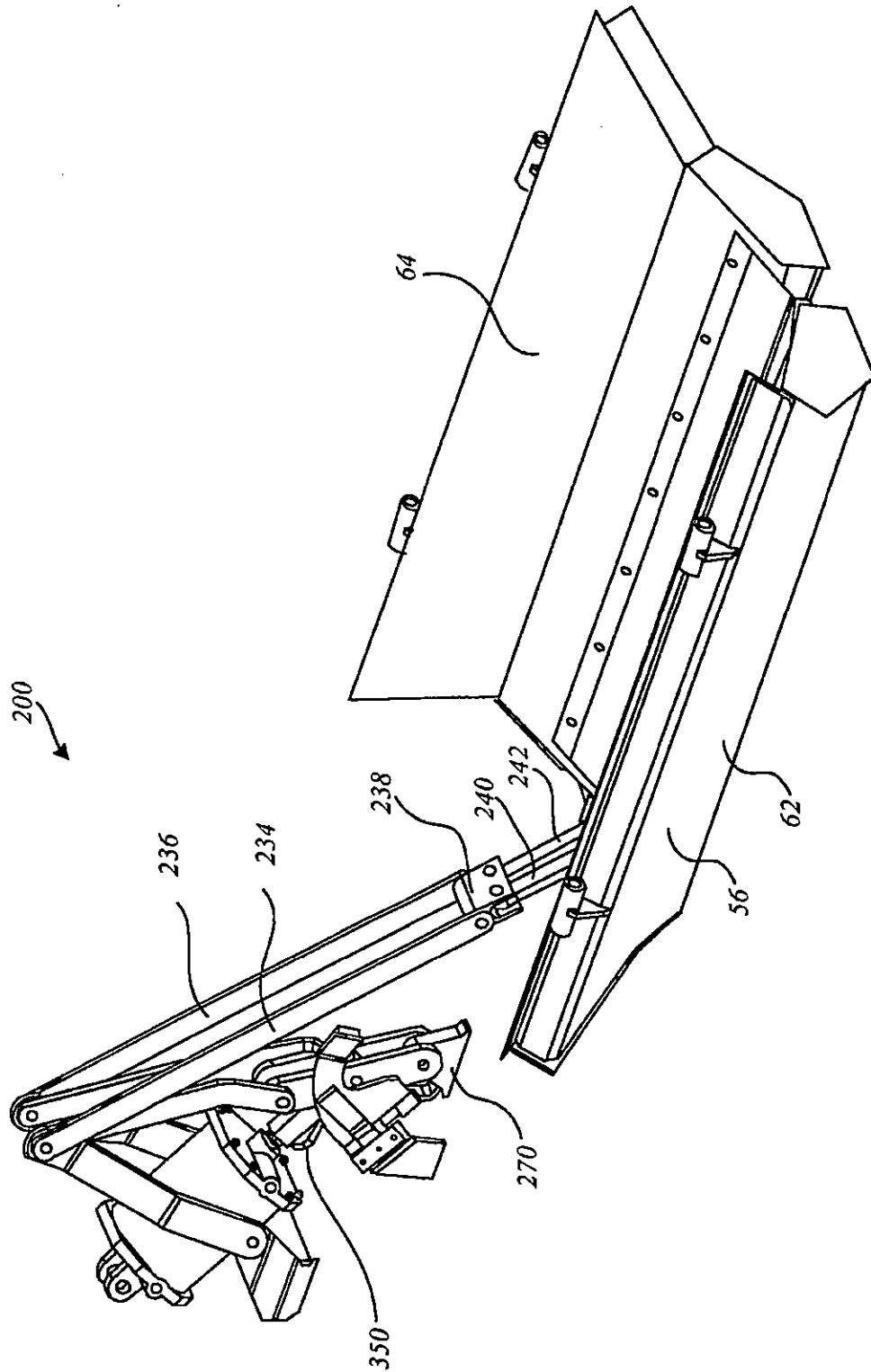


Figure 4c

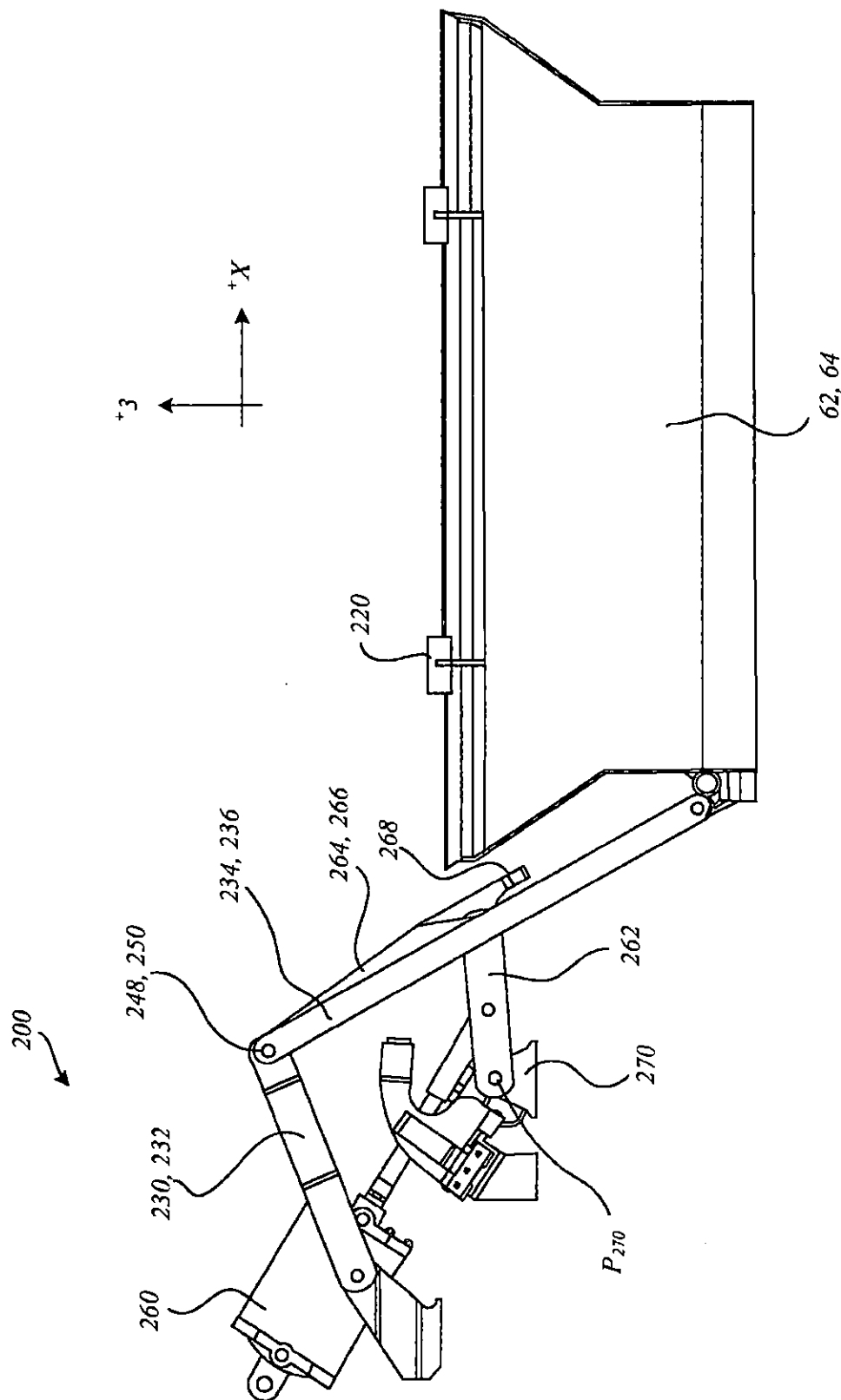


Figure 5a

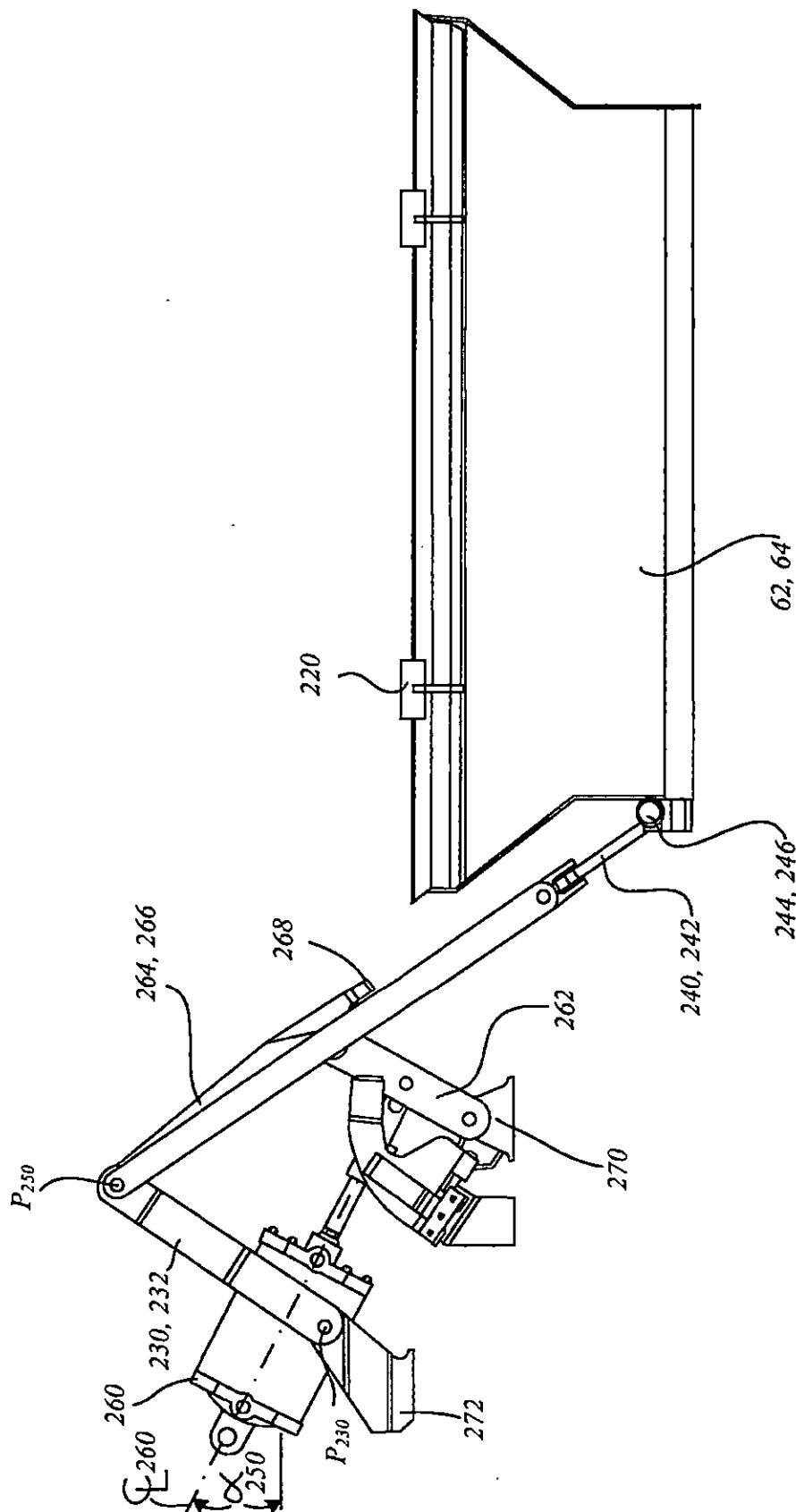


Figure 5b

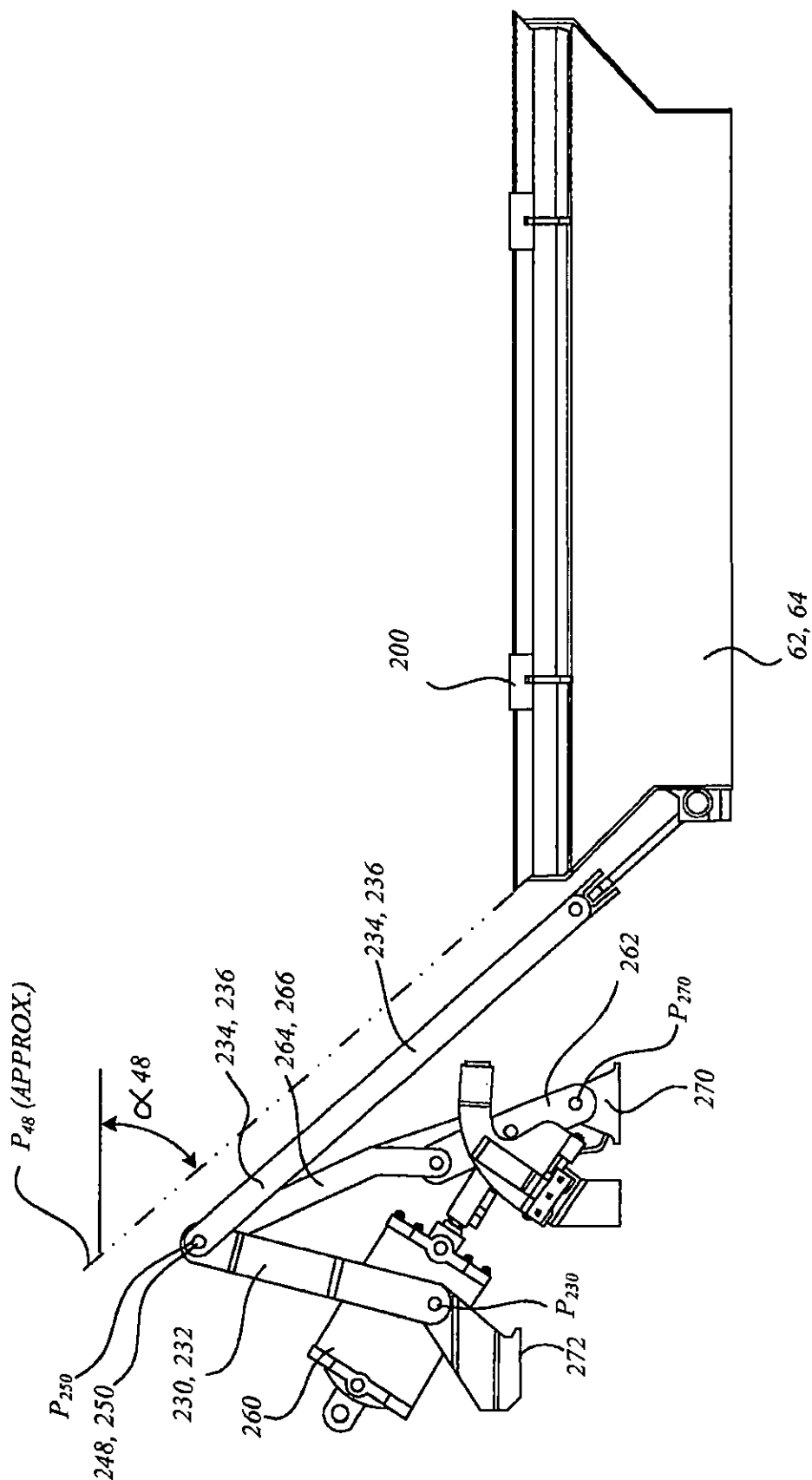


Figure 5c

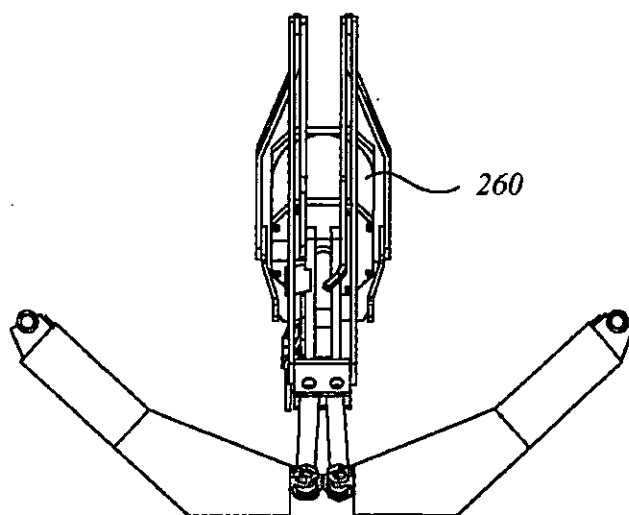


Figure 6c

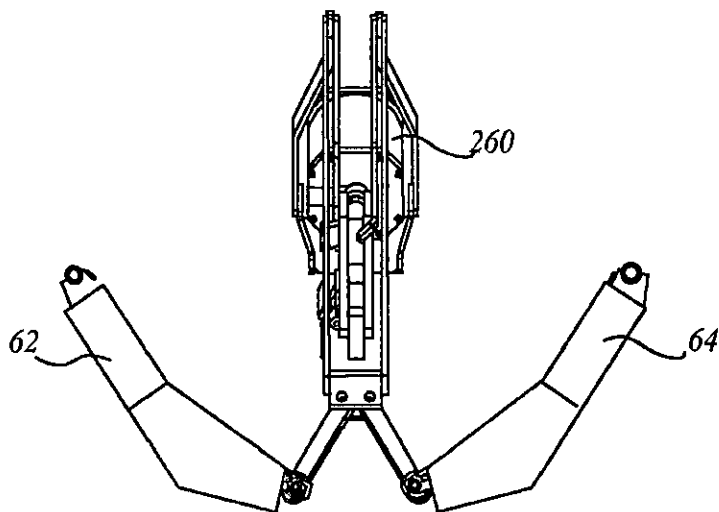


Figure 6b

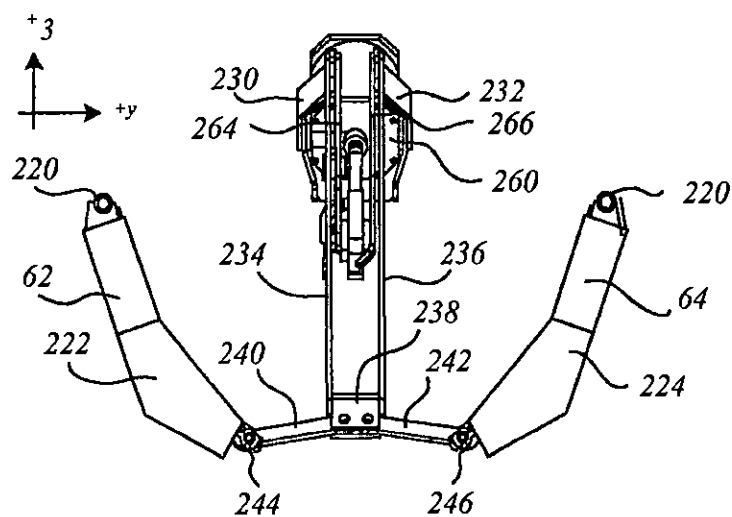
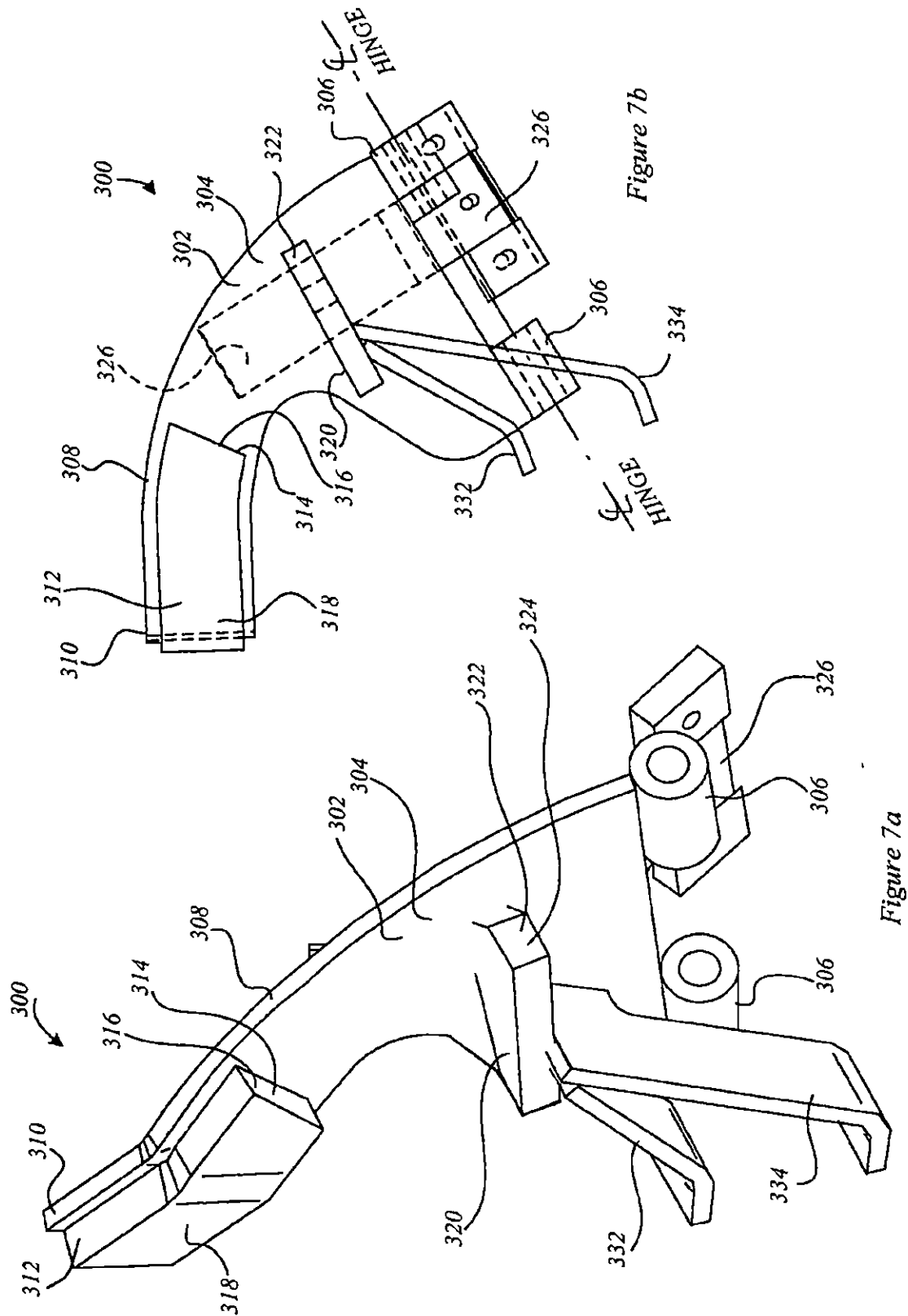


Figure 6a



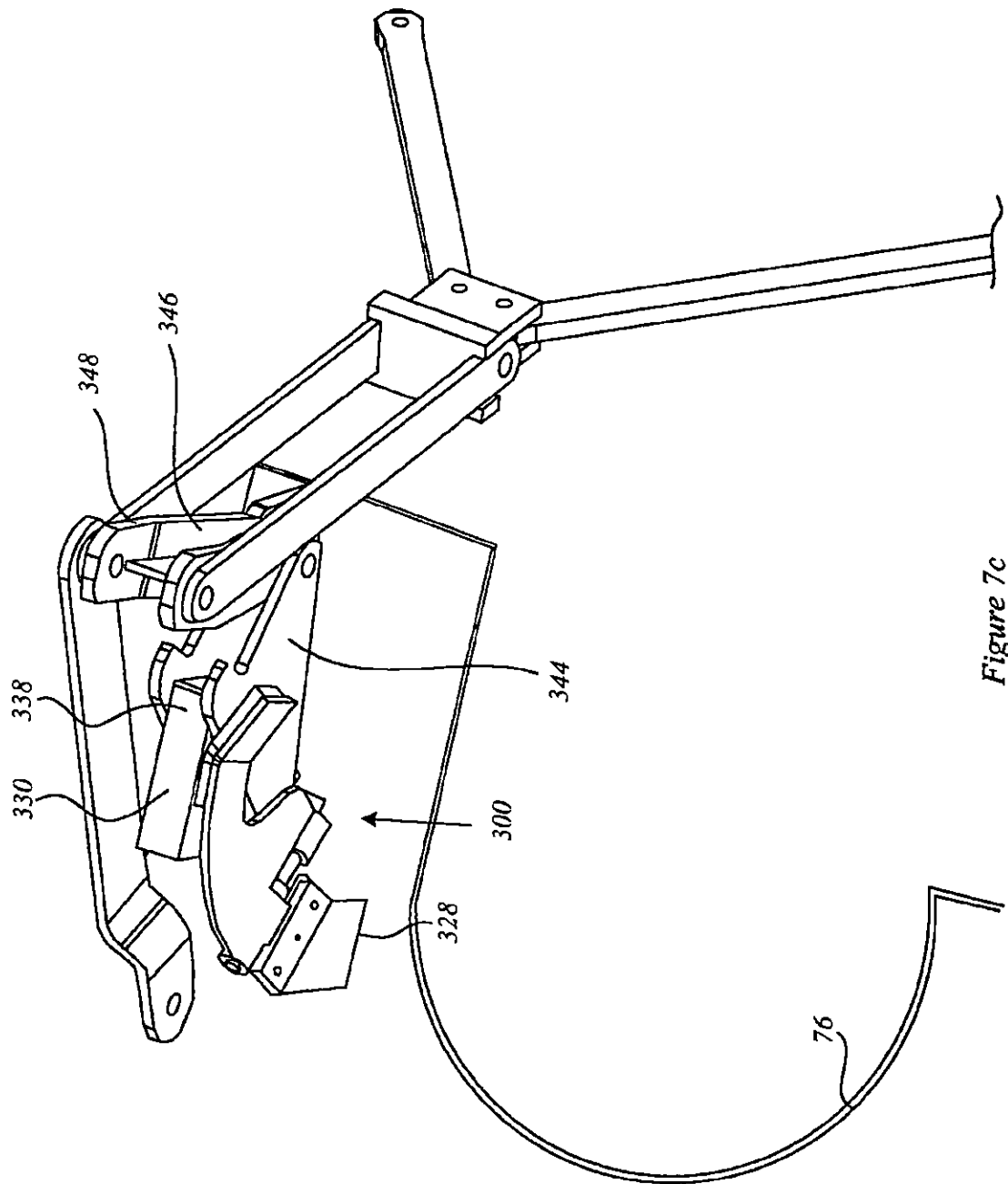


Figure 7c

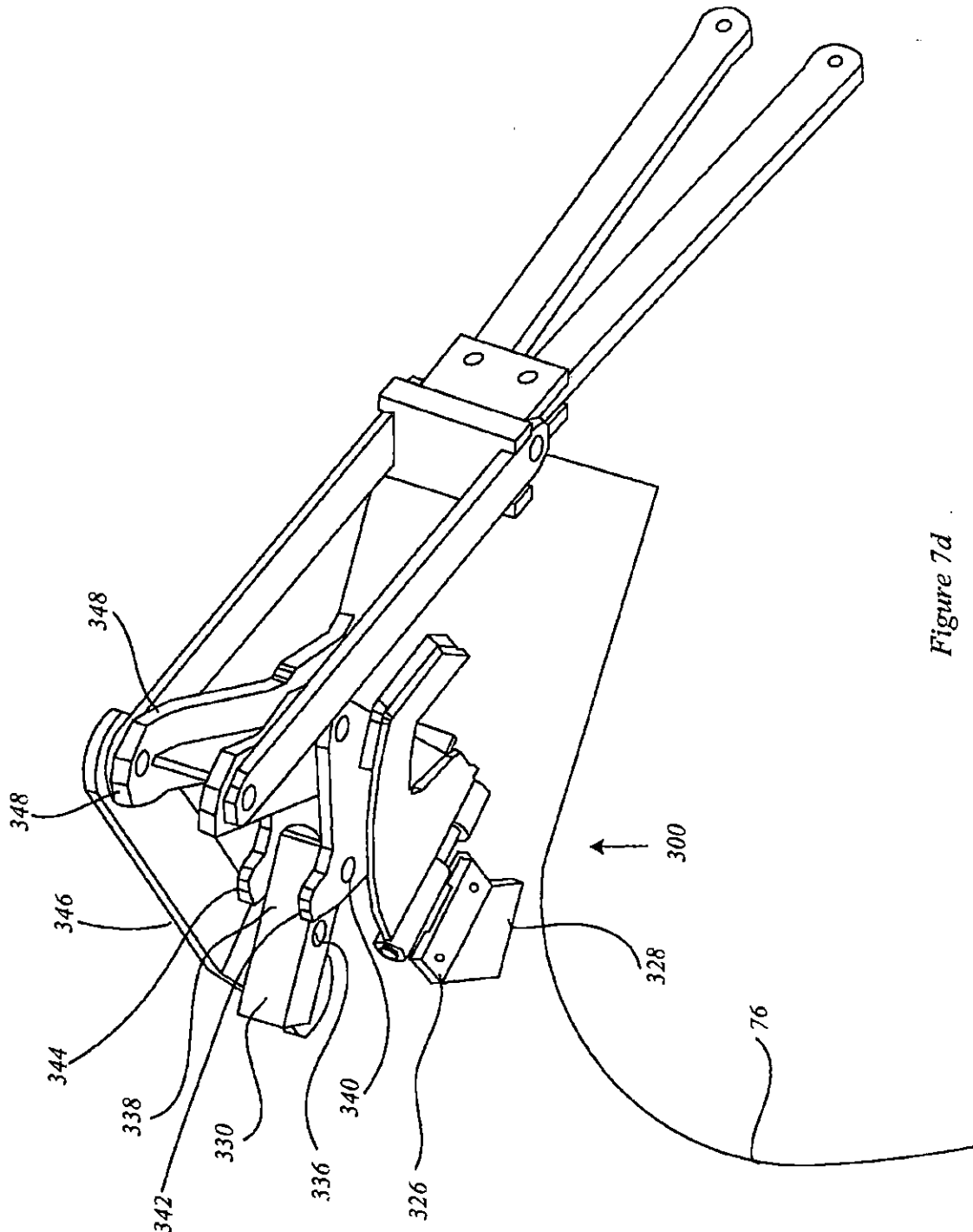


Figure 7d

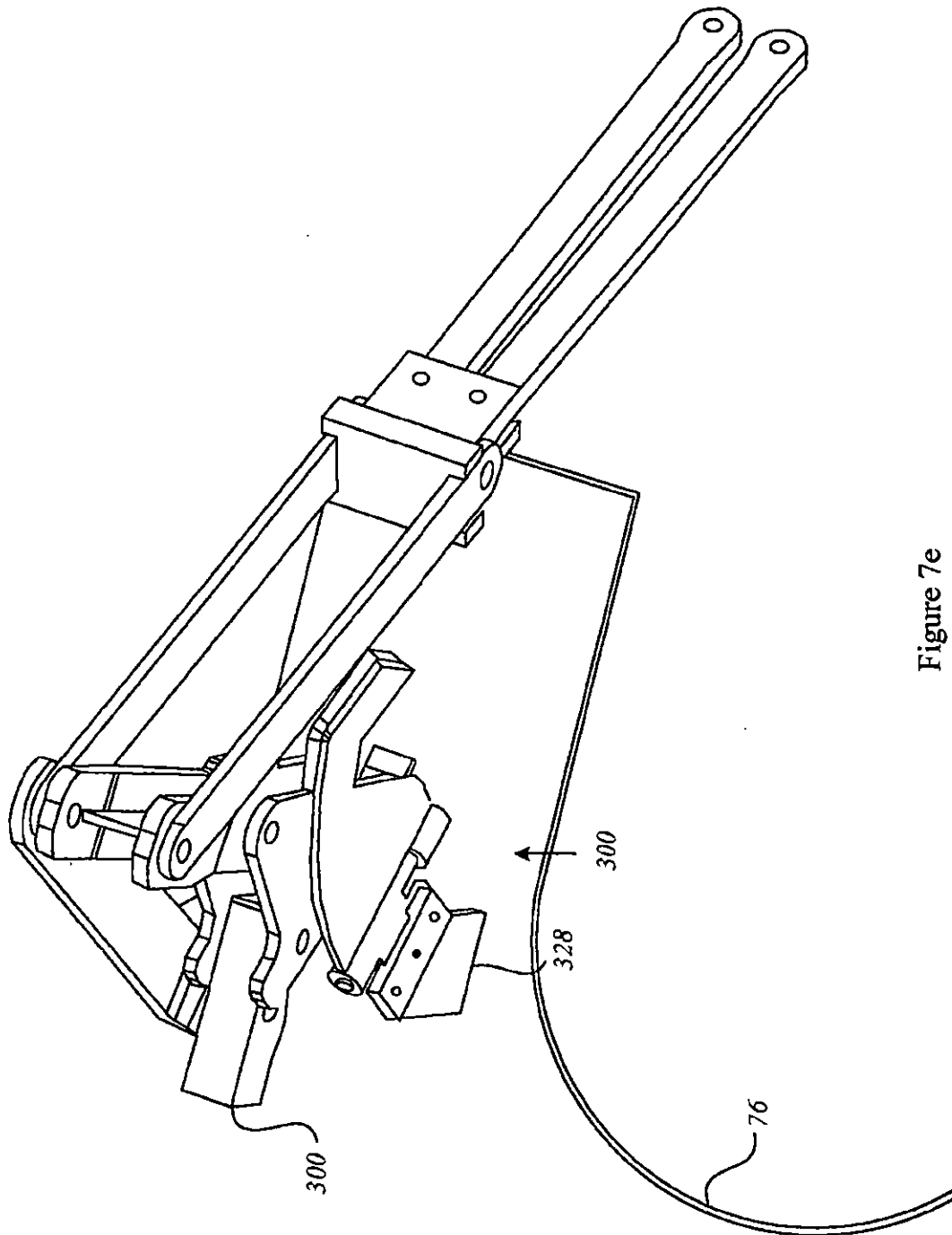


Figure 7e

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RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR

This application claims priority under 35 USC 119 on the basis of Canadian Patent Application Serial Number 2,678, 447, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 11, 2009, the specification of which is incorporated herein by reference. This application also claims priority to Canadian Patent Application Serial Number 2,678,605.

FIELD OF THE INVENTION

This invention relates to the field of railroad freight cars, and, in particular to rail road gondola cars such as may employ bottom unloading gates or doors.

BACKGROUND

There are many kinds of rail road cars for carrying particulate material, be it sand or gravel aggregate, plastic pellets, grains, ores, potash, coal or other granular materials. Many of those cars have an upper opening, or accessway of some kind, by which the particulate is loaded, and a lower opening, or accessway, or gate, or door by which the particulate material exits the car under the influence of gravity. While the inlet opening need not necessarily have a movable gate, the outlet opening requires a governor of some kind that is movable between a closed position for retaining the lading while the lading is being transported, and an open position for releasing the lading at the destination. The terminology "flow through" or "flow through rail road car" or "center flow" car, or the like, may sometimes be used for cars of this nature where lading, typically particulate lading, is introduced at the top, and flows out at the bottom.

Discharge doors for gondola cars or other bottom dumping cars may tend to have certain desirable properties. First, to the extent possible it is usually desirable for the door opening to be large so that unloading may tend to be relatively fast, and for the sides of any unloading chute to be relatively steep so that the particulate will tend not to hang up on the slope. Further, to the extent that the door can be large and the slope sheets steep, the interior of the car may tend to have a greater lading volume for a given car length. Further still, any increase in lading achieved will tend to be at a relatively low height relative to Top of Rail (TOR) and so may tend to aid in maintaining a low center of gravity. A low center of gravity tends to yield a better riding car that is less prone to derailment, and perhaps less prone to cause as much wear or damage to tracks.

For a given length of car, hopper volume, and hence overall car volume, can be maximized by reducing the proportion of the length of the car occupied by the trucks, and occupied by the door opening drive mechanism. Furthermore, where the lading to be carried by the car is of greater than usual density, it may often be helpful for the truck center length to be relatively short such that the length of the span between the trucks is smaller, and the weight of the structure may be correspondingly decreased relative to the maximum permissible gross weight on rail for the car. In some instances, as with iron ore or other high density lading, that truck center distance may be very short.

It may also be that in some circumstances ore cars are used in quasi-permanent sets that form a unit train. The unit train may tend to follow a single route for substantially its entire operational service life. In the case of an ore car, that operational route may be from a mine or concentrator facility, at

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which the cars receive the lading; to a discharge facility, whether a mill or a break of bulk terminal at a port. In these circumstances the line may be owned by the mine or mill, and the cars may not necessarily be used for interchange service. To the extent that they are not used for interchange service they may not necessarily comply with all AAR standards. The cars may have short, possibly non-standard draft sills, draft gear, and couplers, or a combination thereof.

The cars may have tightly limited space envelopes over the end shear plates, and yet these spaces may nonetheless be intended to accommodate, for example, the brake reservoir and pneumatic gear for operating the gondola discharge doors.

SUMMARY OF THE INVENTION

In an aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a door movable between a closed position for retaining lading and an open position for permitting egress of lading. The hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has at least a first end slope sheet inclined downwardly in the lengthwise direction toward the door. There is a linkage connected to the door. The linkage is oriented lengthwise with respect to the car. A drive is connected to the linkage. The drive is operable to move the linkage and thereby to urge the door to a closed position. The linkage is movable from a first position corresponding to the open position of the door to a second position corresponding to the closed position of the door. The linkage includes at least a drag link. When the linkage moves from the first to the second position one of (a) the overall motion from the first to the second position includes displacement of the drag link in a direction having a predominant component of motion parallel to the first end slope sheet; and (b) the motion of the drag link is at least instantaneously parallel to the first end slope sheet.

In another feature of that aspect of the invention the linkage includes a first pivot arm pivotally connected to a datum structure at a first pivot connection. The drive is also mounted to the datum structure. The linkage includes a second pivot arm pivotally connected to the datum structure at a second pivot connection. The second pivot arm has the door mounted thereto. The first pivot arm has a second connection distant from the first pivot connection. The second pivot arm has a second connection distant from the second pivot connection. A mechanical transmission is mounted between the second connection of the second pivot arm and the second connection of the first pivot arm. The mechanical transmission includes the drag link. The drive is connected to move the first pivot arm, and, in moving from the first position to the second position, each position of the first pivot arm being associated with a unique position of the drag link. In a further feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connections. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. Each second pivot arm has a respective second con-

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nection distant from the respective second pivot connection. A mechanical transmission is mounted between the respective second connections of the second pivot arms and the respective second connections of the first pivot arms. The drag link is a left hand drag link, and the mechanical transmission includes a mated parallel right hand drag link. The left and right hand drag links each have a first end mounted to one of the respective second connections of the first pivot arms. The left and right hand drag links have second ends yoked together distantly from the first ends. The transmission member includes left and right hand slave links extending between and connecting the second ends of the drag links to the second connections of the second pivot arms respectively.

In still another feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. The left and right hand pivot arms co-operate to define a bifurcated lever straddling the drive. In yet another feature, the drive includes an actuating cylinder having an axially reciprocating member, the axially reciprocating member being inclined relative to horizontal. In still another feature the drag link lies between the actuating cylinder and the first end slope sheet of the hopper. In another feature the railroad hopper car includes a first end section, the first end section includes a draft sill and a substantially horizontal shear plate mounted over the draft sill, the drive includes an actuating cylinder having an axis of reciprocation lying in a central vertical-lengthwise plane of the car, the actuating cylinder is mounted above the shear plate, the first end slope sheet at least partially overhangs the actuating cylinder; and the drag link is located between the actuating cylinder and the first slope sheet.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. The car includes structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. A door operating linkage is connected to the gate, the door operating linkage being oriented lengthwise with respect to the car. An actuating cylinder connected to drive the door operating linkage, the actuating cylinder also being oriented to act lengthwise with respect to the car, the actuating cylinder having an axis of reciprocation. The axis of reciprocation being tilted such that displacement of the actuating cylinder includes a vertical component of motion.

In another feature of that aspect of the invention, the hopper car includes an end section mounted over one of the trucks, the end section includes a substantially horizontal shear plate, and the actuating cylinder is mounted on a pedestal mounted to the shear plate, the pedestal including an inclined mounting for the cylinder. In a further feature, the railroad hopper car has a longitudinal-vertical central plane, and the axis of reciprocation lies in the longitudinal-vertical plane. In a still further feature, the hopper includes at least a first end slope sheet extending longitudinally and being inclined longitudinally inboard and downwardly toward the gate, and at least part of

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the actuating cylinder is overhung by at least part of the first end slope sheet. In a yet further feature, the hopper car includes an end section having a substantially horizontal shear plate mounted over a draft sill. The hopper includes a first end slope sheet, the first end slope sheet at least partially overhanging the horizontal shear plate. The actuating cylinder is mounted above the shear plate, centrally aligned over the draft sill. The actuating cylinder is at least partially overhung by the first end slope sheet. In still yet another further feature the first slope sheet is substantially planar and has a first angle of inclination relative to horizontal. The actuating cylinder is inclined longitudinally inboard downwardly, and is inclined at a second angle. The second angle lies between horizontal and the first angle. In yet another feature the car has an underframe and the door operating linkage includes a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, the first pivot linkage being a first pivot arm constrained to pivot on an axis of rotation oriented horizontally cross-wise relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and includes at least the gate. The third linkage component includes a drag link element connected to the first pivot arm, the drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator. In still another feature the main pivot connection of the first pivot arm to the first linkage component is located lower than the actuating cylinder. In yet still another feature, the drag link element is connected to the first pivot arm at a distal pivot connection relative to the main pivot connection, and, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection.

In another aspect there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. It has first and second end sections to which the hopper is mounted, the first and second end sections being mounted to respective first and second railroad car trucks for rolling motion along railroad tracks in a lengthwise direction of the car. There is a door operating linkage connected to the gate, the door operating linkage being oriented lengthwise with respect to the car and connected. An actuating cylinder is connected to drive the door operating linkage. The actuating cylinder is also oriented to act in a lengthwise extending plane with respect to the car. The actuating cylinder has an axis of reciprocation. The door operating linkage includes a first pivot arm pivotally mounted to the first end section at a first pivot connection. There is a mechanical transmission connected between the first pivot arm and the gate. The mechanical transmission includes at least a drag link movably connected to the first pivot arm at a location distant from the first pivot connection. The first pivot connection is lower than the actuating cylinder as seen when viewing the first end section in side view.

In another feature of that aspect of the invention, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot con-

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nection and the distal pivot connection. In still another feature, the actuating cylinder drives an intermediate lever that is connected to drive the first pivot arm.

In another aspect of the invention there is a rail road hopper car. It has a hopper carried between a pair of trucks, the hopper having first and second upstanding sidewalls running lengthwise therealong. The hopper has a lower discharge and convergent slope sheets giving onto the discharge. The rail road car has a side sill and a top chord. The first upstanding sidewall extends from the side sill to the top chord. The first upstanding sidewall has a predominantly upwardly running sidewall stiffener mounted thereto. The sidewall stiffener is located at a longitudinal station intermediate the trucks. The first upstanding sidewall has a first region, the first region being a lower region thereof. The first upstanding sidewall has a second region. The second region is an upper region thereof. The sidewall stiffener has a first portion, the first portion being a lower portion thereof. The first portion is mounted to the first region of the first upstanding sidewall. The sidewall stiffener has a second portion, the second portion being an upper portion thereof. The second portion is mounted to the second region of the upstanding sidewall. The first portion of the first upstanding sidewall stiffener is laterally outboard of the first region of the first upstanding sidewall. The second portion of the sidewall stiffener is laterally inboard of the second region of the first upstanding sidewall. The sidewall has a continuous section between the first and second regions thereof. The sidewall stiffener has web continuity between the first and second portions thereof.

In a feature of that aspect of the invention, the first and second portions of the sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and the stiffener has vertical web continuity through the transition portion. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof. The hopper includes first and second sloped side sheets. The first sloped side sheet meets the first sidewall at the transition portion. In another feature, the first sidewall has an overall height from the side sill to the top chord, L , and the transition is located a distance above the side sill that is in the range of $\frac{1}{4}$ to $\frac{3}{5} L$. In a still further feature the first sidewall has an overall height from the side sill to the top chord, L , and the first sloped sheet meets the transition at an height that is in the range of $\frac{1}{4}$ to $\frac{3}{5} L$ above the side sill.

In a further aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge having a bottom discharge governor movable between a closed position for retaining lading and an open position for permitting egress of lading. The car has structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has a door operating linkage oriented lengthwise with respect to the car. There is an actuating cylinder also oriented to act in a lengthwise extending plane with respect to the car, the actuating cylinder being connected to drive the door operating linkage. The door operating linkage includes a pair of first and second linkage members co-operably mounted to either transverse

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side of the actuating cylinder, whereby the actuating cylinder is bracketed by the linkage members.

In another feature of that aspect of the invention, the car has an underframe and the linkage is a closed loop bar linkage in which there is a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, and which includes the first and second linkage members, the first and second linkage members being a matched pair of left and right hand pivot arms constrained to pivot on a common axis of rotation relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and which includes at least one pivotally mounted door assembly defining the bottom discharge governor. The third linkage component includes a drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator.

In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. Displacement of the third linkage component associated with motion of the door assembly between the open position is predominantly in a direction generally parallel to the end slope sheet. In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. During at least an instantaneous portion of motion of the third linkage component while the door assembly is in a position between the open position and the closed position the third linkage component moves parallel to the end slope sheet. In still another feature the third linkage component includes at least a first element and a second element mounted thereto. The first element is pivotally mounted to the first linkage component, and is constrained to move in a lengthwise-vertical plane relative to the first linkage component. The second element has a first connection to the first component the first connection being a pivot connection. The second element has a second connection to the fourth linkage component, the second connection having at least one degree of freedom of motion. The second element is constrained always to be coplanar with the first connection, the second connection, and the main pivot connection. In yet still another feature, the bottom discharge governor includes a door. The actuating cylinder is connected to drive the door operating linkage through a lever assembly. The lever assembly has an over-center lock that is operable to prevent release of the bottom gate to the open position when the actuating cylinder is inactive. In yet a further feature, motion of the first pivot linkage occurs in a longitudinal-vertical plane. The second pivot linkage moves in a plane generally cross-wise to the longitudinal-vertical plane. In still a further feature the main pivot connection is beneath the actuating cylinder when the hopper car is seen in side view. In again another feature one of (a) the main pivot is beneath the drag link element; and (b) the actuating cylinder is between the main pivot and the drag link element. In a yet still further feature, the hopper includes at least a first end slope sheet, and the bottom discharge governor includes a door. The first end slope sheet is inclined longitudinally

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downwardly and inboard toward the door. The drag link element is inclined on a slope predominantly parallel to, and adjacent to, the first end slope sheet. The actuating cylinder is oriented along the lengthwise direction, and is also tilted longitudinally downwardly and inwardly toward the door.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper carried by railroad car trucks for motion in a lengthwise direction of the car along railroad tracks. The hopper has a bottom discharge. The bottom discharge has a door movable between a closed position for retaining lading and an open position for permitting egress of lading. A mechanical transmission is connected to the door. The mechanical transmission is oriented lengthwise with respect to the car. A door actuator is connected to the mechanical transmission and is operable to urge the door from the open position toward the closed position, the door actuator being oriented to reciprocate in a first direction. The hopper car has a first lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. The hopper car has a second lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator.

In another feature of that aspect of the invention, the car has a central lengthwise-vertical plane, the door actuator is positioned to reciprocate in the central lengthwise-vertical plane, and the second lock is movable between the engaged and disengaged positions in motion predominantly transverse to the central lengthwise-vertical plane. In another feature, the second lock is mounted on an hinge and pivots in a circumferential direction between the engaged and disengaged positions. In still another feature the second lock is mounted on an hinge, the hinge has an axis lying parallel to the lengthwise vertical plane, and the second lock pivots circumferentially between the engaged and disengaged positions. In another feature, the second lock is biased toward the engaged position. In still another feature, the second lock is biased toward the engaged position. In yet another feature the apparatus is one in which one of: (a) the second lock has a cam and the actuator has a mating cam follower; and (b) the second lock has a cam follower and the actuator has a mating cam. The cam and cam follower are co-operable, and are oriented to deflect the second lock away from the engaged position as the door moves from the open position to the closed position thereof.

In another aspect of the invention, there is a lock mechanism for a door actuating transmission of a railroad gondola car, the door actuating transmission including a reciprocating actuating cylinder mounted to a datum structure, the cylinder being movable forward and backward in an axial direction. The lock mechanism has a body having a first fitting, a second fitting and a third fitting. The first fitting is a mounting by which to connect the lock mechanism to the datum structure. The second fitting is one of (a) a cam for co-operation with a member of the door actuating transmission, that member being a cam follower; and (b) a cam follower for co-operation with a member of the door actuating transmission, that member being a cam. The third fitting includes an abutment for co-operation with a mating fitting of the door actuating transmission. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door

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actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction.

In another feature, the lock mechanism there has a bias member oriented to urge the third fitting toward the first position thereof. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure. In another feature, the first degree of freedom of motion is an angular degree of freedom, and the predominantly cross-wise motion is predominantly circumferential motion about an axis of rotation. In a feature the first fitting is an hinge, the axis of rotation is an axis of rotation of the hinge, and the axis of rotation of the hinge is substantially parallel to the axial direction of the door actuating transmission. In still another further feature, the first fitting of the lock mechanism includes an hinge and a footing of the hinge for mounting to the datum structure. The axis of rotation is an axis of rotation of the hinge, and the footing has a substantially planar footprint. The axis of rotation of the hinge is angularly inclined relative to the substantially planar footprint. In yet another feature, the lock mechanism has all or any combination of the forgoing additional features.

In still another aspect of the invention there is a railroad hopper car for carrying particulate material. The hopper car there has a hopper and first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction. The hopper is suspended between the first and second end sections. The hopper has a discharge section through which to release lading, and first and second end slope sheets oriented toward the first and second end sections, the slope sheets being inclined in the longitudinal direction to feed the discharge section. The first end section includes a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to either side of the draft sill, and a shear plate mounted to the draft sill and to the main bolster. The shear plate extends lengthwise along the draft sill and cross-wise from side to side of the hopper car. The first end slope sheet of the hopper overhangs the shear plate of the first end section. The hopper car is free of primary structure directly above the shear plate of the first end section under the overhang of the first slope sheet of the hopper.

In another feature of that aspect of the invention, there is one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall. In another feature, the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. In a further feature, the bolster has first and second laterally outboard distal ends, and

the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet.

In still another feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. In another feature, one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall; the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. The bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. The hopper car has a machinery space bounded by (a) the first slope sheet; (b) the shear plate of the first end section; (c) the end post; and (d) the corner posts, and the machinery space is free of any other primary structure.

In yet another feature the hopper car has at least one longitudinally hinged discharge door, the discharge door being movable cross-wise between open and closed positions. A longitudinally acting pneumatic actuator is at least partially lodged in the machinery space directly above the draft sill. In still yet another feature a brake reservoir is also at least partially lodged in the machinery space. In a yet further feature the shear plate is mounted above and to the main bolster and defines an upper flange thereof. The main bolster has a lower flange downwardly spaced from the upper flange, the lower flange terminating at respective distal end portions at either side of the car. The car includes a side sill running along the car between the first and second end sections. The side sill has an upper flange, the upper flange of the side sill being substantially co-planar and connected to the shear plate. The side sill has a lower flange, the lower flange of the side sill being substantially co-planar with a respective one of the distal end portions of the lower flange of the main bolster. In another further feature, the shear plate defines an upper flange of the draft sill whereby the draft sill upper flange, the shear plate and the side sill upper flange are all substantially co-planar. In another feature the machinery space is free of elephant ears.

In a further aspect of the invention there is a railroad freight car having a freight car body for carrying lading, the body being mounted on railroad car trucks for rolling motion in a longitudinal direction along railroad tracks. The car body includes a draft sill having a draft gear pocket for accommodating draft gear, and a shear plate overlying the draft sill and functioning as an upper flange of the draft sill. The draft sill has an inboard end oriented toward a truck center of one of the trucks, and an outboard end terminating at a striker. The draft sill has an underside and an access opening formed in the underside to admit entry of draft gear into the draft gear pocket from below. The car has a draft gear carrier plate. The carrier plate is mounted to the underside of the draft sill beneath the draft gear pocket. The carrier plate is removable to permit installation of the draft gear into the draft gear pocket. The car body has one of (a) an aperture formed in the shear plate over an inboard end region of the draft sill, the aperture permitting a portion of the draft gear to protrude upwardly therethrough during installation in the draft gear pocket; and (b) a coupler carrier seat defined in the draft sill

longitudinally inboard of the striker, and a coupler carrier co-operable therewith, the coupler carrier being removable to permit installation of draft gear in the draft pocket, and, when the coupler carrier is installed, the coupler carrier providing a support for a coupler shank when the coupler shank is connected to the draft gear within the draft sill.

In another feature of that aspect of the invention the freight car has both (a) and (b). In another feature, there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In still another feature, the draft sill has a pair of vertically oriented, longitudinally running spaced apart side webs. The webs have a greater depth of section adjacent to the striker. The webs have respective first and second apertures formed therein. The first and second apertures define the draft gear retainer seat, and the retainer is a sideways slidable shaft that is movable to extend across the draft sill between the first and second apertures in the draft sill side webs. In a further feature there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In another further feature the draft sill has a centerplate centered on the truck center, rear draft stops are welded within the draft sill, and at least a portion of each of the rear draft stops extends longitudinally inboard of the truck center. In still another further feature, the car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of less than 50 inches; and (b) the freight car has a truck center to coupler pulling face length of less than 65 inches when the draft gear is fully extended in draft. In another feature, the railroad freight car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of about 38 inches (+/-2"); and (b) the freight car has a truck center to coupler pulling face length of about 53 inches (+/-2") when the draft gear is fully extended in draft.

These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations.

BRIEF DESCRIPTION OF THE FIGURES

The description is accompanied by a set of illustrative Figures in which:

FIG. 1 is a general arrangement, isometric view of a railroad freight car according to an aspect of the invention with all ancillary systems removed to leave only primary structure visible;

FIG. 2a is an isometric view of a sidewall of the gondola car of FIG. 1;

FIG. 2b shows a side view of the sidewall of FIG. 2a;

FIG. 2c shows an end view of the sidewall of FIG. 2a;

FIG. 3a shows a perspective view of the end structure of the railroad freight car of FIG. 1;

FIG. 3b is a side view of the structure of FIG. 3a;

FIG. 3c is a detail of the end structure of FIG. 3b, with the near side web of the draft sill removed to show the draft stop, center plate, and coupler relationship.

FIG. 4a is an isometric view of a portion of the door opening mechanism for the railroad car of FIG. 1 in a fully open position;

FIG. 4b is an isometric view of a portion of the door opening mechanism for the railroad car of FIG. 1 in an intermediate position;

FIG. 4c is an isometric view of a portion of the door opening mechanism for the railroad car of FIG. 1 in a fully closed position;

FIG. 5a is a side view of the door opening mechanism of FIG. 4a;

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FIG. 5b is a side view of the door opening mechanism of FIG. 4b;

FIG. 5c is a side view of the door opening mechanism of FIG. 4c;

FIG. 6a is an end view of the door opening mechanism of FIG. 4a;

FIG. 6b is an end view of the door opening mechanism of FIG. 4b; and

FIG. 6c is an end view of the door opening mechanism of FIG. 4c;

FIG. 7a is a perspective view of a secondary lock mechanism for the door opening mechanism of FIG. 4a;

FIG. 7b is a plan view of the mechanism of FIG. 7a;

FIG. 7c is a perspective view of the mechanism of FIG. 7a when the door are open

FIG. 7d is a view similar to FIG. 7c, of the mechanism of FIG. 7a in a deflected condition; and

FIG. 7e is a perspective view of the mechanism of FIG. 7a in a locked position;

DETAILED DESCRIPTION

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings may be taken as being to scale unless noted otherwise.

The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the rail road industry in North America. Following from decision of the CAFC in *Phillips v. AWH Corp.*, the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record in accordance with *In re Lee*, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years experience in the industry in North America or in other former territories of the British Empire and Commonwealth.

In terms of general orientation and directional nomenclature, for rail road cars described herein the longitudinal direction is defined as being coincident with the rolling direction of the rail road car, or rail road car unit, when located on tangent (that is, straight) track. In the case of a rail road car having a center sill, be it a stub sill or a straight-through center sill, the longitudinal direction is parallel to the center sill, and parallel to the top chords. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail, TOR, as a datum. In the context of the car as a whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, or of the centerline of a centerplate at a truck center. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit.

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Pitching motion is angular motion of a railcar unit about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the rail road car described herein may tend to have both longitudinal and transverse axes of symmetry, a description of one half of the car may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. In this description, the abbreviation kpsi stands for thousand of pounds per square inch. To the extent that this specification or the accompanying illustrations may refer to standards of the Association of American Railroads (AAR), such as to AAR plate sizes, those references are to be understood as at the earliest date of priority to which this application is entitled.

Bottom dumping hopper cars, of which ore cars and coal cars may be examples, may tend to have either longitudinal doors or transverse doors. Longitudinal doors are oriented such that the doors operate on hinges or axes of rotation that are parallel to the direction of travel of the railroad car generally. U.S. Pat. No. 4,250,814 of Stark et al., issued Feb. 17, 1981 and U.S. Pat. No. 3,800,711 of Tuttle, issued Apr. 2, 1974 show cars with longitudinal doors. By contrast, transverse doors are ones in which the axes of rotation of the hinges or other pivots tend to be predominantly cross-wise to the direction of travel, most often perpendicular to it. An example of a transverse door car shown in U.S. Pat. No. 4,843,974 of Ritter et al, issued Jul. 4, 1989.

FIG. 1 shows an isometric view of an example of a rail road freight car 20 that is intended to be representative of a range of rail road cars in which one or more of the various aspects of the present invention may be incorporated. While car 20 may be suitable for a variety of general purpose uses, it may be taken as being symbolic of, and in some ways a generic example of, a flow through car, in which lading is introduced by gravity flow from above, and removed by gravity discharge through gated or valved outlets below. Flow through, or center flow cars may include open topped hopper cars, grain cars, plastic pellet cars, potash cars, ore cars, coal gondolas, and so on. In one embodiment car 20 may be a hopper car such as may be used for the carriage of bulk commodities in the form of a granular particulate, be it in the nature of relatively coarse gravel or fine aggregate in the nature of fine gravel or sand or various ores, ore concentrate or coal. The principle, or primary, structure of car 20 may be symmetrical about both its longitudinal and transverse, or lateral, centerline axes. Consequently, it will be understood that the car has first and second, left and right hand side beams, bolsters and so on.

By way of a general overview, car 20 may have a car body 22 that is carried on trucks 24 for rolling operation along railroad tracks. Car 20 may be a single unit car, or it may be a multi-unit car having two or more car body units, where the multiple car body units may be substantially permanently connected at an articulated connector, or by draw bars, as opposed to by ordinarily releasable AAR couplers. Car body 22, and the various structural members and fittings described herein may be understood to be typically of metal construction, whether welded or Huck™ bolted, or riveted together, the metal members being most typically steel, stainless steel, or aluminum, as may be appropriate. Some car builders have also used reinforced plastic composites for car elements, and those materials could also be employed where suitable. The default construction may be taken as being steel, of which the majority may be mild steel having, typically, a 50 kpsi yield. Car body 22 may have a lading containment vessel or shell 26 such as may include an upstanding wall structure 28 which

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may have a pair of opposed first and second end walls 30, 32, that extend cross-wise, and a pair of first and second side walls 34, 36 that extend lengthwise, the end walls 30, 32 and side walls 34, 36 co-operating to define a generally rectangular form of peripheral wall structure 28. Wall structure 28 may include top chords 38 running along the top of the walls, and side sills 40 running fore-and-aft along lower portions of the side sheets or side sheet assemblies 42 of side walls 34, 36. In some instances, such as that of the illustration of FIG. 1a, car 20 may have stub center sills 44 at either end, in which case side walls 34, 36 may act as deep beams, and may carry vertical loads to main bolsters 90 that extend laterally from the centerplates. In the case of a single, stand alone car unit, draft gear and releasable couplers may be mounted at either end of the stub center sill. In a center flow, or flow through car, the upper portion of the car may typically include means by which to admit lading under a gravity drop system. Such an intake 46, or entryway may be a large rectangular opening such as that bounded by top chords 38.

Car body 22 may include end sheets 48 and side sheets 50. Car 20 of FIG. 1 et seq., is illustrated as a car having a single hopper 52, a single hopper discharge section 54, and an outflow or discharge governor in the nature of a discharge door assembly 56. However, car 20 could, alternatively, be a multiple hopper car. In a multiple hopper car, the car may have laterally extending members or reinforcements, which may be cross-bearers, or cross-bearers with shrouds, or merely shrouds, particularly where the car is a multiple hopper car. These cross-members may run fully across the car from side sill to side sill, and may intersect the center sill, or the center sill shroud as may be. The car may also include upper wall bracing, in the nature of diagonal struts which extend diagonally upwardly and outwardly from the apices of the respective cross-members at the centerline of the car to upper regions of the side walls near or at the top chords; and lateral ties or struts that run across the car from sidewall to side wall to meet the upper ends of the diagonal struts at their wall brackets. Those brackets may be aligned with, and mated through the wall to, the vertical exterior posts that run from the side sill to the top chord and reinforce the walls.

End sheets 48 may be substantially planar slope sheets or slope sheet assemblies that are inclined downwardly in the longitudinally inboard direction to feed the discharge section. Not atypically, each pair of fore- and aft opposed slope sheets may be inclined at equal and opposite angles, and the angles of those sheets may be selected to be somewhat steeper than the free slope angle, or natural talus slope angle of the lading for which the car is designed, such that, when the gates are opened, the lading may tend to flow out, rather than sit at rest.

The primary structure of body 22 of car 20 includes lading containment vessel 26 which is in the nature of hopper 52. Hopper 52 has an upper portion 58 with substantially vertical wall panels, and a lower stationary portion defined by a set of converging sloped walls, namely the side and end slope sheet assemblies 48 and 50. At the lower margin of the sloped walls there is the outflow governor, namely door assembly 56, which, in this instance, may have the form of a pair of first and second, or left and right hand doors 62, 64. This containment structure seats on, and is carried by, a pair of first and second end structures, 66, 68, at either end of the car. End structures 66, 68 are in turn carried by trucks 24. A door operating apparatus or mechanism, or drive train, or transmission, however it may be termed, and identified generally as 70, is provided to move doors 62, 64 between open and closed positions.

Considering this structure in greater detail, trucks 24 are most immediately surmounted by center plates 72 of longi-

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tudinally extending stub sills 44. Stub sills 44 in turn carry laterally extending main bolster of main bolster 90. Arms 74 extended perpendicularly away from the centerplate 72, i.e., they are centered on the truck center, CL-Truck. Side sills 40 run lengthwise along the car between, and tie together, the most laterally outboard extremities of main bolster. A shear plate 76 is mounted in an x-y horizontal plane defining the top cover plate of stub sill 44. Shear plate 76 extends laterally from side sill to side sill, and longitudinally from the fore-and-aft end slope sheet 48 to the laterally extending end sill 78 of the car, which, in this instance may be an upturned flange formed on the longitudinally outboard margin of shear plate 76. In car 20, the primary structure includes an end post 80 and a pair of side or corner posts 82, 84.

End post 80 is rooted in shear plate 76 in line with center sill 44, and may have lateral webs or gussets aligned with the webs of stub sill 44 to provide vertical web continuity across shear plate 76. End post 80 then extends fully between shear plate 76 and top chord 86 of end wall 30 or 32, as may be. Corner posts 82 and 84 are rooted to, and stand upwardly from, the junction of the laterally outboard ends of left and right hand main bolster and side sills 40. Posts 82 and 84 extend upwardly from this junction to mate with various elements of the end and side walls, as may be described below.

As described in additional detail below, car 20 has an abnormally short distance from the striker 88 to the truck center, i.e., the CL of centerplate 72. Striker 88 is the vertical planar surrounding face plate at the outboard end of the stub sill 44. In the terminology of the industry, the portion of the center sill 44 (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center CL-Truck may also be referred to as the draft sill. In car 20, the short draft sill length, identified as L_{88} , leaves an anomalously small space in which to install other systems, such as the brake reservoir and the door operating pneumatic cylinder. Car 20 has an end of car machinery space, indicated generally as 75, that is bounded by shear plate 76 on the bottom, the sloped end wall assembly 30 or 32 of the car on the top, main vertical central end post 80, and main side posts 82, 84 at the ends of main bolster 90. This space may be referred to as having the shape, generally, of a triangular prism and is substantially unobstructed by the primary structure of the car. For the purposes of this description, primary structure is defined as the underframe, including side sills and center sill (i.e., including the draft sill), the side walls, the slope sheets and top chords, the hopper construction including the stationary parts of the discharge section, as well as any cross-bearers, cross-ties, bolsters, shear plates and so on. Primary structure excludes secondary or ancillary structure or systems such as ladders, cat-walks and other safety appliances, brakes, brake rods and brake fittings, air hoses, reservoirs and pneumatic fittings, movable door members, door operating linkages, and so on.

In existing cars, this space, 75, is often occupied or otherwise obstructed by other primary structure, such as so-called "elephant ears". In this context, "elephant ears" are large, substantially triangular planar plates, sometimes provided with central lightening holes, that have one edge fixed along the junction of the center sill webs and the center sill cover plate, and another edge welded to the end slope sheet. The third edge is typically a free edge. Often these plates lie in a plane that is oriented at an angle to the vertical—i.e., it leans laterally outboard. Car 20 avoids the use of these "elephant ears" and so provides the large unobstructed space shown in FIG. 1b.

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FIGS. 1 and 2a, 2b and 2c, all show the sidewall of the car, indicated generally as 34 or 36. Sidewall 34 and 36 function as short beams of low (e.g., less than 4:1, possibly less than 3:1) length-to-depth ratio. Sidewall 34 or 36 can be seen to have a bottom flange or chord member, namely side sill 40, a top flange or chord member, namely top chord 38, which may have the form of a square or rectangular hollow structural steel tube; and an intermediate shear force transfer web, namely side sheet assembly 42. Side sheet assembly 42 may include an upper sheet portion or member 92 that is welded to the outside face of top chord 38 at a lap joint, and that extends downwardly therefrom; and a lower sheet portion or member 94. Member 94 may have the form of a Z-section, having a first portion, namely an upper flange or leg or margin 96 that extends in a substantially vertical plane and has an uppermost margin that overlaps the lowermost edge or margin of member 92; a second or intermediate portion 98 that runs in an inclined plane sloping inwardly and downwardly on the slope of the hopper side sheets generally, and a third or bottom portion, namely bottom flange, or leg, or margin 100 that extends in a substantially vertical plane downwardly. Sidewall 34 or 36 also includes a central post, or web stiffener, 102 that has a lowermost first portion 104 an intermediate second portion 106, and an uppermost third portion 108.

Side sill 40 includes a channel 110 that is welded toes-inward against the lowermost marginal portion of lower leg 100 to form a closed section. The first or lowermost portion 104 of web stiffener 102 has the form of a quadrilateral gusset having a first edge welded to the upper leg of channel 110, a second edge welded to the vertical margin 100, a third edge welded to the sloping portion 98, and the fourth, laterally outboard, edge being free. As may be noted, portion 104 stands outboard of the sidewall sheet.

Portion 108 is a rectangular web stiffener that is welded to, and extends downwardly from, the underside of top chord 38 along the inside face of vertical web portion 92. Intermediate portion 106 is a web, or plate, or gusset, that is also a quadrilateral, having a first edge that overlaps, and is welded to, the lower margin of portion 108. A second edge is welded to the lower region of vertical web portion 92, and to the upper flange or leg 96. A third edge is welded along the sloped portion 98 of member 94. The fourth edge is free, and faces inwardly into the lading containment space of the hopper. Portions 104 and 106 are co-planar, or substantially co-planar, such that stiffener 102 has web continuity through member 94. The upper margin of the side slope sheet 50 of the hopper discharge section is welded to the lower margin of the inclined or sloped portion 98, such that the structure presents a continuous sloped surface for containing, and then slidably discharging, particulate lading. Expressed differently, the web of the sidewall traverses the sidewall stiffener, commencing on its inboard margin at side sill 40, traverses the web mid-way up the post, and ends along its outboard margin at top chord 38. In this arrangement, the vertical stiffener, 102, acts as the web of a T-section, and the local region of the wall section to which it is joined functions as the flange of that T-section.

In this example, the locus of intersection of the side slope sheet plane P_{94} with the plane of the side wall sheet P_{92} , lies above the level of side sill 40 by a substantial distance, indicated as L_{94} . This distance may lie in the range of $\frac{1}{4}$ to $\frac{3}{5}$ of the distance L_{50} from side sill 40 to top chord 38, and, in the particular may be about $\frac{1}{2}$ of that distance. Further, although the post has stiffening member web continuity in a vertical plane, the wall sheet traverses the stiffening web intermediate the top chord and the side sill, and does so obliquely on the slope of plane P_{94} .

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The upper leg of channel 110 forms the upper flange of side sill 40, and the lower leg of channel 110 forms the lower flange of side sill 40. Shear plate 76 forms the top flange of main bolster 90. Main bolster 90 also has a lower or bottom flange 91. In car 20 the upper leg of channel 110 is co-planar or substantially co-planar with, and is connected in flange continuity with, shear plate 76. Similarly, the lower leg of channel 110 is co-planar or substantially co-planar with, and connected in flange continuity with, bottom flange 91 of main bolster 90.

Continuing with the sidewall assembly, the main sheet, namely upper sheet portion 92, ends at the corners, and there are respective first and second end upper web stiffener portions and inwardly stepped plate members 112, which may be termed "ears". The top edge of each ear is welded to the inside face of top chord 38 in a lap joint. The longitudinally outboard end edge forms a plane to which the vertical end sheet of the end slope sheet wall abuts and is welded. The bottom edge follows the slope of, and is welded to, end slope sheet 48. The forward, transversely outwardly bent edge is welded to the upper end portion of side sheet assembly 42. The lower region of the main sidewall sheet also includes lightening apertures 114, in the space between the corner posts and the slope of the end slope sheets. Finally, the lower portion of region 100 of the main sidewall sheet has longitudinal extensions 116 that are welded to the side edges of the shear panel, namely shear plate 76, outboard of main bolster 90, thereby forming a portion of the peripheral flange of the shear plate.

End walls 30, 32 each include upper and lower sloped surface members 122 and 124, which could be made as a single piece, or as two pieces butt-welded together, as here. Upper member 122 has notches 126 formed therein to accommodate corresponding corner posts 82, 84 as may be, with local reinforcement doublers 128 at the junction. Lower portion 124 tapers in width to match the narrowing width between the sloped side sheets with which it mates. At the upper end of end wall 30 the end wall assembly includes a laterally extending first formed member 130 that has a first, vertical leg 132 that laps the inside face of the top chord 86, and a bent flange 136 that extends initially horizontally, with a distal lip bent upward to mate perpendicularly with the upper margin 138 of the end slope sheet 48. The distal tip of end slope sheet 48 is fillet welded to vertical leg 132. This results in a substantially triangular closed section defining a laterally extending end slope sheet reinforcement beam 140. The ends of this beam abut, are welded to, and are capped by elephant ears 112. Vertical leg 132 also lies against, and is welded to, end post 80.

A formed angle 142 is mounted toes-in at an intermediate height on sloped end wall 48, forming thereby another hollow section laterally extending end sheet reinforcement or beam 148. Vertical leg 144 of angle 142 is substantially aligned with the central web of the corner post (be it 82 or 84) and therefore also with the central web of the main bolster. Another formed angle 150 is welded toes-in to the back of sloped end wall 30 at the level of shear plate, thereby forming yet another slope-sheet reinforcement in the form of a laterally extending beam.

The corner posts 82 and 84 each have a lower corner post flange plate 160 (that includes a lifting lug aperture) that has a bottom tab welded to the outside, or back, of the end of side sill 40 in line with the main bolster, then an angled portion following the angle of the outside edge of the vertically extending side wall reinforcements, 161, to an upper end at the juncture of the side slope sheet with the side wall vertical leg of the lower side wall sheet. Each end post has two internal reinforcements 154. Each corner post also includes an intermediate member, or web, or gusset, or plate 162, which is

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considerably wider than intermediate gusset 106, and a substantially triangular inside edge web stiffener 164. Plate 162 is a quadrilateral. A first edge of plate 162 runs along the upward and outward slope of wall extension 166. A second edge runs vertically against the upper leg of wall extension 166. A third upper edge adjacent runs horizontally along lateral reinforcement beam 148. The fourth edge runs vertically downward to and along edge stiffener 164. As such, a vertical post is established.

Considering FIGS. 3a, 3b and 3c, center sill 44 includes a bottom flange or bottom cover plate 165, and a pair of spaced apart webs 168. The central region of shear plate 76 forms the top flange, or top cover plate of the center sill. At its inboard end, the center sill terminates centrally under the bottom lateral reinforcement of the end slope sheet 48. A draft pocket 175 is defined between webs 168, shear plate 76 and bottom cover plate 165 longitudinally inboard of the striker plate.

Center plate 72 is mounted at truck center CL-Truck, in line with main bolster 90 and the corner posts 82, 84. Rear draft stops 172 are welded within the center sill above center plate 72. As seen in FIG. 3c, the inboard end of rear draft stop 172 extends longitudinally inboard of the truck center. While this is known to have been used in at least one single piece, integrally cast draft sill, the inventor is unaware of such a construction in an all-welded fabrication draft sill assembly. The removable draft sill access cover plate, or draft gear carrier plate 174, which is bolted to the draft sill (i.e., the stub sill) bottom flange margins, is mounted immediately longitudinally outboard of center plate 72. Front draft stops 176 are, in turn, mounted longitudinally outboard of carrier plate 174. In this embodiment there is also a removable member, such as a top leeway or access plate 178, mounted to shear plate 76. Plate 178 is removed when draft gear 180 is removed or installed. On installation, draft gear 180, to which yoke 188 is already mounted, is fed into draft pocket 175 from below, on an angle, whereby the rear corner protrudes upwardly through the opening that is otherwise covered by plate 178. The front end of draft gear 180 is rotated into place, and the rear end is rotated downward. As this occurs, yoke 188 is also raised into place. Plates 178 and 174 are then reinstalled. The shank 182 of the coupler, 184 is inserted, and the coupler key 186 is fed through the slot in front draft stops 176 to link coupler 184, and yoke 188 in the customary manner. It may be noted that coupler 184 combines an AAR Type E shank with and AAR Type F knuckle with a bottom shelf. Draft gear 180 itself has abnormally short travel, namely about 2½ inches deflection before going solid, as compared to a "normal" deflection of over 3" before going solid.

Draft sill webs 164 have, at their longitudinally outboard end an end portion 190 of increased depth of section with a downwardly protruding bulge or horn, such as might be termed a "chin". End portion 190 has an aperture or slot 192 formed therein to permit lateral sliding insertion of a coupler support, carrier or bar 194 immediately behind striker plate 88. Removal of bar 194 permits yoke 188 to be swung into place during installation of draft gear 180. When coupler 184 is installed, the shank may rest on bar 194. Bar 194 is held in place by bolts that secure it relative to webs 164. Overall, a coupler installation of very short length is achieved. In this example, L_{ga} may be in the range of less than 50 inches, and in one embodiment may be about 38"±2", from the truck center to the outboard face of striker plate 88. An alternative expression of the relative compactness of the draft gear is that the length from the truck center to the pulling face of the coupler, when the draft gear is extended in tension, is in the range of less than 65 inches, and in one embodiment is in the range of 53"±2".

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Car 20 may also include a door opening mechanism 200. There are left and right hand, or first and second, doors 62, 64. Each door has a proximal, hinged edge 206, and a distal free edge 208. The hinges are carried on hinge fittings welded to mounting brackets depending from the slope sheets and side sills. The hinges run parallel to the longitudinal or lengthwise axis of the car, generally such that doors 62, 64 are longitudinal doors. Each door has the form of a hollow section beam, having a proximal beam 210 along the hinge side, a distal beam 212 along the free edge, internal cross-braces, not shown, and front and back skins or sheets or plates 214, 216. The hinges are indicated as 220, the end closure plates as 222, 224. The doors have door seal members 226, 228 that mutually engage when the doors are moved to a closed position. Seal members 226, 228 are sprung, such that when they are closed they deflect somewhat and in so doing take on a spring pre-load against each other. The door mechanism includes a pair of first and second, matched left and right hand pivot arms 230, 232; a corresponding pair of first and second drag links 234, 236; a shared yoke 238, and a pair of slave links 240, 242 that each pick up on a knuckle fitting 244, 246 of each of respective doors 62, 64. The whole assembly has left and right hand symmetry.

Inasmuch as, when tripped, doors 62, 64 open under the influence of gravity, particularly when assisted by the weight of the lading being discharged, one may consider the motion that occurs as the doors are closed in the sequence of views 4a, 4b, and 4c; 5a, 5b, and 5c; and 6a, 6b and 6c. Knuckles 244 and 246 are constrained by geometry to move in circular arcs of fixed radii in planes perpendicular to the respective axes of rotation of doors 62 and 64, those axes being the hinge axes of their respective hinges 220, which each lie in a plane parallel to the x-z plane of the car centerline. The plane of rotation of knuckles 244, 246 will then tend to be perpendicular to the central x-z plane. Slave links 240 and 242 are each of fixed length; each has an end pivotally connected at a two rotational degree of freedom knuckle, be it 244 or 246, as may be; each of slave links 240 and 242 has another end pivotally connected at a second pivot connection at yoke 238; and slave links 240 and 242 do not transmit a bending moment, and so therefore pull in pure tension. The upper, or near (i.e., proximal), ends of drag links 234, 236 are connected to the distal ends of pivot arms 230, 232 at pivot connections 248, 250, which may, if desired, share a common axis of rotation or pivot pin.

Yoke 238 is constrained by symmetry to pull in an x-z plane, which in the embodiment illustrated is the vertical plane of the centerline of the car. As such, movement of yoke 238 away from the plane of motion of knuckles 244 and 246 will necessarily draw knuckle fittings 244 and 246 closer together, and toward the vertical centerline plane of the car, eventually causing resilient door seals 226, 228 mutually to engage, thus closing the opening. This motion can be achieved by pulling on drag links 234, 236. Each pivot connection of slave links 240, 242 has a single angular degree of freedom. Similarly yoke 238 has an angular degree of freedom about the axis of rotation of the axle, or trunnions, by which it is pivotally mounted to the drag link, or drag links 234, 236. This gives the drag link connection two angular degrees of freedom in total. As the drag links are withdrawn, the slave links pull in tension, finding the natural hypotenuse between the plane of the arc of motion of knuckle fittings 244, 246 and the plane of motion of drag links 234, 236. Since this mechanism operates in tension, pivot connections 248, 250 and knuckle fittings 244, 246 are co-planar, with drag links

234, 236, yoke 238, slave links 240 and 242, and their associated pivot connections also lying in that same plane as well. (See FIGS. 5a, 5b, 5c).

Driving force for this system is provided by an actuator, identified as 260. Actuator 260 may be a pneumatic actuator, which may be charged by the pneumatic system of the train generally, as supplied through the pressurized air connection of the train line. Actuator 260 may include its own reservoir and check valve. Actuator 260 is connected to move a first member, in the nature of a primary driven pivot arm or lever, 262, which is in this instance actually a pair of matched lever arm members, which in turn is pivotally connected to, and drives, a second member in the nature of, a push rod, or, given the symmetrical nature of the assembly, a pair of left and right hand push rods 264 and 266. One or both of push rods 264, 266 may have a secondary member, such as may be an extending arm, or detent, or stop, or abutment, identified as an over-center travel limiter or governor, 268. The far ends of push rods 264, 266 may be connected to either pivot (or 232, as may be), or to drag link 234 (or 236, as may be). It may be convenient to connect the far end of push rods 264, 266 at the same pivot connection, or connections 248, 250.

Lever 262 has a first end pivotally mounted to primary structure of car 20 at footings, identified as mounting fixtures, fittings or brackets 270. The drive rod of actuator 260 picks up on lever 262 at an intermediate location, such that lever 262 provides magnification of displacement. Similarly, pivot arms 230, 232 have a first or base end pivotally connected to primary structure at mounting fixtures, fittings, or brackets 272. Actuator 260 is located on the centerline (i.e., in the central x-z plane) of car 20, between and in substance below pivot arms 230, 232. "Below" in this context may be thought of as radially more proximate to the pivot axis P_{270} of brackets 270 than is the pivot axis of connections 248, 250, as well as in the context of being lower than as in closer to Top of Rail. In the past the lever fitting has more commonly been mounted to the slope sheet such that the output pin is lower than the pneumatic cylinder. Turning this arrangement upside down, in effect, and fitting the cylinder may then permit a more compact installation than otherwise. Similarly, the pivot axis, P_{230} , of driven arms 230, 232 is below the output knuckle, i.e., at P_{250} , and is below the actuator cylinder as shown in FIG. 5b in which P_{250} lies below the center line CL_{260} or actuator 260. This may be taken in the sense of being further from the plane of the end slope sheets, identified as P_{48} . Expressed differently, actuator 260 lies between the base or datum pivot point P_{230} of driven arms 230, 232 and the plane P_{48} of end slope sheet 48.

As may be noted, the line of action of drag links 234, 236 has a predominant component that is substantially parallel to plane P_{48} . Expressed differently, at some point during mid-stroke, the line of action will be at least instantaneously parallel to plane P_{48} . Finally, it may be noted that rather than placing actuator 260 on shear plate 76, and orienting actuator 260 such that its longitudinal axis (i.e., the working axis or axis of reciprocation of the actuator), that actuator is itself raised upwardly from the shear plate and oriented to work along a line of action that is tilted downward and longitudinally inboard, the angle of tilt being identified as α_{260} . This angle of inclination lies in the range from horizontal to the angle of inclination of end slope sheet 48, identified in FIG. 5c as α_{48} . Placing the mounts and pivot points under the apparatus, raising the actuator cylinder, orienting it on an incline, and making the line of action or the zone swept by the draglinks in the progressions of FIGS. 4a, 4b and 4c (or 5a, 5b and 5c) tend to correspond to a displacement substantially or predominantly parallel to plane P_{48} , all aid in providing a

more compact installation, in particular one that is longitudinally short as may suit the short distance from the truck center to the striker. It is also an installation that may tend to leave space for other car systems, such as the brake system.

This arrangement may be thought of in terms of a four bar, or multi-bar, linkage. The first bar of the linkage may be thought of as being the underframe, and structure rigidly mounted to the underframe. This is the datum, or frame of reference member of the linkage. The second member or linkage component is the first pivot arm, 230 (or 232) having a fixed main pivot point, and an output distal pivot point constrained to move on a fixed radius about main pivot point P_{230} . The fourth component or element of the linkage is the second pivot arm, namely 62 or 64, each of which is a second lever or pivot arm mounted to a pivot axis fixed with respect to the first or datum link, and having a distal connection, in this case also a pivot connection, constrained to move in an arc of constant radius about the base pivot axis. The third linkage is the drag link. Although the drag link is made of two portions that are held together at yoke 238, the geometric symmetry of the assembly constrains both the upper portion of the drag link, (i.e., drag link 234, 236) and the lower portions, (i.e., slave links 240, 242) to be co-planar during closing of the doors. In any case, the single input of the actuator cylinder acting through the over-center links against the first pivot arm (at the distal pivot connection) produces a unique output geometry such that position of the elements is determinate as if it were a four bar linkage.

When the door opening apparatus is retracted to the position shown in FIGS. 4c, 5c and 6c, driven primary pivot arms and the over-center links are driven to a slightly over-center relationship such that the pivot connection between the primary pivot arms and the over center arms lies below a line drawn from the primary pivot axis and the over-center link output connection as axis P_{250} . In this condition tensile force on drag links 234 and 236 (as from weight placed on doors 62, 64, for example) will tend to urge the main driven pivot arms, namely lever 262, counter-clockwise as viewed in FIG. 4c. Motion in this direction is prevented by the over center stop, 268, thereby defining a first lock that prevents inadvertent opening of doors 62, 64 from moving to the open position when actuator 260 is dormant, i.e., inactive. This first lock is released by reversing actuator 260 to open the doors.

Car 20 has a secondary door mechanism, or secondary latching system, identified generally as 300. This secondary latch system, and, indeed, the door closure linkage apparatus of FIGS. 7a-7e, are slightly different from those shown in FIGS. 4a, 5a, and 6a. In latching system 300 there is a latch assembly 302, shown in FIGS. 7a and 7b. Assembly 302 includes a first member, or main member, or plate 304, which performs the function of a body or armature or spider that ties the other various physical elements of the assembly together. Along one edge plate 304 has physical motion constraint fittings, identified as hinge fittings 306, that limit plate 304 (and assembly 302 more generally) to a single degree of freedom, that single degree of freedom limiting plate 304 to motion of any point to motion in a plane perpendicular to the hinge axis, and in particular to pivotal motion in that plane about that axis. To the extent that the hinge axis is substantially or predominantly parallel to the axis of reciprocation of pneumatic actuator 260, that motion can be said to be sideways, or predominantly transverse of cross-wise to that direction of reciprocation.

Plate 304 has a portion or finger, or arm member 308 extending away from the hinge. In this case, arm member 308 extends arcuately away, and has a bent termination, or end, or lip, or tip, indicated at 310. Another member 312 in the form

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of a block is mounted, e.g., welded, at the distal end of arm member 308. Member 312 has the same general shape, a dog-leg bend, as tip 310. Member 312 has a first, generally inwardly (i.e., away from the tip) facing surface 314 that defines an abutment 316. Member 312 also has an oblique surface 318 that defines a wear or cam surface, which may be termed a reset cam, or return cam.

Another member 320, which may have the form of a plate or block, is welded to the major portion of the body of plate 304 relatively close to the hinge axis. The axially foremost face of member 322 is relieved—i.e., it does not define a face in a plane perpendicular to the hinge axis—or to the axis of reciprocation of the pneumatic actuator clevis. This face may be arcuate or chamfered, and so defines a first or deflection cam 324. That is, as installed, it lies in the path of actuator clevis 330. When the leading corner of clevis 330 encounters cam 324, plate 304 will tend to be urged to rotate, i.e., pivot, about its axis in the clockwise direction as viewed looking from actuator 260 toward hopper 52. Assembly 302 also includes a motion resisting, or return biasing member in the form of a spring, identified as leaf spring 326 that is anchored at the proximal end to stationary structure of the secondary lock footing, or base, 328 which is welded to shear plate 76. The footprint of base 328 against shear plate 76 is planar. The hinge axis is inclined relative to the plane as shown, the angle of inclination being substantially similar to, and possibly the same as, the mid-stroke angle of inclination of actuator 260 (which, itself, varies slightly during operation). The distal end of spring 326 bears against plate 304 distant from the hinge. Finally, assembly 302 includes reaction force transmission members 332, 334 in the form of welded flat bars that bear against, i.e., abut, the longitudinally outboard face of mounting fitting 270 when the latch is in the engaged position.

In operation, as actuator 260 works, lost motion is taken up in slot 336 of the distal or forward end 338 of the reciprocating actuator ram. Eventually the end of slot 336 engages a pivot pin 340 of bell crank arm 342 and causes driven member 344 (analogous to driven member 262), causing it to rotate counterclockwise as viewed in FIG. 7a. This forces push rods 346, 348 (analogous to push rods 264, 266) to act against connections 248, 250, and hence to force drag links 234, 236 along their retracting path. Since 262, 264, 230 and the car body form a four bar linkage, the output path of connections 248, 250 is determinate and unique.

While this happens, clevis 338 keeps moving rearward to engage reset cam surface 318, with the effect that assembly 302 is urged to rotate out of the way, against the resistance of spring 326 (FIG. 7d). Eventually the trailing portion of clevis 338 clears cam 324, and soon thereafter the most longitudinally inboard edge of driven member 344 clears abutment 316. Assembly 302 then moves under the influence of spring 326 into the locked position shown in FIG. 7e. In this locked position, any moment tending to pivot driven member 344 clockwise is reacted not by the hinge fittings, but rather by the reinforcements, namely members 332, 334. In this locked position driven member 344 and push rods 346, 348 are drawn to, and locked in, their over center position.

When the doors are to be released, actuator 260 moves in the opposite direction. The lost motion of the length of slot 336 reverses, such that the end of clevis 338 bears against the release cam, namely cam surface 324, which causes plate 304 to pivot away, and thus disengages abutment 316, moving it out of the path of driven member 262 against which it would otherwise abut. The outboard end of slot 336 then engages pin 340, releasing the over-center hold of driven member 344, and permitting the doors to open under the influence of gravity.

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The cams need not necessarily be on the plate, i.e., the latch body, but could be on the clevis, as shown at 350 in FIG. 4c. That is, it is to some extent arbitrary which part is identified as the cam, and which part is identified as the cam follower. The point is that the parts mutually engage such that the one intercepts the other during motion of the actuator cylinder to trip the door opening condition, with the result that the secondary latch is urged to deflect out of the way sideways. In the other direction, of course, the abutment relationship of items 262 and 316 prevents the doors from opening. The apparatus of FIG. 4c works in substantially the same way, and combines both arms of the bell crank driven member 344 into a single driven lever, namely lever 262.

In summary, car 20 has a first lock, the over center lock, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. Car 20 also has a second lock, symbolized by latching system 300, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator. Actuator 260 is positioned to reciprocate in the central lengthwise-vertical plane of car 20. Latching system 300 is movable predominantly transverse to the central lengthwise-vertical plane as it pivots in a circumferential direction between the engaged and disengaged positions. The hinge axis lies parallel to the lengthwise vertical plane, and the second lock pivots circumferentially. The second lock is biased toward the engaged position. The lock mechanism can be thought of as having a first fitting, a second fitting and a third fitting. The first fitting is the mounting, 238 by which to connect the lock mechanism to the datum structure. The second fitting is one of a cam or a cam follower for co-operation with a member of the door actuating transmission. The third fitting is the abutment, i.e., 316, that co-operates with a mating part of the door actuating transmission, in this case the side of lever 262. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure, namely shear plate 76. The first degree of freedom of motion is an angular degree of freedom, and is predominantly cross-wise circumferential motion. The axis of rotation is the hinge axis, which is substantially parallel to the axial direction of the door actuating transmission.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

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We claim:

1. A rail road hopper car comprising:

a hopper carried between a pair of trucks, said hopper having first and second upstanding sidewalls running lengthwise therealong;

said hopper having a lower discharge and convergent slope sheets giving onto said discharge;

said rail road car having a side sill and a top chord;

said first upstanding sidewall extending from said side sill to said top chord;

said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;

said first upstanding sidewall having a first region, said first region being a lower region thereof;

said first upstanding sidewall having a second region, said second region being an upper region thereof;

said sidewall stiffener having a first portion, said first portion being a lower portion thereof, said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;

said first portion of said first upstanding sidewall stiffener being laterally outboard of said first region of said first upstanding sidewall;

said second portion of said sidewall stiffener being laterally inboard of said second region of said first upstanding sidewall;

said first sidewall having a continuous section between said first and second regions thereof; and

said sidewall stiffener having web continuity between said first and second portions thereof.

2. A rail road hopper car comprising:

a hopper carried between a first end section and a second end section;

said first and second end sections being carried by respective first and second trucks for rolling motion in a longitudinal direction along railroad tracks;

said hopper having first and second upstanding sidewalls running lengthwise therealong;

said hopper having a lower discharge and convergent slope sheets that slope downward toward said discharge;

said discharge having a door movable between a closed position and an open position to govern egress of lading from said hopper;

one of said convergent slope sheets being a first end slope sheet;

said first end slope sheet extending laterally between said first and second upstanding sidewalls;

said first end slope sheet having a first, lower, longitudinally inboard end proximate said discharge, and a second, upper, longitudinally outboard end distant from said discharge;

said first end section having a first draft sill and a main bolster extending cross-wise to said first draft sill, said first draft sill and said main bolster intersecting at a first truck center, said first truck being located centrally under said first truck center;

said draft sill having a striker longitudinally outboard of said first truck center;

said first end section having a shear plate mounted overtop of said first draft sill and said main bolster;

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said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet;

said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;

said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;

said lower, longitudinally inboard end of said first end slope sheet being reinforced by a second cross-wise extending beam;

said first end slope sheet overhanging said shear plate;

a door actuator mounted above said shear plate, said door actuator being at least partially overhung by said first end slope sheet;

said door actuator being connected to said door by a mechanical transmission;

said first end section being free of longitudinally oriented elephant ears extending between said draft sill and said first end slope sheet;

said hopper having respective first and second top chords running longitudinally therealong;

said car having respective first and second side sills running longitudinally between said first and second end sections;

said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;

said first upstanding sidewall having a first region, said first region being a lower region thereof;

said first upstanding sidewall having a second region, said second region being an upper region thereof;

said first and second regions of said sidewall adjoining each other at a height intermediate said first side sill and said first top chord;

said second region of said sidewall extending downwardly or said first top chord;

said first region of said sidewall extending downwardly and laterally inboard from said second region of said sidewall;

said sidewall stiffener having a first portion, said first portion being a lower portion thereof,

said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;

said first portion of said first upstanding sidewall stiffener being laterally outboard of said first region of said first upstanding sidewall;

said second portion of said sidewall stiffener being laterally inboard of said second region of said first upstanding sidewall;

said first sidewall having a continuous section between said first and second regions thereof; and

said sidewall stiffener having web continuity between said first and second portions thereof.

3. The rail road hopper car of claim 2 wherein said first and second portions of said sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

4. The rail road hopper car of claim 2 wherein said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet

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transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and said stiffener having vertical web continuity through said transition portion.

5 5. The rail road hopper car of claim 4 wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said transition portion is located a distance above said first side sill that is in the range of $\frac{1}{4}$ to $\frac{3}{4}$ L.

6. The rail road hopper car of claim 2 wherein:

said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof;

said hopper includes first and second sloped side sheets; and

said first sloped side sheet meets said first sidewall at said transition portion.

7. The rail road hopper car of claim 6 wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said first sloped side sheet meets said transition portion at an height that is in the range of $\frac{1}{4}$ to $\frac{3}{4}$ L above said first side sill.

8. The rail road hopper car of claim 2 wherein said hopper has a cross-wise extending outboard end top chord; and an end post extends from said draft sill to said end top chord, said end post being mounted above said draft sill between said truck center and said striker.

9. The rail road hopper car of claim 8 wherein:

said hopper has an end wall extending downward of said end top chord;

said upper, longitudinally outboard end of said first end slope sheet meets said downwardly extending end wall; and

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said first cross-wise extending beam is located where said downwardly extending end wall meets said first end slope sheet; and

said first cross-wise extending beam is of hollow cross-section.

10. The rail road hopper car of claim 8 wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

11. The rail road hopper car of claim 10 wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.

12. The rail road hopper car of claim 2 wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.

13. The rail road hopper car of claim 12 wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

14. The rail road hopper car of claim 2 wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

15. The rail road hopper car of claim 2 wherein said first and second portions of said sidewall stiffener are made of flat bar, are positioned in vertical-transverse planes, are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

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