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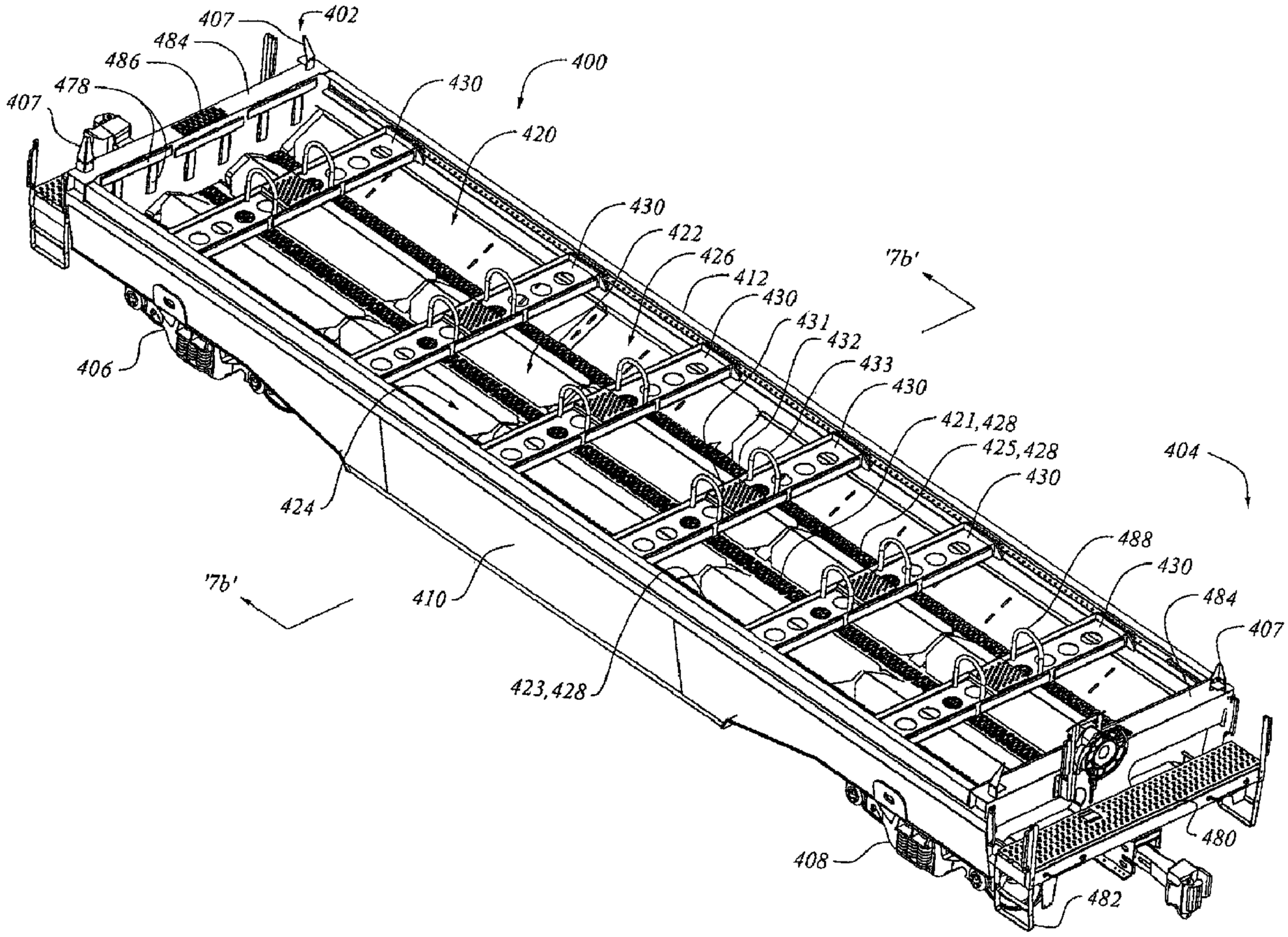

(57) Abrégé/Abstract:
A coil car has a pair of deep side sills and a trough structure mounted to, and suspended between, the deep side sills for carrying coils. The side sills extend between the rail car trucks and act as a pair of deep side beams for carrying vertical loads. The deep

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side sills are arranged to extend above and below the center sill of the coil car to give vertical stiffness to the coil car. The top chord members of the side sills are outwardly splayed relative to the bottom chord members of the side sills. Cross-bearers extend outwardly and away from the center sill to attach to the side sills. The trough structure has three parallel, longitudinally extending troughs - a central trough lying between two laterally outboard outer troughs. Each trough is shaped to cradle steel coils, or other similar loads, between its inwardly and downwardly sloping shoulder plates. The shoulder plates are lined with cushioning to buffer coils during loading or travel. The outboard troughs are mounted above longitudinally extending stringers and are carried at a greater height relative to top of rail than the central trough. The car has coil stops to discourage longitudinal shifting of loaded coils. The coil stops have rollers to facilitate repositioning during loading, and a mid-span step and hand grabs to facilitate climbing over the coil stop by personnel walking along the trough structure.

COIL STOP FOR RAIL ROAD COIL CAR

Abstract of the Disclosure

A coil car has a pair of deep side sills and a trough structure mounted to, and suspended between, the deep side sills for carrying coils. The side sills extend between the rail car trucks and act as a pair of deep side beams for carrying vertical loads. The deep side sills are arranged to extend above and below the center sill of the coil car to give vertical stiffness to the coil car. The top chord members of the side sills are outwardly splayed relative to the bottom chord members of the side sills. Cross-bearers extend outwardly and away from the center sill to attach to the side sills. The trough structure has three parallel, longitudinally extending troughs – a central trough lying between two laterally outboard outer troughs. Each trough is shaped to cradle steel coils, or other similar loads, between its inwardly and downwardly sloping shoulder plates. The shoulder plates are lined with cushioning to buffer coils during loading or travel. The outboard troughs are mounted above longitudinally extending stringers and are carried at a greater height relative to top of rail than the central trough. The car has coil stops to discourage longitudinal shifting of loaded coils. The coil stops have rollers to facilitate repositioning during loading, and a mid-span step and hand grabs to facilitate climbing over the coil stop by personnel walking along the trough structure.

COIL STOP FOR RAIL ROAD COIL CAR

FIELD OF INVENTION

This invention relates to the field of railroad cars having multiple troughs for transporting heavy cylindrical objects such as, for example, coils of rolled sheet metal.

BACKGROUND OF THE INVENTION

Railroad coil cars are used to transport coiled materials, most typically coils of steel sheet. Coils can be carried with their coiling axes of rotation (that is, the axes of rotation about which the coils are wound) oriented longitudinally, that is, parallel to the rolling direction of the car. The coils are generally carried in a trough, or troughs, mounted on a railcar underframe. The troughs are generally V-shaped and have inwardly inclined surfaces that support the coil. The troughs are typically lined with wood decking to provide cushioning for the coils. When a coil sits in a trough, the circumference of the coil is tangent to the V at two points such that the coil is prevented from rolling.

A coil car may have single, double or triple longitudinally extending troughs. The use of multiple troughs allows any single car to carry either a load of large coils in the center trough or a load of relatively smaller diameter coils, or coils of various diameters such that lading more closely approaches maximum car capacity during a higher percentage of car operation. Additionally, some coil cars have been provided with trough assemblies that can be shifted to permit conversion between different trough modes. An example of a coil car that can be converted from a single to a double trough mode can be found in U.S. Pat. No. 3,291,072, issued to Cunningham on Dec. 13, 1966. Similarly, conversion of a coil car from a single or triple trough arrangement to a double trough mode is shown in U.S. Pat. No. 4,451,188, issued to Smith et al., on May 29, 1984. The general object is to provide versatility such that overall car utilisation is improved. Hence, the car is more economically attractive to a user.

Historically, coil cars have been constructed on a flat car underframe having a through-center-sill, that is, a main center sill that runs from one end of the rail car to

the other. In this type of car the center sill serves as the main structural member of the car and functions as the primary load path of the car both for longitudinal buff and draft loads from coupler to coupler, and for carrying the vertical load bending moment between the trucks. The trough structure, or bunk, is mounted on the flat car deck. In such a car the cross-bearers carry loads into the main center sill. The side sills tend to be relatively small, and serve to tie the outboard ends of the cross-bearers together. Conventionally, the center sill is box-shaped in cross-section. That is, it is rectangular and has a constant depth of section. The top and bottom flanges of the main center sill tend to be very heavy in such cars, since they are relied upon to carry the vertical bending load.

Alternatively, another way to construct a coil car having a triple trough arrangement employs a central trough supported by a main center sill and an array of laterally extending cross-bearers and cross-ties that are angled upward and outward in a V-shape. At their distal end the cross-bearers and cross-ties meet, and are tied together by, relatively small side sills in a manner generally similar to a flat car. A central trough extends longitudinally above the center sill with side troughs lying outboard of the central trough. The side troughs are formed using slanted decking and are mounted above the cross-bearers at about the same height as the central trough relative to top of rail. In this arrangement the center sill is still relied upon to carry the great majority of the bending load.

Coil cars can also be fabricated as integrated structures. One way to do this is to employ a deep center sill, elevated side sills, and substantial cross-bearers mounted in a V between the center sill and substantial, load bearing side sills. The cross bearers and trough sheets carry shear between the side sills and the center sill. In this way the structural skeleton of the car acts in the manner of a deep V-shaped channel with flanges at each toe, namely the side sills, and at the point of the V, namely the center sill. In this arrangement, under vertical bending loads, the side sills are in compression, and the main sill is in tension.

In the cases of either a V-shaped integrated structure, or even a traditional flat car based structure, it may be beneficial to employ a "fish belly" center sill. A fish belly center sill is a center sill that is relatively shallow over the trucks, and has a much deeper central portions in the longitudinal span between the trucks. It is advantageous to have a deeper section at mid-span where the bending moment due to vertical loads may tend to be greatest.

Another way to achieve a greater depth of effective section in an integrated structure, so that a higher sectional second moment of area is obtained, is to employ deep side sills, in a manner akin to a well car. The deep side sills act as longitudinal beams. A longitudinal cradle, namely the trough structure, is hung between the side sills. In this kind of car, the main longitudinal structural members are the side sills which carry the great majority of the bending load. The cradle itself may have a center sill to tie the cross-bearers together at mid-span between the side sills. A center sill of modest proportions is sufficient for this purpose. The side sills carry the load back to main bolsters, and then into the draft gear mounted longitudinally outboard of each truck.

Where deep side sills are used, the minimum height of the bottom chord of the side sill is determined by the underframe portion of the design envelope prescribed by the AAR, such as for AAR plate B, plate C, or such other plate as may be applicable. At lower heights, the allowable width of the car diminishes, so the overall width of the car measured over the side sill bottom chords needs to be relatively narrow as sectional depth increases. Conversely, to accommodate the largest possible load width, it may tend to be desirable for the top chords of the side sills to be spread as far as possible within the allowable car width of 10' - 8". Thus it may be beneficial to locate the bottom chord closer to the car centerline than the top chord.

It may be desirable to be able to carry steel coils in a side-by-side arrangement. If three troughs are provided, it is advantageous for the center trough to be carried at a different height, relative to top of rail (TOR), than the outboard, or side, troughs. This may be beneficial for at least several reasons.

First, the total width of lading that can be carried by a coil car at one time is limited by the allowable car width envelope. If three identically sized coils are mounted such that the axes of the coils are carried at the same height relative to top of rail, then the sum of the diameters of the coils, plus the necessary clearance between coils, is limited by the maximum allowable coil car lading width. However, if the coiling axis of rotation of one coil is higher than an adjacent coil of equal or lesser diameter, then it may be possible to carry the coils in a partially encroaching, or overlapping, arrangement. That is, a greater sum of diameters may be accommodated than would otherwise be possible within the nominal maximum loading width. As a

result, lading can include a combination of larger coils than might otherwise be possible, thus tending to improve car capacity utilisation.

Second, it is desirable that the point of maximum width of the load be carried at a height that is greater than the height of the uppermost extremity of the top chord members of the side sills. Once again, the advantage of this is that, generally, this will allow the vertical projection of the outboard coil to encroach more closely to the inner edge of the top chord, and so permit a larger coil to be carried in the outboard trough. This condition may be reached when the car is carrying two coils in excess of 40 inches in diameter side by side, with the central trough either empty, or carrying a relatively small coil, such as a coil of rather less than 30 inches in diameter. Since the second moment of area of the primary load bearing structure varies strongly with the depth of section, it is better for the side sill top chord to be carried at a relatively high level. Since the height of the top chord is related to the height of the outboard trough, an increase in elevation of the outboard trough by even a few inches is advantageous.

Third, in terms of car versatility, it is advantageous to be able to carry a variety of loads, whether a single very large coil in the central trough, two medium sized coils side-by-side in the outside troughs, or three somewhat smaller coils in each of three troughs. In general, the larger the central trough, the smaller the outboard troughs. If the outboard troughs are raised relative to the central trough, the overall trough capacity, and hence car versatility, will be increased. That is, a car with a central trough capable of accommodating a 74 inch coil, may only be able to accommodate 36 inch coils in the outboard troughs when the central trough is empty if the troughs are all carried at the same height. However, if the outboard troughs are carried at a higher level, then it may be possible to carry outboard coils of greater diameter, such as 44 or 48 inches, when the central trough is empty.

Reference is made herein to troughs being carried at the same, or different, heights relative to top of rail, commonly on an assumption of troughs of generally similar geometry. For the purposes of this description, each of the troughs has planar sloped side sheets. The planes of the opposed side sheets meet at some line of intersection parallel to the longitudinal center line of the car, the line of intersection lying at some height below the flat bottom of the valley of the trough. In structural terms, the difference in the height at which one trough is carried relative to another trough can be taken by comparison of the heights of the flat bottoms of the valley,

since the bottom height may tend to be defined by the upper flange of a longitudinally extending structural member.

Reference can also be made to the height at which the centerlines of coils of the same size would lie for the various troughs. This is not a function of the height of the bottom of the valley, but rather of the height of the line of intersection of the planes of the slope sheets (assuming them to be planar), and the angle of the slope sheets. Once the angle of slope has been chosen, the difference in height of the flat bottom of the valley relative to the line of intersection of the planes is determined by the minimum diameter of coil to be carried, which will, with allowance for clearance, fix the width of the flat bottom. For troughs having the same angle of slope and the same bottom height, a narrow bottom will force a coil to be carried relatively higher than a wide bottom. Similarly, for bottoms of the same height and width, a steep slope will force a coil to be carried higher than a shallow slope.

The slope of the trough is an important design parameter. Whether for single or multiple trough cars, it is generally desirable that a coil not be able to escape from the trough during cornering. One standard is that a coil should not escape under a 0.45 g lateral load as a condition for general interchange service. This implies a trough slope of about 24.2 degrees measured from the horizontal. At least one rail road company has indicated that a slope of 23 degrees is acceptable for its purposes. It is also desirable for the troughs to have some allowance for lateral tilting or swaying of the cars during lateral loading, such as 2 or 3 degrees. This implies a desirable trough angle of about 27 degrees, (namely, 24 plus 3). Trough width is a function of the chord length between the points of tangency of the largest coil to be carried to the opposed trough sheets. Consequently, as the trough slope angle decreases, the trough width decreases. Similarly, as slope angle increases, the trough becomes wider. However, as noted above, the sum of the widths of the troughs is limited by the plate B envelope, less the widths of the side sills and a clearance dimension between the side sills and the coils, and between adjacent coils.

For trough width maximisation, it is advantageous for the side sills to be carried close to the design envelope lateral boundaries. For interchangeable service, the lateral boundaries are defined by AAR plate B, with a width of 128 inches. In the past, coil cars have carried walkways outboard of the side sills of the trough cradles. It is advantageous not to have walkways that would extend beyond the plate B limit. One inventor has suggested using folding walkways that can be moved to a retracted

position within the side sills. It would be advantageous to employ fixed walkways that do not require moving mechanisms.

Another rail road requirement has been for a restraining device, called a coil stop, to prevent longitudinal displacement of the coils during operation. Typically, a coil stop is a transversely oriented beam, or movable bulkhead, located in position across the trough after a coil has been loaded. The coil stop extends between the side sills and can be moved to a location near to a seated coil. The coil stop is then releasably, or removably anchored, typically with pins that locate in perforated strips mounted to the side sills. Shims are then inserted between the coil stop and the coil to give a snug fit. One design criterion suggests that the restraining device bear upon the coil at a height that is at least as high as the horizontal chord that subtends an arc of 108 degrees of the largest coil the trough is capable of carrying.

It is possible to use a coil stop bar retaining strip that extending laterally inboard of the side sill. However, it is generally desirable to trim the coil stop engagement strip back to increase the capacity of the outboard troughs. To this end, alternative embodiments of coil stop are described. In one embodiment, a horizontal pin is used to engage a strip mounted to a side web of the top chord of the side sill. In another embodiment vertical pins of the coil stop engage perforations in a horizontal strip placed within the vertical profile of the top chord.

Since coil stops are relatively heavy, it would be advantageous to provide a coil stop that is designed to be moved more easily from place to place along the troughs of the car. It would be advantageous to employ rollers, or a slider, for this purpose. Ease of adjustment can also be enhanced by reducing the weight of the coil stop, such as by removing material from the horizontal coil stop web.

When outboard troughs are used, as in a triple trough arrangement, it is advantageous for a longitudinal stringer to tie adjacent cross-bearers together along the spine, or groin, of the outboard troughs. Where the cross-bearer has a web and an upper flange defining the slope of the trough sheets, the stringer, such as a hollow section, can be located in a relief formed in the cross-bearer web. The bottom of the trough so formed may also provide a walkway space. When the bottom of the trough is used as a walkway, it may be advantageous for the coil stop to be provided with climbing means, such as a step, or stile, and handgrabs.

SUMMARY OF THE INVENTION

In an aspect of the invention there is a railroad coil car having a length and a width. The coil car has a pair of first and second end structures each mountable upon a rail car truck. The coil car has a pair of side sills extending between the end structures. There is a trough structure for carrying coils mounted between the side sills. Each of the side sills has a top chord, a bottom chord and intermediate structure joining the top and bottom chords. The coil car has a greater width measured across the top chords of the side sills than across the bottom chords of the side sills.

In another aspect of the invention, there is a railroad coil car having a length and a width. The coil car has a pair of first and second end structures each mounted upon a rail car truck. A pair of side sills extend between the end structures. A trough structure is mounted between the side sills. The trough structure includes at least two longitudinally extending parallel troughs. The side sills each have first and second end portions and a medial portion located between the first and second end portions. The medial portion has a greater depth of section than the end portions.

In another aspect of the invention, there is a coil car having a walkway mounted within the trough structure to facilitate movement of personnel along the car, whether for adjusting the coil stops or for cleaning and maintaining the car. That is to say, in that aspect of the invention there is a rail road coil car. It has a trough structure supported for carriage by rail car trucks for travel in a longitudinal rolling direction. The trough structure has a walkway mounted therewithin.

In a further feature of that aspect of the invention, the trough structure includes a first trough. The first trough is longitudinally oriented, and the walkway is oriented longitudinally within the first trough. In another feature, the first trough has a pair of first and second slope sheets defining opposed flanks of the first trough. The first trough has a valley bottom between the flanks, and the walkway extending along the valley bottom. In an additional feature, tread plates are mounted along the walkway. In another feature, the rail road coil car has a longitudinal structural member defining the valley bottom. In still another feature, the longitudinal structural member is a longitudinal center sill.

In a further feature, the rail road coil car includes a center sill and cross bearers extending laterally from the center sill. The cross-bearers support the trough

structure. The longitudinal structural member is a stringer mounted to the cross bearers. The longitudinal stringer lies laterally outboard to one side of the center sill. In another feature, the stringer is a first stringer, and the rail road car includes a second trough parallel to the first trough. The second trough has a second valley bottom lying over a second longitudinal stringer mounted to the cross bearers along the second valley bottom. In another additional feature the first and second stringers are located symmetrically to either side of the center sill. In still another feature, a third trough is mounted over the center sill parallel to the first and second troughs.

In a further feature, the trough structure includes a second trough extending parallel to the first trough, the second trough having third and fourth slope sheets defining opposed flanks of the second trough, the second trough having a valley bottom between the flanks thereof, and the second trough having a second walkway extending along the valley bottom thereof. In another feature, the rail road car has first and second side sills bounding the trough structure, and the walkway is located within the trough structure at a location between the side sills.

In another feature, the rail road coil car has structure defining a cover interface to which a coil car cover can be mounted, the interface defining a boundary to a region of the coil car sheltered when a cover is mounted to the cover interface, and the walkway lies within the boundary. In an additional feature, the rail road coil car includes a rail car body, the trough structure is part of the rail car body, and the rail road coil car includes a cover for sheltering coils carried in the trough structure, the cover being movable to permit loading of the coil car, the cover having a footprint mating with the rail car body, and the walkway falls within the footprint of the cover. In that additional feature, the rail car body includes first and second side sills extending longitudinally along opposite sides of the trough structure, and the cover seats on the side sills. In a further additional feature, the side sills each have a top chord, and the cover seats on the top chords of the side sills.

In another feature, the coil car has at least one movable coil stop mounted thereto, the coil stop being co-operable with the trough structure to accommodate coils of different thickness in the trough structure. In an additional feature, the walkway provides access to the coil stop. In another additional feature, the coil stop is mounted transversely relative to the walkway.

In a further additional feature of the invention, the coil car falls within a design envelope width limit of 128 inches. The trough structure includes first, second and third troughs, the first second and third troughs being parallel and extending in the longitudinal direction. First and second side sills extend longitudinally along opposite sides of the trough structure. The side sills include respective first and second top chord members. At least a portion of each of the respective first and second top chord members lies within 2 inches of the design envelope width limit.

In another aspect of the invention, there is a coil stop for a rail road coil car. The coil car has a trough structure in which to carry coils. The coil stop has a beam member for spanning the trough structure. The beam member has a first end, a second end, and a medial portion extending between the first and second ends. The coil stop has a step mounted on the beam member between the first and second ends to facilitate climbing over the coil stop.

In an additional feature of that aspect of the invention, the step includes a tread plate mounted upon the beam. In another feature, the step is mounted centrally on the beam. In a further feature, a hand grab is mounted to the beam adjacent to the step. In an alternative feature, a pair of first and second hand grabs is mounted to either side of the step.

In still another additional feature, the beam includes a horizontal web, and the step is mounted to the horizontal web. In an additional feature, the horizontal web has lightening holes defined therein. In another feature, at least one of the first and second ends has an indexing member mounted thereto for engagement with the coil car. In still another feature the coil stop includes rollers mounted at the first and second ends therefor for facilitating positioning of the coil stop in the trough structure of the rail car.

In another aspect of the invention there is a coil stop for a rail road coil car. The coil car has a trough structure in which to carry coils. The coil stop includes a beam member for spanning the trough structure. The beam member has a first end, a second end, and a medial portion extending between the first and second ends. The coil stop has rollers mounted at the first and second ends to facilitate positioning of the coil stop relative to the trough structure. In a further feature, the coil stop has indexing members mounted at the first and second ends of the beam member. The indexing members are engageable to maintain the coil stop in a fixed position relative to the trough structure. In an additional feature, the coil stop has attachment means

mounted at the first and second ends of the beam by which to secure the coil stop in a fixed position relative to the trough structure.

In a further aspect of the invention, there is a rail road coil car having a rail car body supported by rail car trucks for rolling motion in a longitudinal direction. The rail car body including a trough structure for carrying coils, and at least one coil stop for restraining coils loaded in the trough structure. The coil stop is movable along the trough structure. A trackway is mounted to the body for guiding the coil stop along the trough structure. The coil stop has fittings engaged with the trackway. The fittings and the trackway are co-operable to permit motion of the coil stop along the trough structure.

In an additional feature of that aspect of the invention, the trough structure includes a first longitudinally oriented trough. The rail car body includes first and second side sills extending along the trough structure, and the trackway is mounted to the side sills. In a further additional feature, the trackway includes a first portion mounted to the first side sill and a second portion mounted to the second side sill, and the coil stop has a beam member spanning the trough. The beam member has a first end mounted to the first side sill and a second end mounted to the second side sill.

In another additional feature, the coil stop includes a beam member for spanning the trough structure. The beam member has a first end, a second end, and a medial portion extending between the first and second ends. The coil stop has a step mounted on the beam member between the first and second ends, whereby persons walking along the trough structure can more easily climb over the coil stop.

In an additional feature of that additional feature, the step includes a tread plate mounted upon the beam. The step is mounted centrally on the beam, and a hand grab is mounted to the beam adjacent to the step. Alternatively, a pair of first and second hand grabs is mounted to either side of the step. In an additional feature, the hand grab is an upwardly extending hand rung.

In another feature, the coil stop includes a beam member for spanning the trough structure, the beam member having a first end, a second end, and a medial portion extending between the first and second ends. The body has at least a first indexing fitting mounted thereto. At least one of the first and second ends has a second indexing member mounted thereto. The second indexing member is co-operable with the first indexing member to maintain the coil stop in a fixed position relative to the trough structure. In still another feature, the coil stop includes rollers

mounted at the first and second ends therefor for facilitating positioning of the coil stop in the trough structure of the rail car.

In another aspect of the invention, there is a coil stop for a coil car having a trough structure in which to carry coils. The coil stop includes a beam member for spanning the trough structure. The beam member has a first end, a second end, and a medial portion extending between the first and second ends. The coil stop has a hand grab mounted on the beam member between the first and second ends, whereby to facilitate climbing over the coil stop by persons walking along the trough structure.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show more clearly how it may be carried into effect, reference will now be made to the exemplary embodiments illustrated in the accompanying drawings, which show the apparatus according to the present invention and in which:

Figure **1a** is a top view of one half of a coil car according to the present invention;

Figure **1b** is a top view of the coil car of Figure **1a** with decking removed to show the structural skeleton of the coil car;

Figure **2** is a side view of half of the coil car of Figure **1a**;

Figure **3a** is a cross-sectional view of the coil car of Figure **1a** at mid-span with the one side sill and one set of deck cushions removed;

Figure **3b** is a staggered sectional view taken on '**3b - 3b**' of the coil car of Figure **1a**;

Figure **4** is a top view of an alternate triple trough coil car to the coil car of Figure **1a**;

Figure **5a** is a cross-sectional view of the coil car of Figure **4** at mid-span, showing a triple trough arrangement having cross-bearers with a stepped lower flange;

Figure **5b** shows the cross-section of Figure **5a** with coils of various loading configurations shown thereon;

Figure **5c** shows a top view of a coil stop of the coil car of Figure **5b**;

Figure **6a** shows an alternate mid-span coil car cross-section to that of Figure **5a** having a cross-bearer with a horizontal bottom flange;

Figure **6b** shows a further alternate mid-span coil car cross-section to that of Figure **5a**, having a cross-bearer with an inclined bottom flange;

Figure **6c** shows a still further alternate cross-section to that of Figure **5a**;

Figure **7a** shows an isometric view of an alternative embodiment of coil car to that of Figure **1**;

Figure **7b** shows a mid-span cross-sectional view of the coil car of Figure **7a**;

Figure **7c** shows an enlarged cross-sectional detail of a top chord of a side sill of the coil car of Figure **7a**;

Figure **7d** shows an isometric detail of the engagement of the coil stop beam with the top chord of the coil car of Figure **7a**;

Figure **8a** shows a partial side view of an alternate coil car to the coil car of Figure **1a**;

Figure **8b** shows a mid span cross-section of the coil car of Figure **8a**;

Figure **8c** shows a staggered cross-section of the coil car of Figure **8b** taken on a section corresponding to staggered section '**3b – 3b**' of the coil car of Figure **1a**.

DETAILED DESCRIPTION OF THE INVENTION

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 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 that follows, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings are not necessarily to scale and in some instances proportions may have been exaggerated in order more clearly to depict certain features of the invention.

In terms of general orientation and directional nomenclature, for each of the rail road cars described herein, the longitudinal direction is defined as being coincident with the rolling direction of the car, or car unit, when located on tangent (that is, straight) track. In the case of a car having a center sill, whether a through center sill or stub sill, the longitudinal direction is parallel to the center sill, and parallel to the side sills, if any. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail **TOR** as a datum. The term lateral, or laterally outboard, refers to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, indicated as **CL - Rail Car**. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit.

Figures 1a, 1b, 2, 3a and 3b

By way of general overview, an example of a coil car is indicated in Figures **1a**, **1b**, **2**, **3a**, and **3b**, generally as **20**. For the purposes of conceptual explanation of the embodiments illustrated in the various Figures, the major structural elements of coil car **20** (and of the alternate embodiments described herein), are both symmetrical about the longitudinal centerline of the car (as designated by axis **CL**) and symmetrical about the mid-span transverse section of the car, indicated as **TS**.

As shown in Figures **1a**, **1b** and **2**, coil car **20** has a longitudinal rolling direction, on straight track, parallel to the longitudinal centerline **CL**. Coil car **20** includes a pair of end structures **22** and **24**. End structures **22** and **24** are mounted on a pair of spaced apart rail car trucks **26** and **28**, respectively. Side sills **34** and **36** extend between end structures **22** and **24** and form the main longitudinal structural elements of coil car **20** for resisting vertical loads. An array of cross-members **32** extends outwardly and away from center sill **30** to attach to side sills **34** and **36**. A trough structure for carrying coils, generally indicated as **38**, is mounted to, and suspended between, side sills **34** and **36**.

As shown in Figure **3a**, trough structure **38** has three parallel, longitudinally extending cradles or troughs – a central trough **40** lying between two laterally outboard outer troughs **42** and **44**. Each trough is shaped to cradle steel coils, or other similar, generally cylindrical coiled loads, between its inwardly and downwardly sloping shoulders, namely sloped plates **46** and **47**, **48** and **49**, **50** and **51**, respectively. More generally, in each of the embodiments described herein each pair of opposed sloped plates defines the flanks of a valley, or trough, for cradling coils, and each of the valleys has a flat valley bottom, as described below. Each valley is centered over a longitudinally extending structural member, whether a center sill or a stringer spaced laterally outboard of the center sill, as described below, with the upper face of the longitudinal structural member also defining the valley bottom. Sloped plates **46** and **47**, **48** and **49**, **50** and **51** are lined with cushioning in the nature of wood decking **52** that acts as a cushion to buffer coils during loading or travel. This geometry defines longitudinally oriented troughs, that is, troughs in which the winding axis of the coils will be parallel to the longitudinal, or rolling, direction of the rail car. Load stabilising partitions in the nature of end bulkheads **54** and moveable bulkheads,

namely coil stops (not shown), discourage longitudinal sliding of coils loaded in troughs **40**, **42** and **44**.

Describing now the arrangement of troughs **40, 42** and **44** within trough structure **38**, outer troughs **42** and **44** are arranged on either side of central trough **40**. Central trough **40** lies directly above center sill **30**. When arranged in this fashion, a portion of the upper flange **60** of center sill **30** forms the bottom of the valley of central trough **40**. Central trough **40** is carried lower relative to TOR than outer troughs **42** and **44** as indicated in Figure **3a** by dimension **δ**. Outer troughs **42** and **44** are mounted above stringers **114** and **116** respectively and are carried at the same height as each other relative to TOR. Having outer troughs **42** and **44** carried at a different height than central trough **40**, may tend to facilitate placement of the coils in a position to tend to encroach upon or to marginally overlap each other to some extent such that a greater width of coils can be accommodated in a somewhat narrower width of coil car than might otherwise be the case.

Troughs **40**, **42** and **44** can accommodate various sizes of coils, as illustrated by the outlines of coils **A**, **B**, **C**, **D** in Figure **3b**. When coils are not carried in outer troughs **42** and **44**, central trough **40** can carry a coil having a maximum diameter of 74 inches as indicated by coil 'A'. The largest diameter of coil that can be accommodated by outer troughs **42** and **44**, as illustrated when central trough **40** is not loaded, is 40 inches as indicated by coils 'B'. Coils C and D illustrate lading conditions for all three troughs at once.

In greater detail, center sill **30** includes upper flange **60**, a pair of parallel vertical webs **62** and **64** and a lower flange **66**, all arranged in a rectangular box-shaped form in which the outboard margins of upper flange **60** and lower flange **66** extend past webs **62** and **64**, as shown in Figure **3a**. Center sill **30** is of substantially constant cross-section in the medial span between trucks **26** and **28**. Internal gussets **68** are welded inside center sill **30** to provide web continuity at each cross-bearer location.

The array of cross-members **32** extends between side sill **34** (or **36**, as the case may be) and center sill **30**. Array **32** includes bolsters **72** and cross-bearers **74**. Bolsters **72** are located amidst end structures **22** and **24**, above railcar trucks **26** and **28**. Cross-bearers **74** are spaced apart one from another at successive longitudinal stations along center sill **30** between end structures **22** and **24**. As shown in Figure

3a, each of cross-bearers **74** has a web **76**, an upper flange **78** and a lower flange **80**. Upper flange **78** is carried at the level of upper flange **60** of main center sill **30**, and is welded at its proximal, or inboard, edge thereto. Similarly, lower flange **80** is carried horizontally at the level of, and has its inboard edge welded to, lower flange **66**. Web **76** extends from web **64** of center sill **30** beyond the outboard, or distal, ends of upper and lower flanges **78** and **80** to form a substantial tongue, or tab **82** suitable for welding in a lap joint to web stiffeners of the structure of side sills **34** and **36**, as shown in Figure **3a**.

In terms of major structural elements (that is, excluding handrails, brake line fittings, and ancillary items), coil car **20** is symmetrical about center sill **30**, such that the structure of side sills **34** and **36** is the same. Consequently, a description of one will also serve to describe the other. Referring to Figure **3a**, side sill **36** has an upper flange assembly **86**, a lower flange assembly **88**, and an intermediate structure **90** in the nature of a web, or webbing **92**.

Examining each of these in turn, upper flange assembly **86** has a top chord member **94** in the nature of a hollow rectangular steel tube **96**, upon which pin locating plate **98** is mounted. Plate **98** has an inwardly extending perforated strip or tongue **100**, the perforations having a constant pitch, and being of a size and shape suitable for engagement by the locating pins of moveable bulkheads or cross-beams, namely the coil stops (not shown), used for providing longitudinal restraint of the coiled materials once loaded. Also located intermittently along a more laterally outboard region of plate **98** are eyes **102** for locating a cowling or cover (not shown) to protect coils loaded on coil car **20** from exposure to rain or snow. Lower flange assembly **88** includes a bottom chord member **104** in the nature of a hollow rectangular steel tube **106**.

Webbing **92** extends between, and connects upper flange assembly **86** and lower flange assembly **88**. Webbing **92** includes an upwardly and outwardly inclined steel web in the nature of a side panel sheet **108**. Sheet **108** is reinforced at the longitudinal station of each successive cross-bearer by a web stiffener, or brace, in the nature of a section of channel **110**. Channel **110** extends between tubes **96** and **106** along the inner face of sheet **108**. Channel **110** is a C-channel having its back facing inward and its toes welded to sheet **108**. Channel **110** provides an attachment site for tab **82** of cross-bearer **74** to allow mounting of cross-bearers **74** to side sills **34** and **36**. Specifically, the sides, or legs, of channel **110**, each lie in a vertical plane

perpendicular to the longitudinal centerline of car **20**. As such one side of channel **110** is aligned with the web of each successive cross-bearer **74** and thereby provides a lap surface to which respective tabs **82** of each cross bearer **74** are welded in a lap joint. Sheet **108** has an upper strip, or margin, that is bent to provide an overlapping band welded at a lap joint to the outer face of rectangular steel tube **96**. Similarly, the lower margin, or band, of sheet **108** overlaps, and is welded in a lap joint to, the outer face of the bottom chord member, namely tube **106**.

A gusset **112** provides vertical web continuity at the longitudinal station of the web of each cross-bearer **74** to that portion of channel **110** extending to a height lower than horizontal lower flange **80**. Gusset **112** extends downward to meet the uppermost side of the bottom chord member, namely tube **106**, gusset **112** being smoothly radiused on its most inboard edge to tend to reduce the stress concentration that might otherwise develop at the juncture between cross-bearer **74** and side sill **34**, or **36** as may be.

Longitudinal structural elements, in the nature of stringers **114** and **116**, noted above, are mounted upon cross bearers **74** at a medial location along upper flange **78** somewhat more than half way from the car centerline **CL** to the distal, or outboard, extremity of cross bearer **74**. Each stringer **114** and **116** spans the length of coil car **20** and is mounted to cross-bearers **74** intermediate center sill **30** and each side sill **34** and **36**. Stringers **114** and **116** are secured by welding to trough structure **38** and top flange **78** of cross-bearers **74**. Stringers **114** and **116** function to bridge the gap, or space, between adjacent cross-bearers and so to tie cross-bearers **74** together in their midst, (i.e., at a transversely mid-span location lying between center sill **30** and side sill **34** or **36** as the case may be), and also provide the backbone of side troughs **42** and **44**. Each of stringers **114** and **116** has a hollow, closed section made by employing an upwardly opening channel **118** and welding a cover or closure plate **119** across its toes. Sloped outboard and inboard side plates **46** and **47** (or **51** and **50**), respectively, extend on an upward slope away from closure plate **119**, the junctures of plates **46** and **47** (or **51** and **50**) with closure plate **119** occurring above the respective toes of channel **118**. At its outboard edge, sloped side plates **46** and **51** are each welded in a lap joint to the inboard face of tube **96** of top chord assembly **94**.

Vertical web continuity is provided by a web plate, or outboard web **124** located in the same plane as web **76** of cross bearer **74**. Gusset **124** has a lower edge welded to upper flange **78** of cross bearer **74**, and extends upwardly therefrom to

connect to a sloped flange **125** that lies against the underside of sloped side plate **46**. An inboard toe of gusset **124** abuts the outboard upwardly extending leg of channel **114**, (or **116**) and an outboard edge of gusset **124** is welded in a lap joint to one of the legs of channel **110** of intermediate structure **90**. Web stiffeners **126** are welded to both the fore and aft faces of gusset **124**. Web stiffeners **126** extend between sloped flange **125** and flange **78**, perpendicular to sloped side plate **125**, from a location under the mid-point of cushioning decking **52**, to discourage buckling of gusset **124**.

An inboard web **128** is also located at the longitudinal station of the plane of the web of cross member **74** and has a first, lower, edge abutting flange **78**, an outboard toe abutting the inboard upturned leg of channel **118**, a first upper inclined edge abutting sloped flange **127** directly below shoulder plate **50** (or **47**) of outer trough **44** (or **42**), and a second upper inclined edge abutting sloped flange **129** directly below shoulder plate **49** (or **48**) of trough **40**. Flanges **127** and **129** can be fabricated from a single piece of flat bar bent to form the vertex between trough **40** and trough **42** (or **44**). Web stiffeners **130** are provided to extend from inclined flange **125** to flange **78**, web stiffeners **130** running perpendicular to shoulder plate **49** (or **48**) from a point in the midst of decking **52**. Further web stiffeners **132** run perpendicularly from flange **78** to the vertex formed at the intersection of shoulder plates **49** and **50**. Further gussets **134**, **136**, and **138** are located between, and run vertically perpendicular to, flanges **78** and **80** at locations directly beneath web stiffeners **132** and the toes of channel **120**.

Side sills **34** and **36** have an inclined orientation with respect to the vertical, as noted above. That is, webbing **92** is inclined at an angle η from the vertical such that the width $\mathbf{W_1}$ measured across respective top chords **88** of side sills **34** and **36** is greater than the width $\mathbf{W_2}$ measured across respective bottom chord members **104** of side sill **34** and **36**. (For the purposes of illustration ($\mathbf{W_1}/2$) and ($\mathbf{W_2}/2$) have been shown as measured from the centreline **CL**). Bottom chord members **104** are located at a height relative to TOR that is lower than the lower flange **66** of center sill **30**. It is advantageous for the top chords of the side sills to be widely spread to tend to increase the trough width, and hence the maximum coil diameters that can be carried within the AAR plate B width limit. At the same time, increasing the depth of section to increase the second moment of area, and hence resistance to flexure under vertical loading, may tend to encourage use of bottom chords that are stepped laterally inward relative to the top chords, as shown, to fall within the inwardly sloping underframe

limit such as is permitted under AAR plate "**B**" or plate "**C**" envelope shown in dashed lines and indicated as "**UF**".

Although different angles could be used for the slopes of the sides of central trough **40** and side troughs **42** and **44**, in the embodiment illustrated in Figure **3a** they are the same. Their angle, (that is, the angle of sloped sheets **46**, **47**, **48**, **49**, **50** and **51**) when measured from the horizontal, is greater than 20 degrees, and in general lies in the range of 23 to 29 degrees. It is preferable that the angle be greater than 24.22 degrees, (at which L/V = 0.45) and less than 28 degrees, and it is most preferred that the angle be 27 degrees or thereabout.

Side sills **34** and **36** have a maximum depth of section at mid-span **70** to provide resistance against the bending moment induced by the loads carried by coil car **20**. Considering the side view of Figure **2**, moving away from the mid-span **70**, the portion of side sill **34** having the greatest depth of section ends at a point designated as "**X**" in Figure **2**. At point "**X**" bottom chord member **104** is obliquely truncated and welded to a doglegged upswept fender, or flange **140**. Upswept flange **140** follows the lower edge of sheet **108** as it narrows in a transition portion **142** from the deep, mid-span or medial portion **144** to the narrow, or shallow, end structure portion **146**, the upswept flange **140** reaching a sufficient height to clear trucks **26** and **28**, as the case may be.

Figures 4, 5a and 5b

Referring to Figures **4**, **5a** and **5b**, in another embodiment a coil car is generally indicated as **200**. Coil car **200** is generally similar to coil car **20**. It has a center sill **202**, a pair of side sills **204** and **206** and cross-bearers **208** for tying side sills **204** and **206** to center sill **202**. The arrangement of center sill **202**, cross-bearers **208** and side sills **204** and **206** support a trough structure **210**. Trough structure **210** has three parallel, longitudinally extending troughs **212**, **214** and **216**. Each trough is shaped to cradle steel coils, or other similar loads, between its inwardly and downwardly sloping opposed flanks, or shoulders plates **218** and **220**, **222** and **224**, **226** and **228**, respectively.

Center sill **202** is similar to center sill **30** of coil car **20**. It includes an upper flange **230**, a pair of parallel vertical webs **232** and **234** and a lower flange **236**, all

arranged in a rectangular box-shaped form in which the outboard margins of upper flange **230** and lower flange **236** extend past webs **232** and **234**.

Each cross-bearer **208** has an upper flange **240**, a lower flange **242** and a web **244**. Unlike upper flange **78** of coil car **20**, upper flange **240** is carried above the level of upper flange **230** of center sill **202**, and lies against the underside of trough structure **210**. As upper flange **240** extends from side sill **204** and **206**, it slopes downwardly and upwardly, as the case may be, to match the orientation of shoulder plates **218**, **220**, **222**, **224**, **226** and **228**. Web **244** extends between lower flange **242** and trough structure **210**. At its outboard end or tip, web **244** is welded to the structure of side sills **204** and **206** in a lap joint. As above, the upper flanges of the center sill and longitudinal stringers form the bottom of the valley of the respective troughs.

Lower flange **242** is a stepped lower flange carried at a level higher than the lower flange **236** of center sill **202**. At its inboard edge, lower flange **242** has an inboard portion **247** welded to lower flange **236**. Inboard portion **247** extends on an upward slope outboard and away from lower flange **236** to join a horizontal transition portion **248**. In turn, transition portion **248** joins an upwardly sloped portion **249** that extends toward side sill **206** or **208**, as the case may be. The sloped portion **249** of lower flange **236** has been trimmed short of side sill **204** or **206**. The upward slope of inboard portion **247** provides a larger space, indicated generally as 'B' in which to locate a brake line. This is advantageous, since it is not then necessary to punch a hole through web **244** for the brake line, saving fabrication and installation costs, and avoiding a stress concentration in web **244**.

Each side sill **204**, **206** has an upper flange assembly **250**, a lower flange assembly **252**, and an intermediate structure **254** in the nature of webbing **256**. Upper flange assembly **250** has a top chord member **258** in the nature of a hollow generally rectangular steel tube **260**. Steel tube **260** is a formed section having a lower portion on a dog leg bend to match the angle of inclination ρ of webbing **256**. Unlike top chord **94** of coil car **20**, top chord **258** is not provided with an inwardly extending plate such as plate **98** for locating the pins of the moveable bulkheads (not shown), thus tending to permit trough structure **210** to accommodate coils of a larger diameter within the limits of AAR plate B than would otherwise be the case. Rather a perforated formed channel, or strip, **259** is mounted along the face of the inner web of top chord **258**, the perforations serving as sockets for receiving, and retaining, the lugs

of a coil stop **280** described below. An angle iron **261** is welded along the inboard face of the inboard web of top chord member **258**, to bear the weight of the coil stop. That is, the coil stop can slide along angle iron **261** and be locked in place by seating removable pins in strip **259** as described below. The arrangement of lower flange assembly **252** and webbing **256** is generally similar to that described earlier in respect of lower flange assembly **88** and webbing **92** of coil car **20**.

Longitudinal structural elements in the nature of stringers **262** and **264** are mounted upon cross bearers **208** at a medial location along web **244** somewhat more than half way from the car centerline **CL** to the distal, or outboard, extremity of cross bearer **208**. Stringers **262** and **264** seat in pockets or recesses **263** and **265** formed in web **244**. Stringers **262** and **264** function to tie cross-bearers **208** together in their midst, i.e., at a mid-span location, and also provide the backbone of side troughs **214** and **216**. Each stringer **262**, **264** has a hollow, rectangular steel section in the nature of a tube **266**. Respective sloped side plates **224** or **226** and **222** or **228** each have a lip welded to the respective inboard and outboard uppermost corners of tube **266** and extend on an upward slope away therefrom. At its outboard edge, sloped side plate **222** (or **228**) has a bent lip welded in a lap joint to the inboard face of tube **260** of top chord assembly **258**. The undersides of sloped side plates **224** (or **226**) and **222** (or **228**) are welded to the undulating upper flange **240** of cross-bearer **208**.

Tread plates, generally indicated as **272**, are mounted to the top surface of tube **266** intermediate attachment sites **274** where wood decking **52** is fastened to trough structure **210**, as best shown in Figure **10**. The arrangement of tread plates **272** in this way does not interfere with wood decking **52** mounted within outer troughs **214** and **216**. Similarly, tread plates **272** are generally sufficiently thin so that when coils are loaded in outer troughs **214** and **216**, the coils do not touch tread plates **272** thereby tending to avoid damage by tread plates **272**. Tread plates **272** provide a no-skid roughened surface to the walkways defined in the valley bottoms and tend to permit railway personnel to secure a coil during loading of coil car **200**. The walkways so defined are fixed in position relative to the trough structure, and do not require special mechanisms for deployment or retraction.

Web stiffeners **276** run perpendicular to lower flange **242** to intersect the vertex formed at the intersection of shoulder plates **224** and **226**. Further gussets **268** and **270** are located between, and run vertically perpendicular to lower flange **242** and the lowermost corners of tube **266**.

The arrangement of troughs **212**, **214** and **216** is generally similar to that of troughs **40**, **42** and **44** of coil car **20**. Outer troughs **214** and **216** are arranged on either side of central trough **212**. Central trough **212** lies directly above center sill **202** and is carried lower relative to TOR than outer troughs **214** and **216**. Each outer trough **214** and **216** is mounted above stringers **262** and **264** and carried at the same height relative to TOR as the other.

Troughs **212**, **214** and **216** can accommodate various sizes of coils, as illustrated by the outlines of coils shown in Figure **5b**. When coils are not carried in outer troughs **214** and **216**, central trough **212** can carry a coil having a maximum diameter of 84 inches. The largest diameter of coil that can be accommodated by outer troughs **214** and **216**, when central trough **212** is not loaded, is 48 inches.

As noted above in the context of coil car **20** of Figures **1a**, **1b**, **2**, **3a** and **3b**, troughs **212**, **214** and **216** of Figures **4**, **5a** and **5b** have slope angles, indicated in Figure **5b** as θ_1, θ_2 and θ_3. In general, these angles need not be the same, although it is convenient, and preferred, that a single angle be chosen. The range of angles chosen for any of θ_1, θ_2 and θ_3 is greater than 20 degrees. As above, the angles can be chosen in the range of 23 to 29 degrees, preferably being 24.2 or more, and 28 degrees or less, and most preferably being about 27 degrees.

In the embodiment illustrated in Figures **5a** and **5b**, in single coil mode, central trough **212** can cradle a coil up to 84 inches in diameter, as indicated in dashed lines as **C84**. A 74 inch coil is indicated as **C74**. Similarly, in a two-coil loading configuration, each of the outboard troughs **214** or **216** can accommodate a coil of up to 48 inches, indicated as **C48**. In the triple coil configuration each of the troughs can hold a 30 inch coil, indicated as **C30**. Alternatively a 38 inch diameter coil, indicated as **C38**, can be accommodated in central tough **214** while two 30 inch coils are cradled in outer troughs **212** and **216**.

A transversely extending member, or cross beam member, is indicated as **275**, and spans the trough structure from side sill **206** to side sill **204**. As illustrated in Figure **5b**, member **275** is in a position to restrain longitudinal motion of coils mounted in any of the three troughs. As indicated by angle ψ, when measured at mid-height (in this case, at the level of its horizontal web) cross beam member **275** subtends a portion of a minor arc of coil **C74**. In the preferred embodiment ψ is

greater than 108 degrees, typically being about 122 degrees for coil **C74** and about 112 degrees for coil **C84**.

The movable cross-beam member **275**, namely coil stop **280**, is shown in Figures **5b** and **5c**. It has the general form of an I-beam set on its side such that flanges **282**, **284** of the I-beam stand in vertical planes perpendicular to the longitudinal centerline of car **200**, and web **283** lies in a horizontal plane between the flanges. Web **283** is perforated, having a number of apertures in the nature of round holes **285** formed in it to reduce its weight. An end plate **286** is welded across each end of the I-beam, each end plate having through holes for accommodating locating releasable retainers in the nature of pins **288**. Each pair of locating pins is joined by a lanyard **290**. Lanyard **290** is preferably a cable but could also be a wire, cable, chain or strap. In use, pins **288** extend through plate **286** to seat in a pair of apertures, or sockets, in strip **259**, thus preventing coil stop **280** from shifting in the fore-and-aft (i.e., longitudinal) direction relative to the troughs. When so engaged, a locking member **292** pivots on a pin to bear against a shoulder of pins **288**, thus preventing them from disengaging from strip **259**. In use, locking member **292** is held in place by a laterally inward retainer **294** that prevents the handle of locking member **292** from moving laterally inboard. To release pins **288**, the handle of locking member **292** is pivoted upwards, such that locking member **292** no longer blocks the retraction of the shoulders of pins **288**. Pulling on lanyard **290** then releases pins **292**, permitting coil stop **280** to be moved to a different location. A slider **296** is mounted under each of end plates **286** and bears upon angle iron **261**. It is advantageous for slider **296** to have a sliding bearing surface, such as a nylon or high molecular weight polymer pad or facing.

Figures 6a, 6b and 6c

Figure **6a** shows an alternative embodiment of coil car to that of Figure **4**, **5a** and **5b**, indicated generally as **300**. Coil car **300** differs from coil car **200** in that, rather than having upwardly stepped cross bearers such as cross bearers **208**, coil car **300** has cross bearers **302** having a horizontal lower flange **304** carried flush with the bottom flange of center sill **306**. Cross bearer **302** has a correspondingly deeper web **308**, and gussets **310**, **312** and **314**. A further radiused gusset **318** lies in the plane of web **308** and extends between lower flange **304** and bottom chord **316**. Coil car **300** has trough structure **210** as described above and employs coil stop **280**, and related fittings, also as described above.

Figure **6b** shows another alternative embodiment of coil car to that of Figures **4**, **5a** and **5b**, indicated generally as **320**. Coil car **320** differs from coil car **200** in having cross bearers **322** having a lower flange **325** that extends in an inclined plane upward and outward from center sill **324**. Corresponding changes are made in the size of web **326** of cross bearer **322**, and in gussets **328**, **330**, **332** and **334**.

In the alternative embodiment shown in Figure **6c**, a coil car **340** can be constructed without a center sill between rail car trucks **26** and **28**. That is, stub sills can be employed at either end of the coil car body with no main sill between deep side sills **342** and **344**. Coil car **340** has transverse structural members in the nature of cross-bearers **346** that extend as continuous beams between a pair of deep side sills **348** and **350**. Gussets **352** and **354** are built up in the manner of gussets **124** and **128** noted above, to support upper flanges **356**, **357** and **358**, that are similar to items **125**, **127** and **129**, noted above. The general stringer, trough sheet and cushion structure is also similar to that of car **20**. The upper flange **360** of cross bearer **346** is supported at the juncture with flanges **358** by gussets **362**. Cross-bearer **346** has a continuous bottom flange **364**.

Figures 7a, 7b, 7c and 7d

Figure **7a** is an isometric view of a preferred embodiment of coil car, indicated generally as **400**. It has first and second end sections **402**, **404**, carried over spaced apart rail car trucks **406**, **408**. Side sills **410**, **412** extend between end sections **402** and **404**. A modest center sill **414** extends from end to end of coil car **400** along the longitudinal centerline, and terminates at draft pockets with draft gear and couplers in the manner of rail road cars generally. Main bolsters extend laterally outboard from center sill **414** at the truck centers to meet side sills **410** and **412**. An array of cross bearers **418** is spaced along car **400**, and is slung between side sills **410** and **412**, and center sill **414** generally as described above in the context of car **200**.

A trough structure, generally indicated as **420**, is mounted above, and supported by, cross bearers **418** and between side sills **410** and **412**. That is, side sills **410** and **412** extend longitudinally along the outboard edges of, and define bounds of, trough structure **420**. As in the other embodiments, side sills **410** and **412** lie at, or just within, that is, within two inches of, the AAR Plate B width limits. Trough structure **420** includes a central trough **422**, and left and right hand laterally outboard troughs **424** and **426**, having the same structure and geometry as troughs **212**, **214** and **216** of coil car **200**, described above. Each of troughs **422**, **424**, and **426** has a walkway **421**,

423, **425** with tread plates **428** located at the base, or groin, that is, the valley bottom, of the particular trough. Movable coil stops, each indicated as **430**, are mounted between side sills **410** and **412** as more fully described below. Each coil stop has a stile, or step, **431** with a roughened tread plate **432** and hand grabs **433** to aid personnel in walking along the valley of central trough **422**. Although six coil stops are illustrated, this is representative of any reasonable number of coil stops more generally, such as may be appropriate for anticipated loading conditions, and overall maximum car weight when loaded. Coil car **400** has a removable cover, indicated generally in Figure **7b** as **405**, and cover guides **407** mounted at the corners of the car on the end bulkheads to aid in locating cover **405** in place.

Coil car **400** differs from coil car **200** in a number of respects. First, as shown in Figure **7b**, lower flange **434** of cross bearer **418** has an upwardly angled portion **435** adjoining the lower flange **436** of center sill **414**, and a flat portion **437** extending from portion **435** to a distal tip next to the lap joint of web **438** with the vertical stiffener **440** of side sill **410** (or **412**, as may be).

Second, the construction of coil stop **430**, and its mating engagement strip of side sill **410** (or **412**) differs from that of coil stop **280** and strip **259** described above. As with coil stop **280**, coil stop **430** has the construction of an I-beam **442** having flanges **443** and **444** lying in spaced apart vertical planes, and a web **445** lying in a horizontal plane between flanges **443** and **444**. As above, web **445** is perforated, having lightening holes indicated as **446**. I-beam **442** is capped at either end by end plates **448**. However, rather than the horizontal pin arrangement of coil stop **280**, end plates **448** have toes **450** that extend past flanges **443** and **444** in the longitudinal direction of car **400**. Toes **450** each have rollers **452** mounted to them to engage a load bearing member of the side sill, as described below. In addition, a pair of perforated bars, or strips **451** and **452** are welded to the laterally outboard faces of plates **448**. Strips **451** and **452** stand in parallel horizontal planes and extend outwardly from end plates **448**. The perforations **454** and **455** in strips **451** and **452** are aligned with each other. Perforations **454** and **455** are slots having an oblong shape to permit lateral tolerance in the placement of coil stop **430** relative to side sills **410** and **412**.

Third, the construction of the top chord is different from that of top chord **250**. As above, each of side sills **410** and **412** has the same profile, given that, in terms of primary structure, coil car **400** is structurally symmetrical both about the longitudinal

centerline and the transverse central plane of the car. Each of side sills **410** and **412** has a top chord assembly, generally indicated as **456**, a bottom chord indicated as **457**, and a webbing assembly **458** extending between the top and bottom chords. Webbing assembly **458** includes both a web sheet **460** and stiffeners in the nature of posts **462** that extend between the top and bottom chords at longitudinal stations corresponding to the longitudinal planes of the webs of cross bearers **418**, to which they are welded.

In contrast to the dog-legged closed box section of top chord **258**, top chord assembly **456** includes a trapezoidal hollow tube **464** having inner and outer walls parallel to the slope angle of web sheet **460**, and a perpendicular base wall. The top wall **465** of hollow tube **464** is formed to lie in a horizontal plane. An inwardly opening C-shaped formed channel member **466** has a back **467** and parallel legs **468** and **469**. Leg **468** lies upon, and is welded to, top wall **465**, such that back **467** stands in a vertical plane. A cowling support bracket **470**, is welded to back **467**. Cowling support bracket **470** has the form of an angle having a relatively tall vertical leg **471** whose toe is welded to the outboard face of back **467** of channel member **466**, and a relatively short inwardly extending horizontal leg **472** that extends from the upper end of leg **471** inboard toward the car centerline. Leg **472** is a flange having sufficient width (i.e., the length of the leg from the angle to the tip of the toe) to support coil cover **405** such as commonly used on coil cars to protect the lading from rain and snow. (More generally, covers such as cover **405** can be used with each of the other embodiments described herein). The upwardly facing surface of leg **472** and the corresponding upwardly facing surfaces of end bulkheads **484** define respective longitudinal and transverse edges of a rectangular periphery bounding the trough structure. The interface surface of the boundary matches the footprint of cover **405**, such that the trough structure, walkways and coil stops are carried within the footprint (i.e., within the vertical projection of area) of cover **405** when installed. Cover **405** is removable to permit loading of coils into the trough structure.

As best seen in the enlarged detail of Figure **7c**, the upper face of leg **468** provides a trackway, or bearing surface, upon which rollers **452** can travel when coil stop **430** is not locked in place. Strips **451** and **452** are carried on plates **448** at height to bracket upper leg **469** of formed channel member **468** in a sandwich arrangement. Upper leg **469** has perforations **471** such that a securement or locking member, such as pin **474**, can be inserted through strip **451**, leg **469** and strip **452**. Pin **474** has a head **475** of sufficient size to seat on the upper face of strip **451**, and a link **476** to which a cable, chain, or similar retraction means such as lanyard **290**can be attached.

When pin **474** is installed, it is in a double shear condition. Two pins **474** are used at each end of coil stop **430** at any given time.

The pitch of the oval, or oblong, holes, apertures, slots or namely perforations **454** in strips **451** and **452** is slightly different from the pitch of perforations **471** in leg **469** such that a movement of less than a full pitch will cause a different set of holes to align, allowing a finer choice of positions. That is, the pitch of holes in leg **469** is 3 inches. The pitch of the slots in strips **451** and **452** is 1.8 inches. Given the 8 slot arrangement, the different pitches are such that at least 2 sets of slots and holes will line up at every 0.6 inch increment in travel along the leg **467**. In this way, perforations **454** in strips **451** and **452**, and perforations **471** in strip **469** act as co-operating indexing members. The pitch of one set of indexing members is different from the pitch of the other, such that the effective resolution, or incremented graduation, is less than either pitch by itself.

The mounting of rollers **452** on the extending lugs or toes **450**, or lugs, of end plates **446** gives a relatively long wheelbase for coil stop **430** and facilitates operation of coil stop **430**. While rollers are preferred, in an alternative embodiment a polymeric slider pad could be used in place of rollers as used in coil car **200**. Nylon pads, or cushions, **477** are mounted to the outside faces of flanges **443** and **444** in a position to contact coils carried in the troughs, and tend to discourage damage to the edge of the coils. Similar pads **478** are mounted to the inward face of the end bulkheads **484**.

In operation, rail yard personnel can ascend the end walkways **480** of car **400** by means of the ladders **482** located at the corners of the car. Personnel can step over end bulkhead **484** and walk along the walkways provided along any of troughs **422**, **424**, or **426**. A step with a tread plate **486** is provided on end bulkhead **484** opposite the end of the walkway of central trough **422**. In stepping over each coil stop **430** personnel can steady themselves with the assistance of the safety appliances, namely handles **433** having the form of U-shaped, downwardly opening hand rungs **488**.

In the process of loading a coil, the coil stop pins are disengaged from leg **469** and coils stops **430** are urged to positions leaving a long enough space for the coil (or coils, if more than one of the troughs is being used) to be loaded. Each coil is lowered into place, typically by a crane. The next adjacent coil stops **430** are urged into position snug against the coil (or coils), or as nearly so as practicable, and the locking

members, namely pins **474** are engaged as shown in Figure **7b**. Shimming or packing materials are used if required. The movement of coil stop **430** can be either by a single person working in the center trough, or by two persons co-operating to push on either side from the outer troughs. The next coil, or coils are placed in position, and further coil stops are moved into position, and so on.

Figures 8a, 8b and 8c

In a further alternative embodiment, a coil car **480** can be constructed with a center sill having a variable depth of section. As above, coil car **480** is symmetrical about both it longitudinal centerline and a transverse axis at mid-span between trucks **26**, **28**, hence only a half illustration is provided to represent both ends. Referring to Figures **8a**, **8b**, and **8c**, the structure of coil car **480** includes a center sill **482** extending longitudinally between rail car ends **484** and **486**. Center sill **482** is the primary longitudinal structural element in coil car **480** for resisting vertical loads. Longitudinally extending side sills **490** and **492** are tied to centre sill **482** by an array of cross-members **488** that extend outwardly and away therefrom. The arrangement of center sill **482**, cross-bearers **448** and side sills **490** and **492** support trough structure **494**. Trough structure **494** has three parallel, longitudinally extending troughs **496**, **497** and **498**. Central trough **498** is arranged between outboard troughs **496** and **497** and is carried at a lower height relative to TOR than outboard troughs **496** and **497**.

Examining center sill **482** in greater detail, it has a deep central portion **500** located intermediate two relatively shallow end portions **502** and **504**. Central portion **500** has a constant depth of section. The transition from the relatively shallow section at end portions **502** and **504** to the deep section at central section **500**, occurs as a step, as shown in Figure **8a**. A center sill of variable section, having shallow ends to clear the trucks, and deeper mid-span depth, whether constant or tapered, are often referred to as fish belly center sills, Alternatively, in another embodiment, central portion **500** can have a variable depth of section, the depth of section being greatest at a mid-span **70** distance between end portions **502** and **504**. The maximum depth of section is provided at mid-span **70** to correspond to the location of the greatest bending moment. The transition from the relatively shallow section at end portions **502** and **504** to the deep section at central section **500**, occurs in a substantially linear fashion, that is, the section tapers linearly moving away from the mid-span **70**.

Center sill **482** is cambered such that, in an unloaded condition, the mid-span clearance above top of rail is greater than at the truck centers. The camber allows the center sill **482**, in an unloaded condition, to have a clearance above top of rail (TOR) at mid-span **70** that is greater than the clearance above TOR at a location away from mid-span **70**. In this way the depth of section of centre sill **482** at mid-span **70** can be maximized, while maintaining the minimum required clearance above (TOR) for the coil car when in a loaded condition.

Referring to Figure **8b**, fish belly center sill **482** includes an upper flange **510**, a lower flange **512**, and a pair of parallel vertical webs **514** and **516** that extend therebetween. Upper flange **510** of fish belly center sill **482** lies flush with the upper flange **506** of cross-bearers **489**. Vertical webs **514** and **516** extend below lower flange **508** of cross-bearers **489** to join lower flange **512**. At the location where lower flange **508** of cross-bearers **489** intersect with vertical webs **514** and **516**, a gusset **518** is provided between vertical webs **514** and **516**. A plate **520** is welded to lower flange **502** of fish belly center sill **482** to provide additional reinforcement.

In this embodiment, a different side sill configuration is used. As shown in Figure **8b**, each of side sills **490** and **492** includes a top flange assembly **526** and a web **528**. No bottom flange assembly or bottom chord member is provided. The structure of side sills **490** and **492** does not extend below lower flange **512** of fish belly center sill **482**. But rather terminates at the level of the lower flange of cross bearer **489**. Top flange assembly **526** has a top chord member **530** in the nature of a hollow rectangular steel tube **532**. Web **528** has a bent upper margin welded to the outer face of rectangular steel tube **532** . Web **528** extends downwardly, and inwardly on an angle, and is attached to the ends of cross-bearers **489**.

The trough structure of coil car **480** is the same as trough structure **38** of coil car **20**, described above. A fish belly center sill coil car can also be manufactured having the main sill and cross bearer construction of coil car **480**, and the trough stricture of either coil car **200** or coil car **400**, as shown in the Figures and described above, including internal walkways in the central or side troughs, or both. It will be understood that a center sill coil car, as shown in Figures **8a**, **8b** and **8c**, can have coil stops such as coil stops **180** or **230**, and coil stop retention means as described above.

A preferred embodiment has been described in detail and a number of alternatives have been considered. As changes in or additions to the above described embodiments may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited by or to those details, but only by the appended claims.

Claims

We claim:

1. A coil stop for a rail road coil car, the coil car having a trough structure in which to carry coils, said coil stop comprising a beam member for spanning the trough structure, said beam member having a first end, a second end, and a medial portion extending between said first and second ends, and said coil stop having a step mounted on said beam member between said first and second ends, whereby to facilitate climbing over said coil stop.

2. The coil stop of claim 1 wherein said step includes a tread plate mounted upon said beam.

3. The coil stop of claim 1 wherein said step is mounted centrally on said beam.

4. The coil stop of claim 1 wherein a hand grab is mounted to said beam adjacent to said step.

5. The coil stop of claim 1 wherein a pair of first and second hand grabs are mounted to either side of said step.

6. The coil stop of claim 1 wherein said beam includes a horizontal web, and said step is mounted to said horizontal web.

7. The coil stop of claim 6 wherein said horizontal web has lightening holes defined therein.

8. The coil stop of claim 1 wherein at least one of said first and second ends has an indexing member mounted thereto for engagement with the coil car.

9. The coil stop of claim 1 wherein said coil stop includes rollers mounted at said first and second ends therefor for facilitating positioning of said coil stop in the trough structure of the rail car.

10. A coil stop for a rail road coil car, the coil car having a trough structure in which to carry coils, said coil stop comprising a beam member for spanning the trough structure, said beam member having a first end, a second end, and a medial portion extending between said first and second ends, and said coil stop having a treaded step located between said first and second ends of said beam member, to facilitate climbing over said coil stop.

11. The coil stop of claim 10 wherein said step includes a tread plate mounted upon said beam member.

12. The coil stop of claim 10 wherein said step is located centrally on said beam member.

13. The coil stop of claim 10 wherein a hand grab is mounted to said beam member adjacent to said step.

14. The coil stop of claim 10 wherein a pair of first and second hand grabs are mounted to either side of said step.

15. The coil stop of claim 10 wherein said hand grab is an upwardly extending hand rung.

16. The coil stop of claim 10 wherein said beam member includes a horizontal web, and said step is located on said horizontal web.

17. The coil stop of claim 16 wherein said horizontal web has lightening holes defined therein.

18. The coil stop of claim 10 wherein at least one of said first and second ends has an indexing member mounted thereto for engagement with the coil car.

19. The coil stop of claim 10 wherein said coil stop includes rollers mounted at said first and second ends therefor for facilitating positioning of said coil stop in the trough structure of the coil car.

20. The coil stop of claim 19 further comprising indexing members mounted at said first and second ends of said beam member, said indexing members being engageable to maintain said coil stop in a fixed position relative to the trough structure.

21. The coil stop of claim 19 further comprising attachment means mounted at said first and second ends of said beam member by which to secure the coil stop in a fixed position relative to the trough structure.

22. The coil stop of claim 21 wherein said attachment means includes a first perforated plate extending from said first end of said beam member, and a second perforated plate extending from said second end of said beam member.

23. The coil stop of claim 21 wherein said attachment means includes a first pair of spaced apart perforated plates extending from said first end of said beam member, and a second pair of spaced apart perforated plates extending from said second end of said beam member.

24. A coil stop for a rail road coil car, the coil car having a trough structure in which to carry coils, said coil stop comprising a beam member for spanning the trough structure, said beam member having a first end, a second end, and a medial portion extending between said first and second ends, said coil stop having a step located on said beam member between said first and second ends, to facilitate climbing over said coil stop, and said coil stop further having a hand grab standing upwardly of said beam member adjacent to said step, said hand grab being an upwardly extending hand rung.

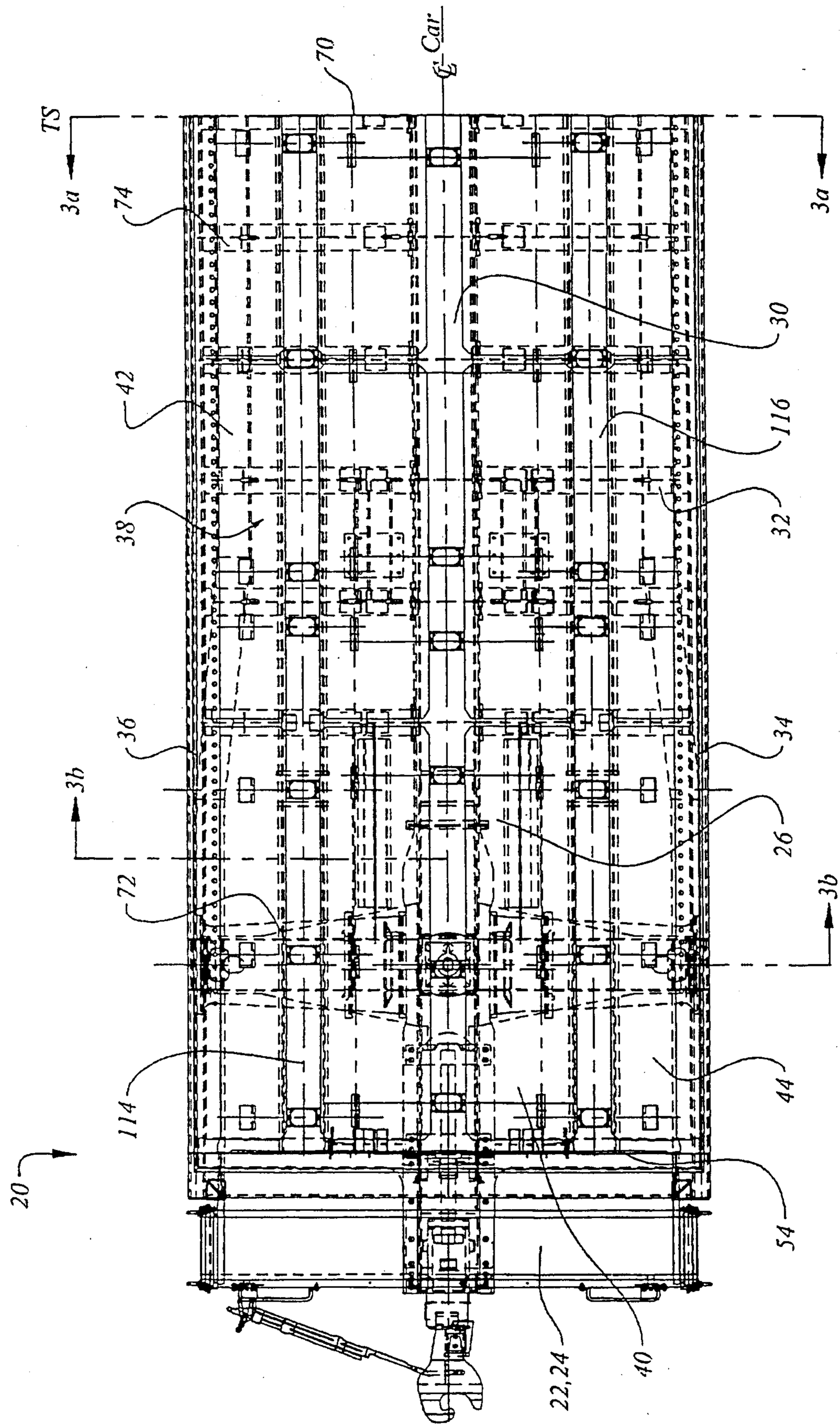

Figure 1a

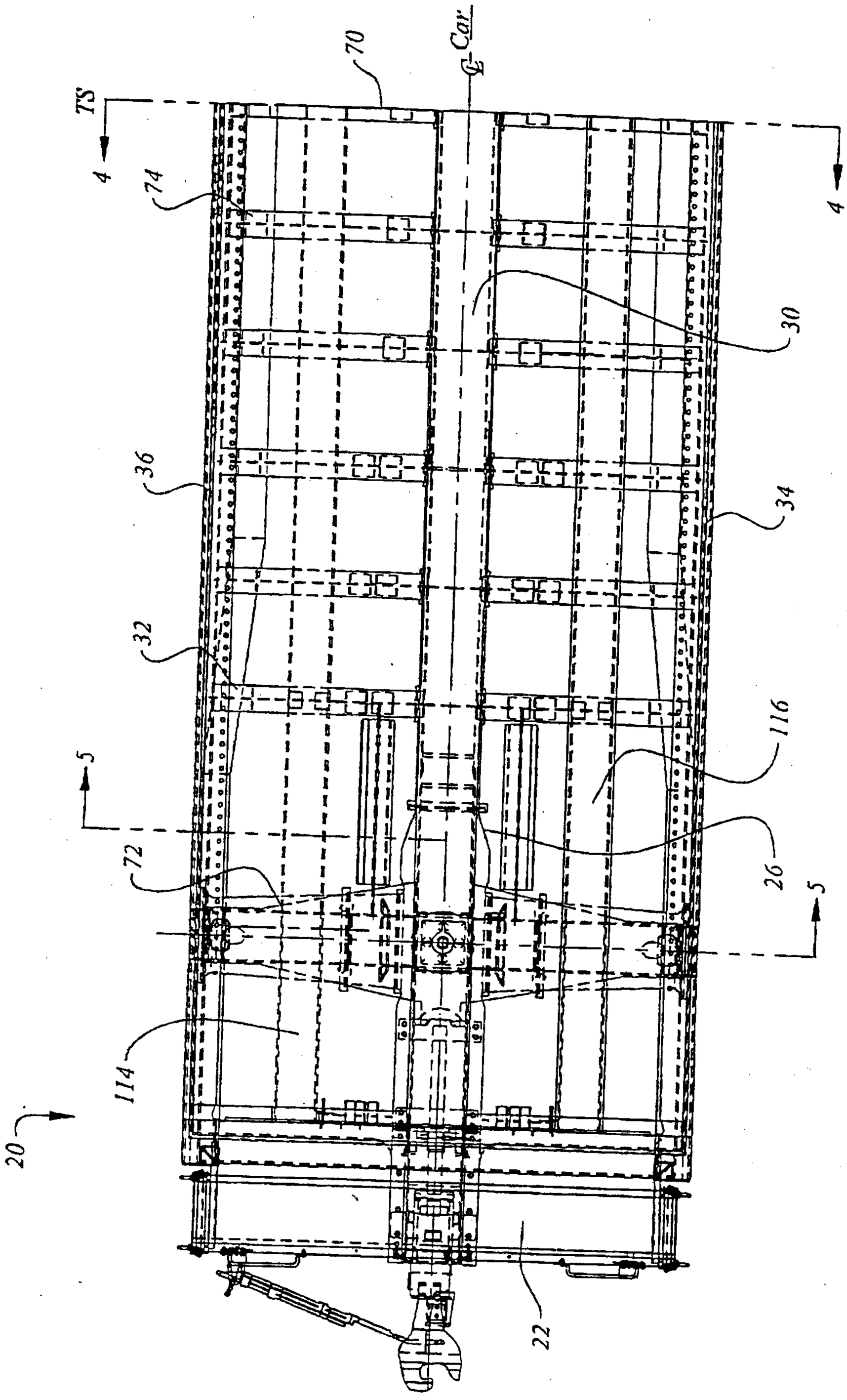

Figure 1b

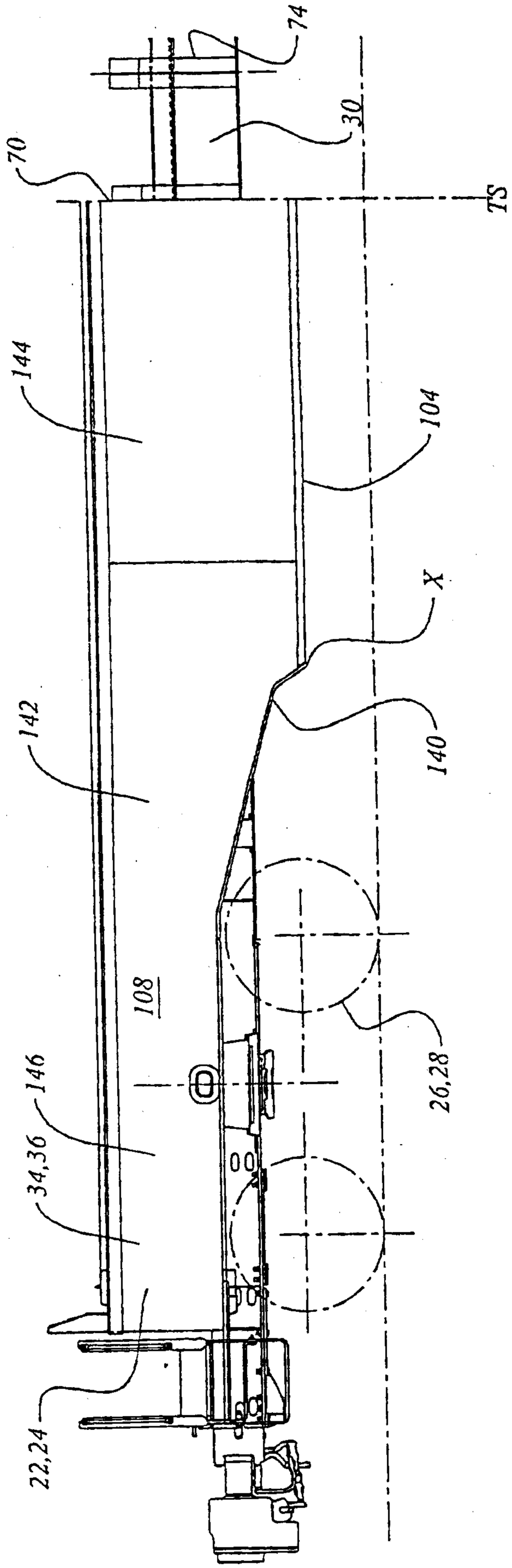

Figure 2

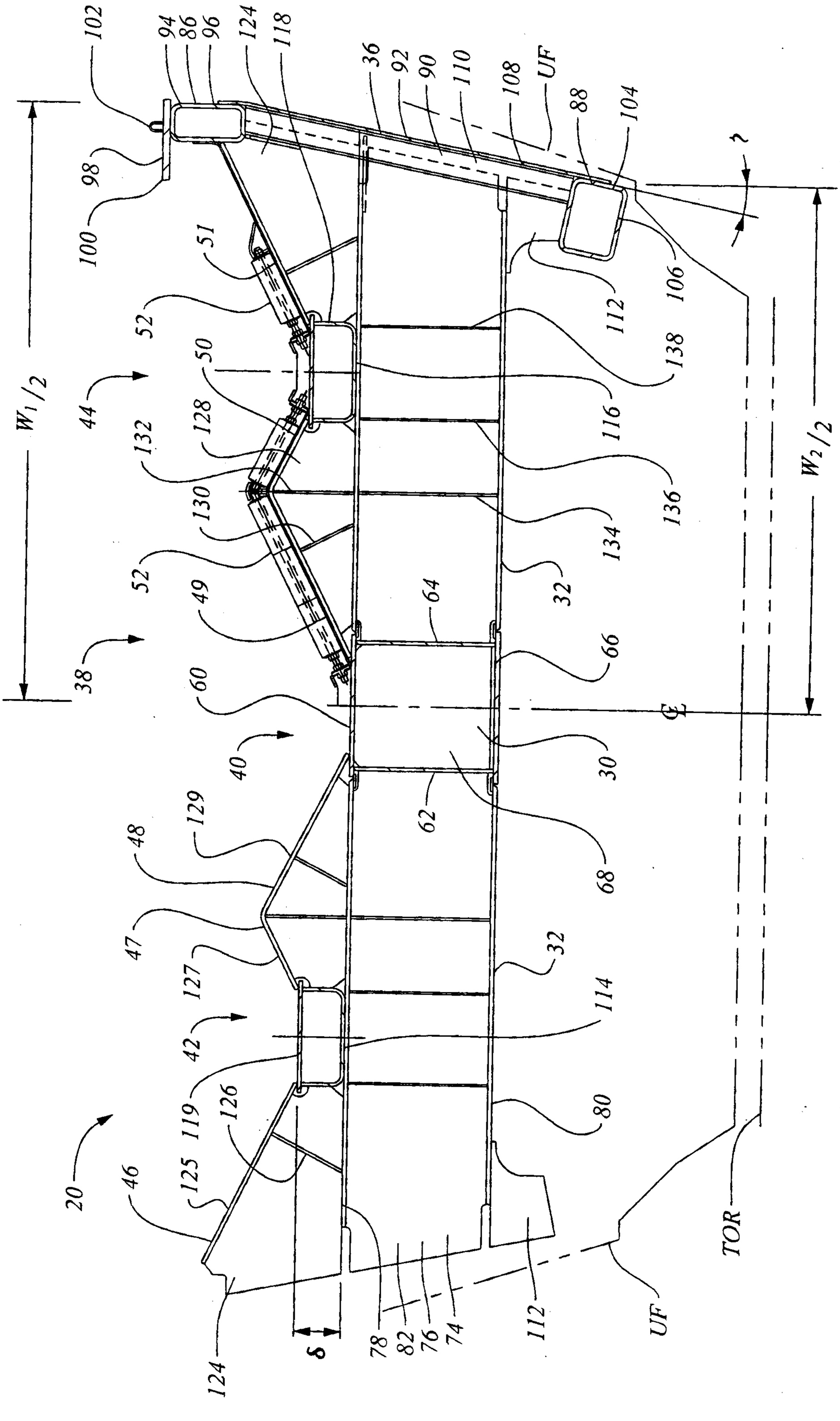
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Figure 3a

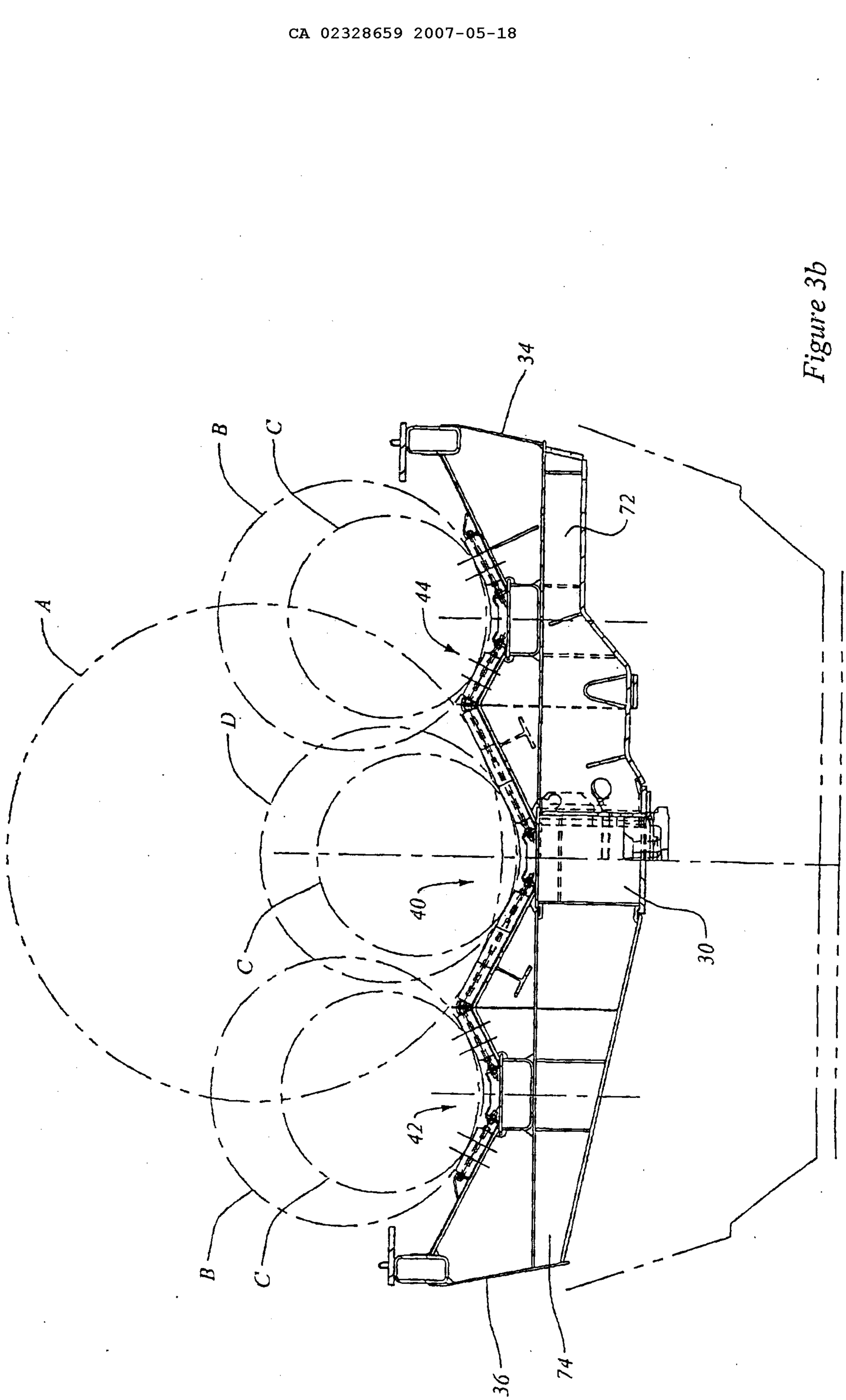

Figure 3b

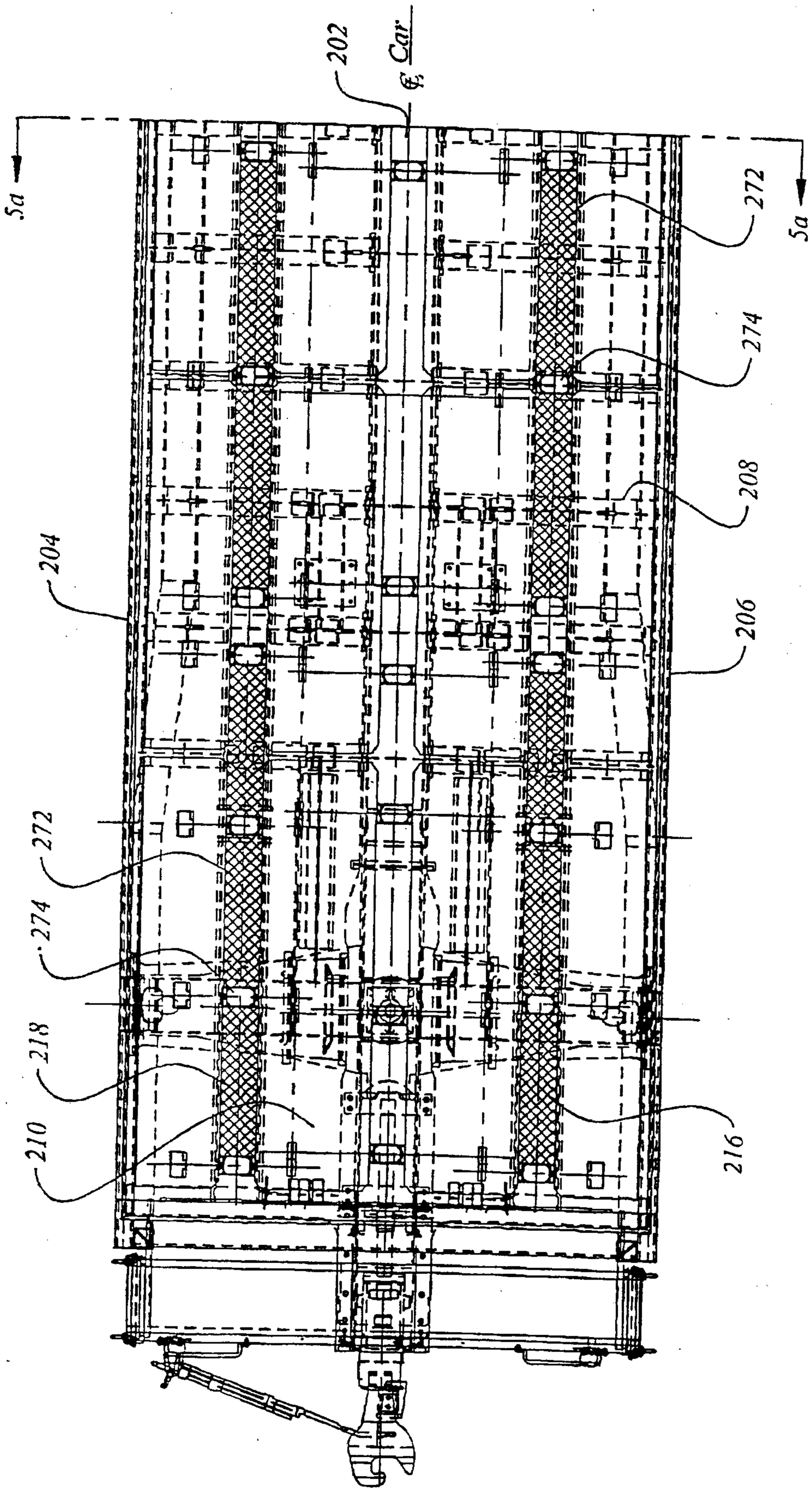

Figure 4

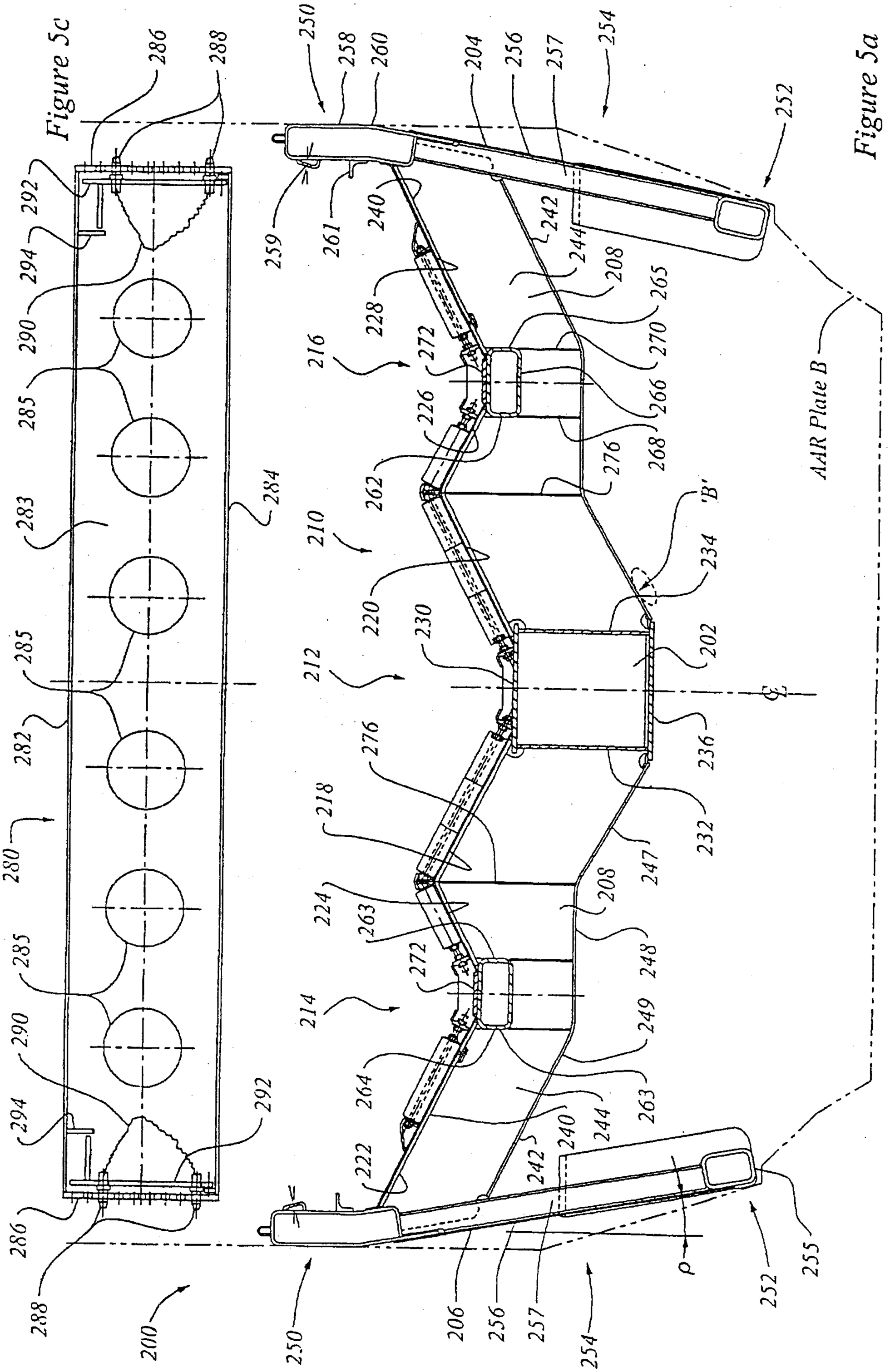
Figure 5c
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Figure 5a
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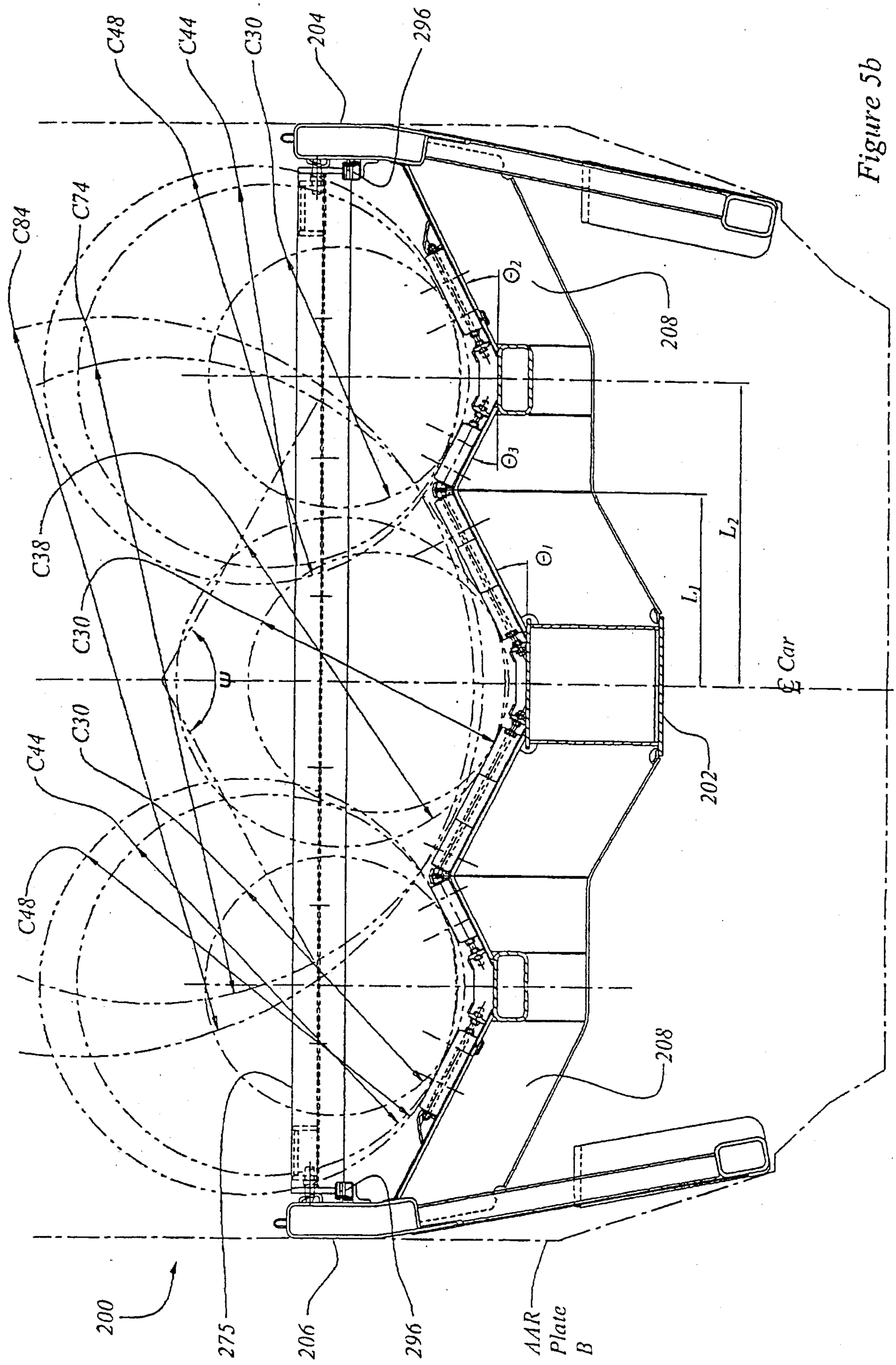
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Figure 5b

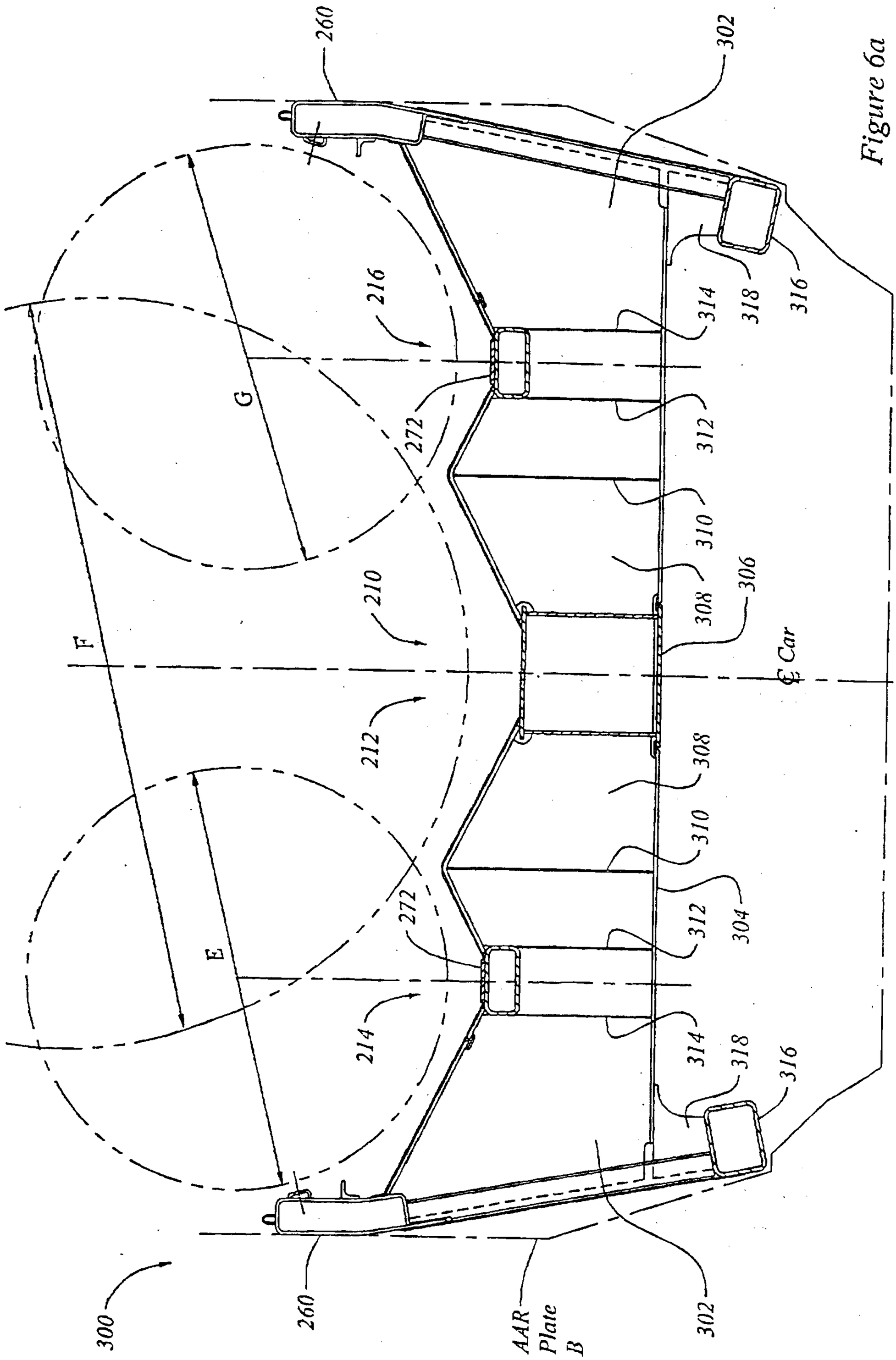
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Figure 6a

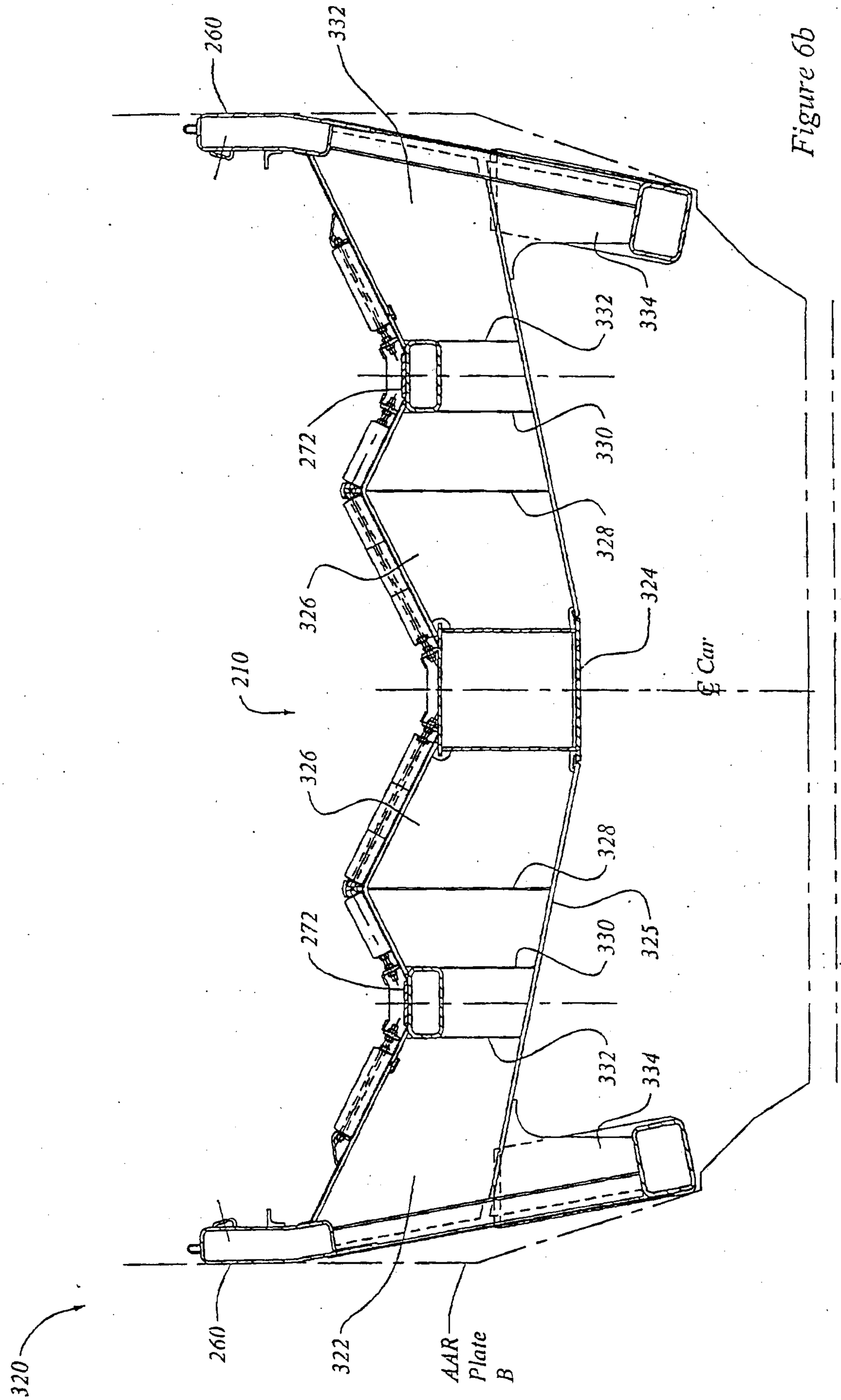

Figure 6b

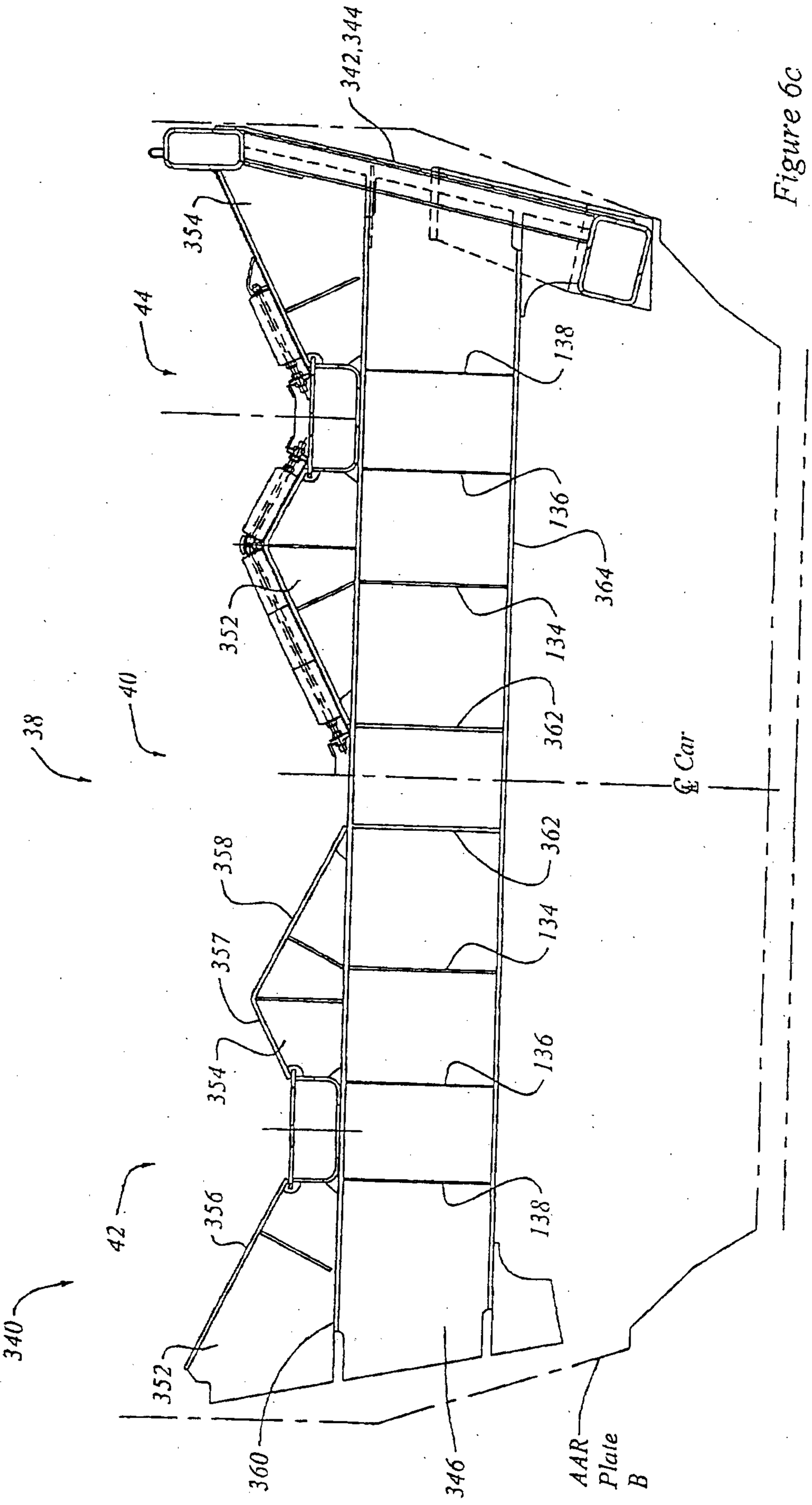
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Figure 6c

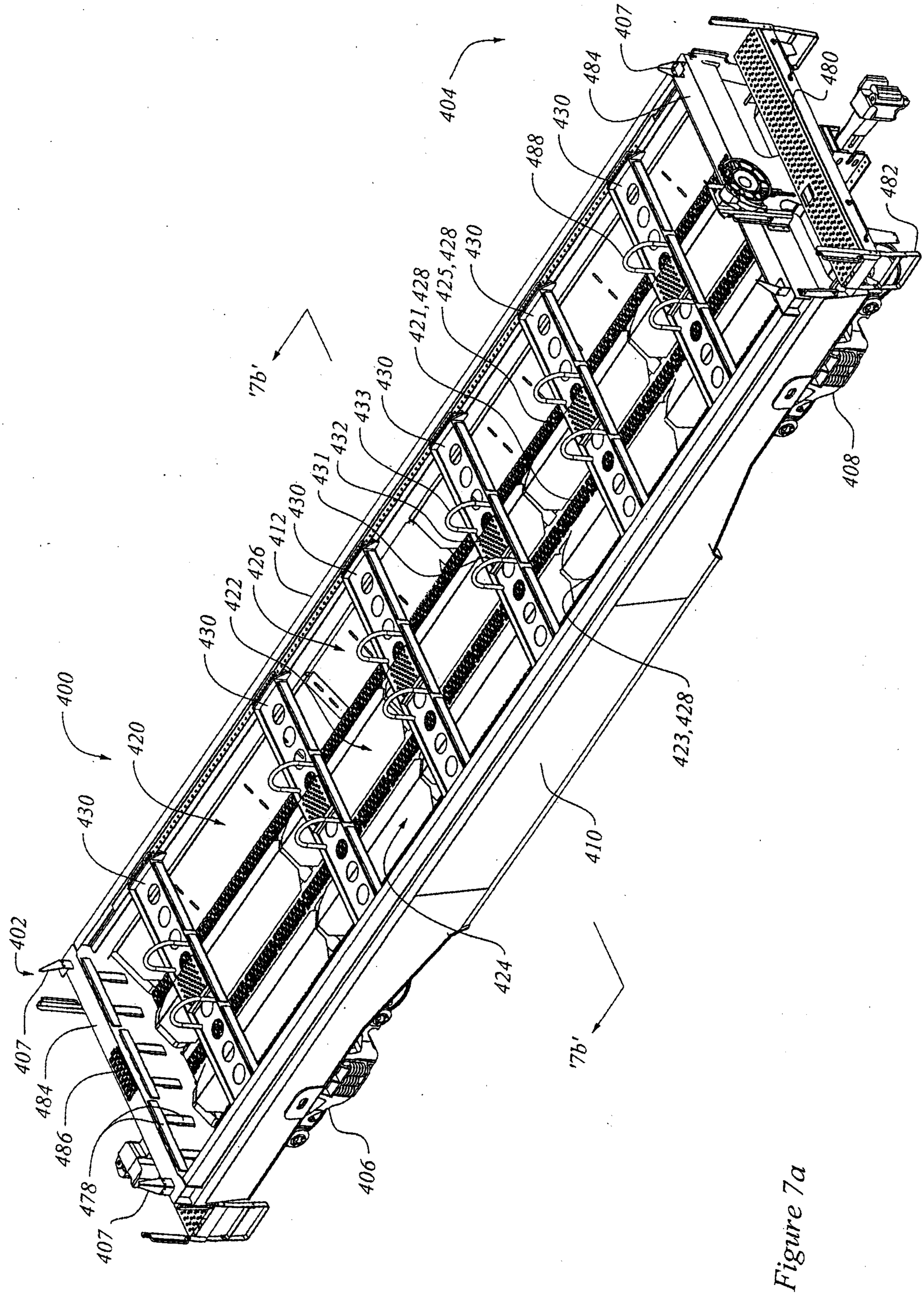
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Figure 7a

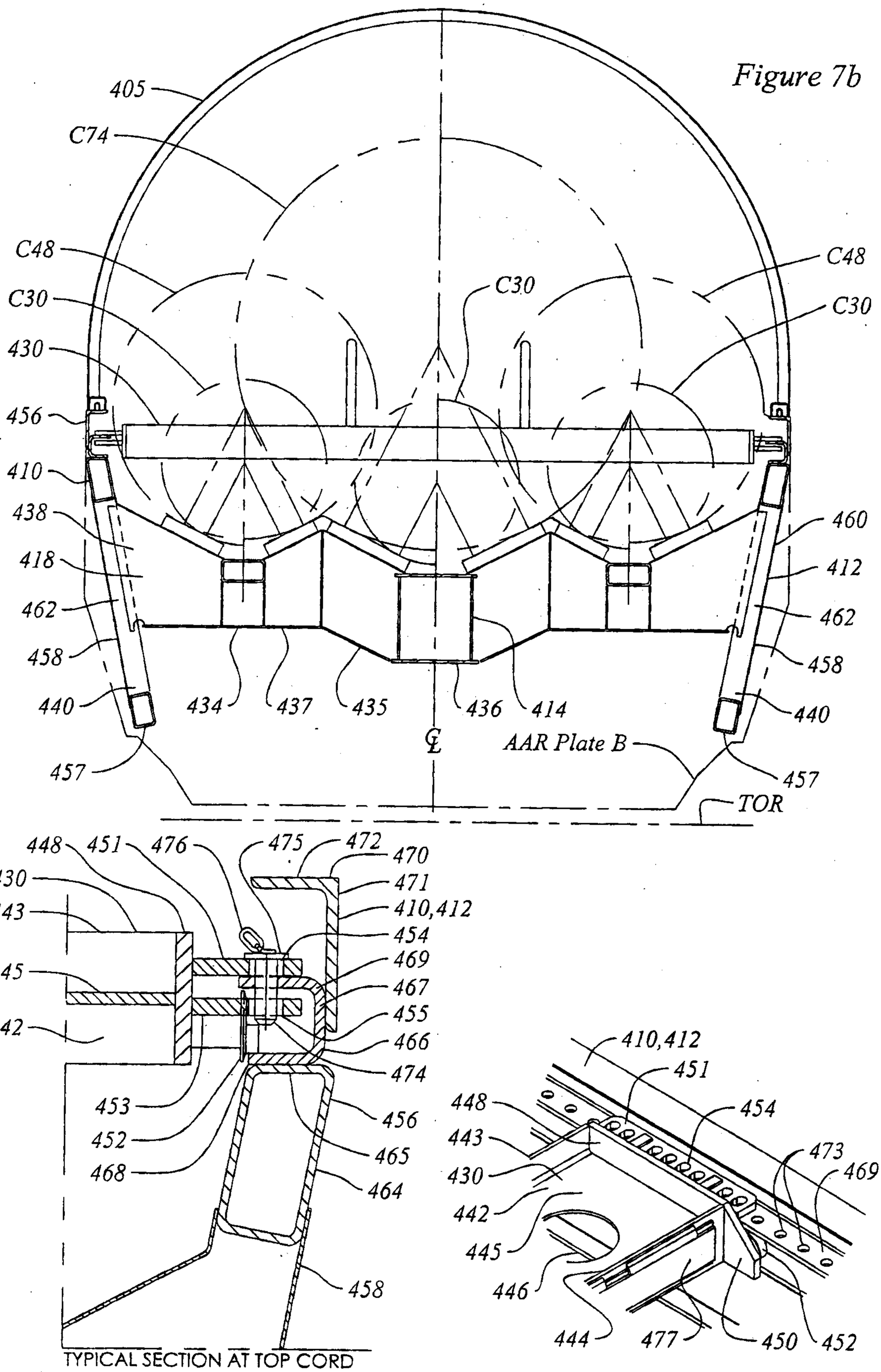

Figure 7b

Figure 7c

Figure 7d

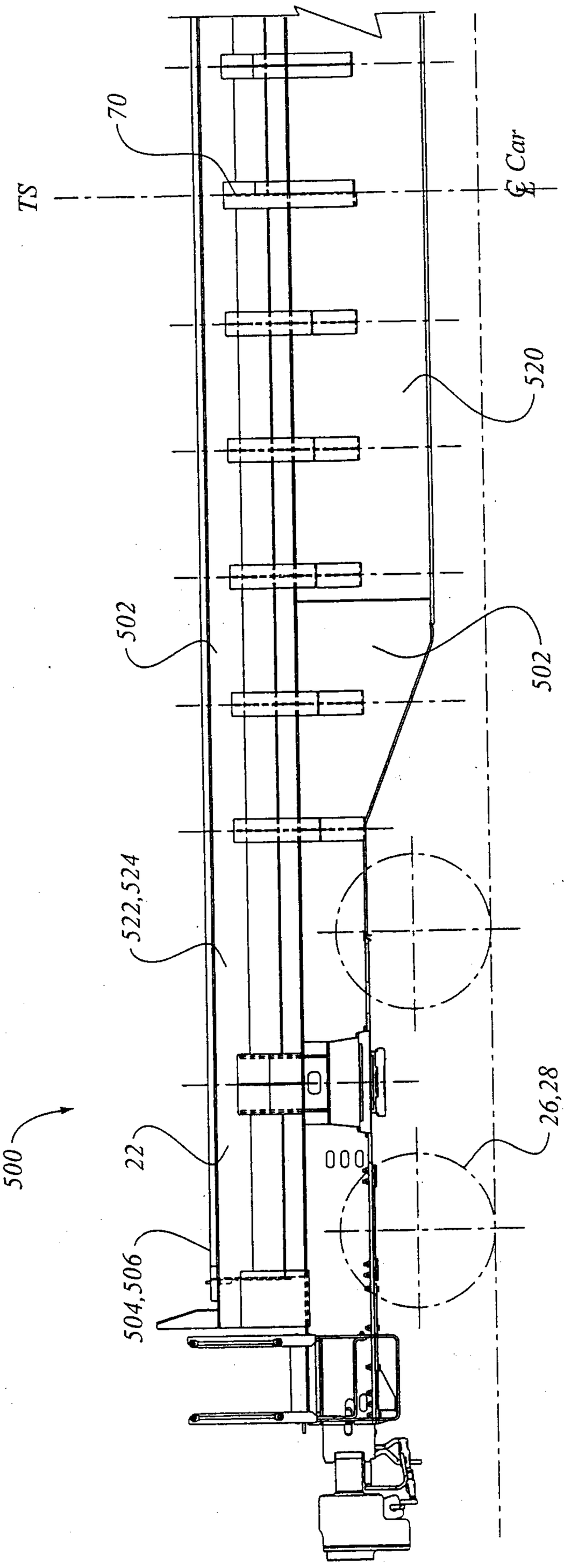

Figure 8a

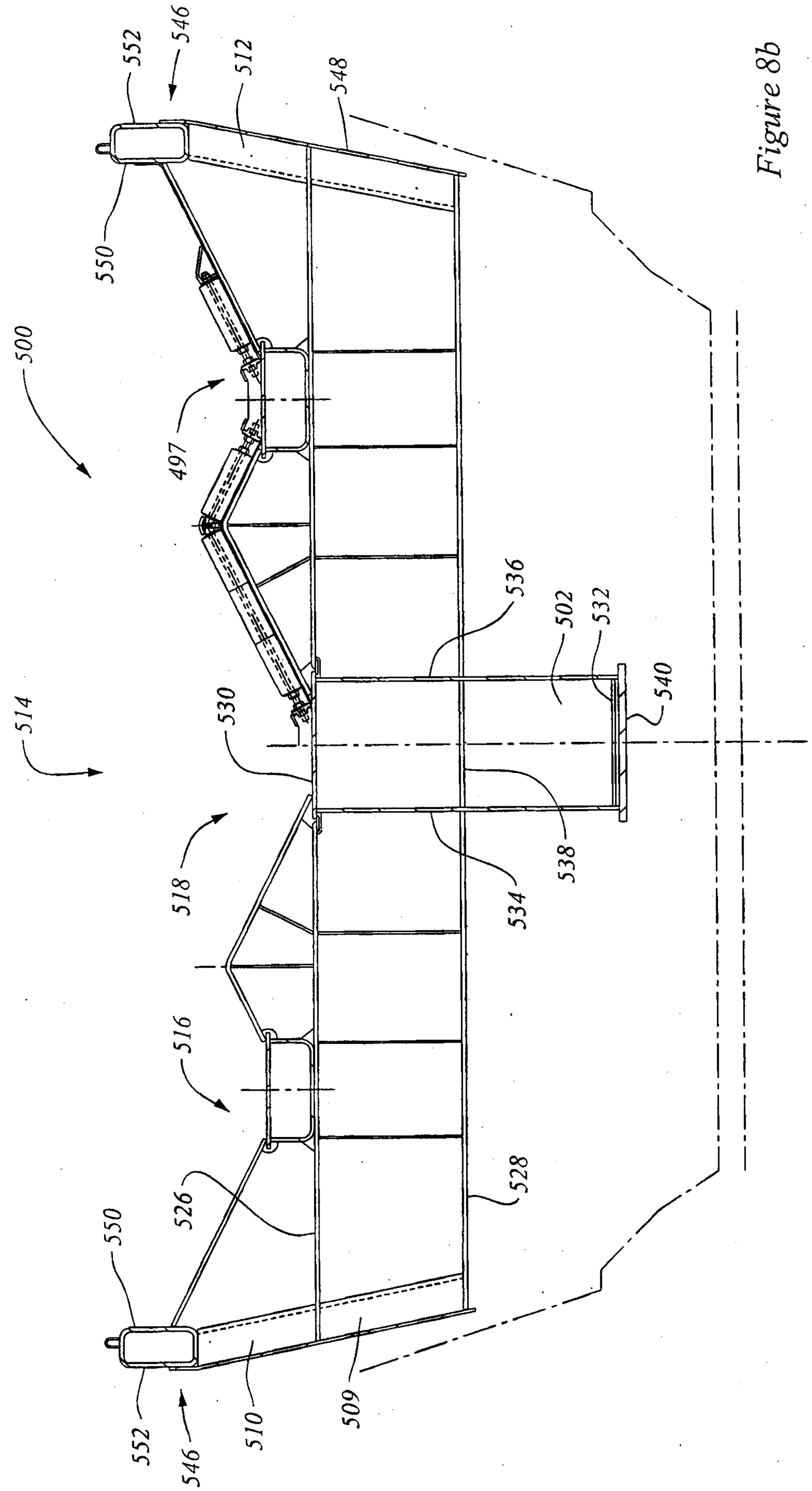
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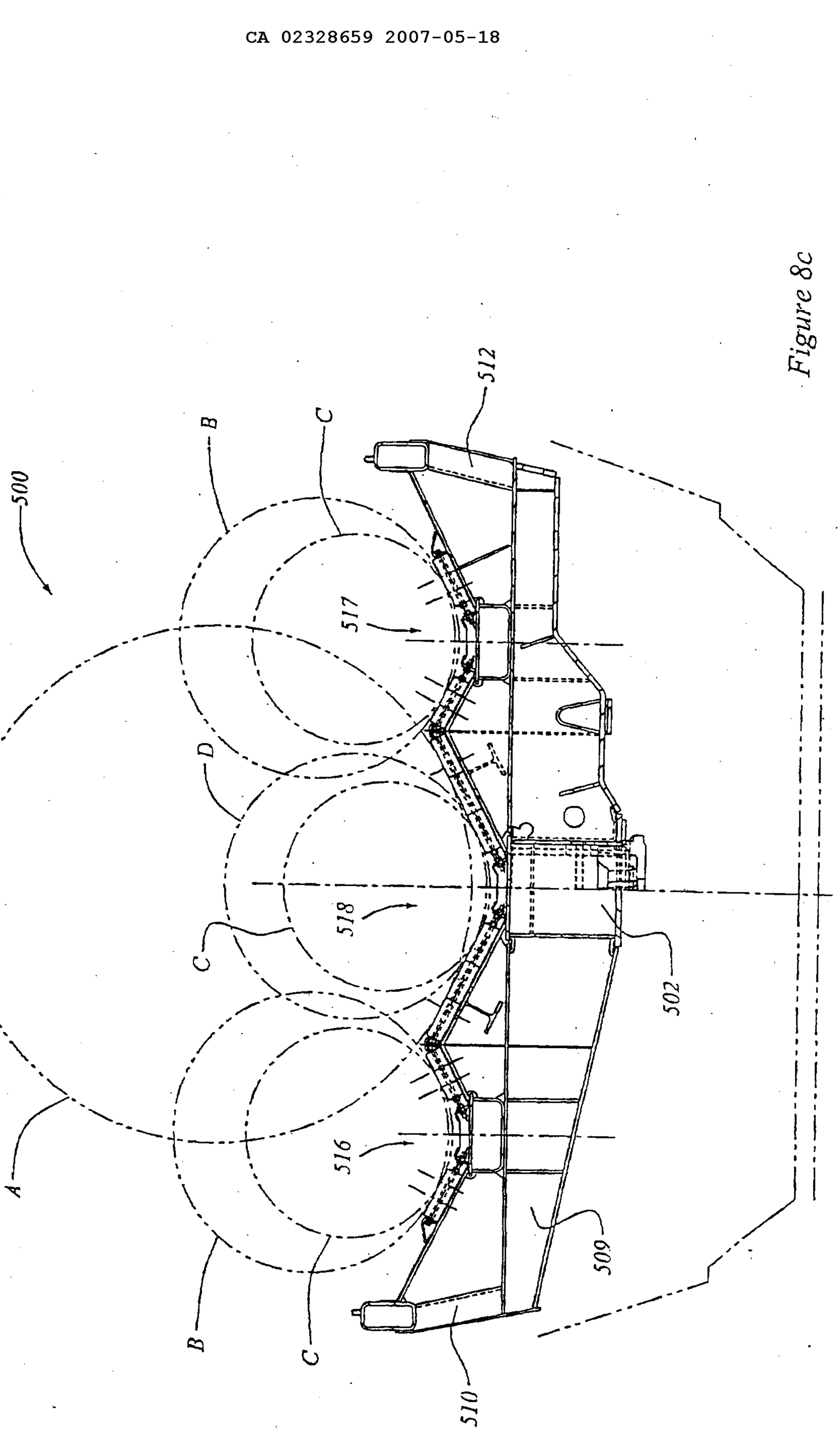
Figure 8b



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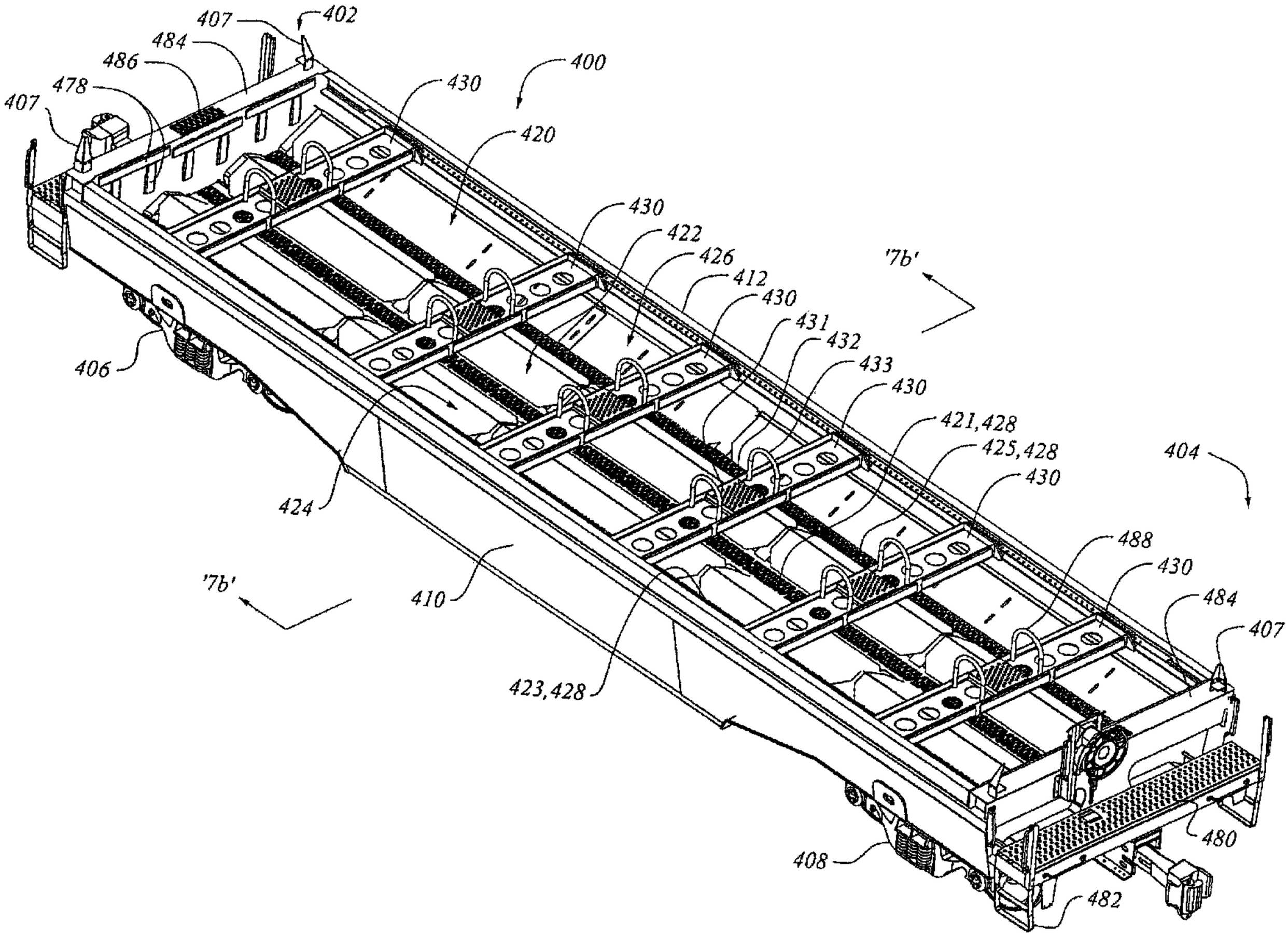
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