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An agency of Industry Canada

CA 2907133 C 2017/04/11

(11)(21) 2 907 133

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2009/01/14

(41) Mise à la disp. pub./Open to Public Insp.: 2009/09/03

(45) Date de délivrance/Issue Date: 2017/04/11

(62) Demande originale/Original Application: 2 716 057

(30) Priorité/Priority: 2008/02/29 (US12/074,258)

(51) Cl.Int./Int.Cl. *E21B 7/02* (2006.01),
E21B 15/00 (2006.01)

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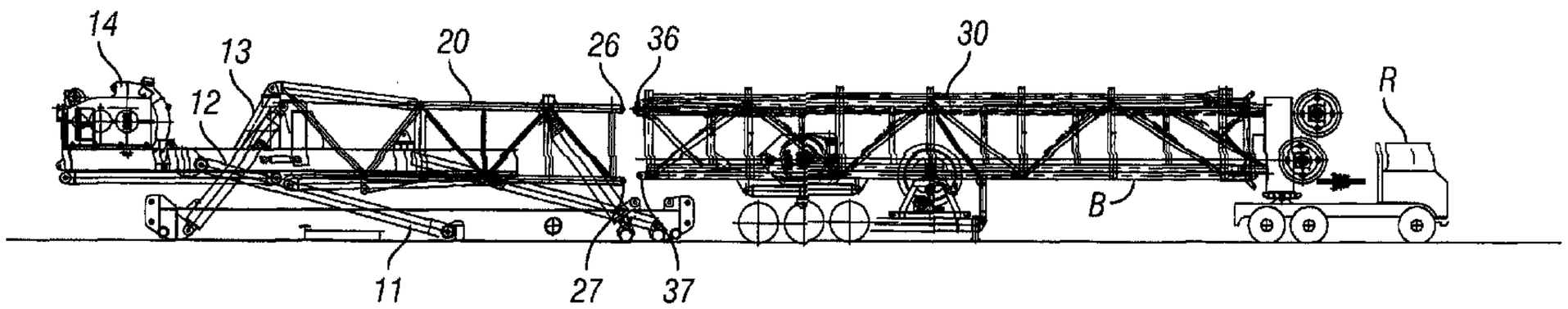
(54) Titre : PROCEDE ET APPAREIL POUR FACILITER L'ASSEMBLAGE ET L'ERECTION D'UN APPAREIL DE FORAGE

(54) Title: METHOD AND APPARATUS FOR FACILITATING ASSEMBLY AND ERECTION OF A DRILLING RIG



(57) Abrégé/Abstract:
A method for facilitating assembly and erection of a drilling rig. The drilling rig comprises a structure and a mast, the mast comprising at least a first mast section and a second mast section and the structure having an open area therein. The method comprises the steps of moving the first mast section in the open area and connecting the first mast section to the structure, the first mast section having first connection apparatus; moving the second mast section adjacent the first mast section using a vehicle, the second mast section having second connection apparatus; and moving the first section so that the first connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the first mast section to the second mast section.

ABSTRACT

A method for facilitating assembly and erection of a drilling rig. The drilling rig comprises a structure and a mast, the mast comprising at least a first mast section and a second mast section and the structure having an open area therein. The method comprises the steps of moving the first mast section in the open area and connecting the first mast section to the structure, the first mast section having first connection apparatus; moving the second mast section adjacent the first mast section using a vehicle, the second mast section having second connection apparatus; and moving the first section so that the first connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the first mast section to the second mast section.

METHOD AND APPARATUS FOR FACILITATING ASSEMBLY AND ERECTION OF A DRILLING RIG

This is a divisional of Canadian Serial No. 2,716,057, filed January 14, 2009.

The present invention relates to a method and apparatus for facilitating assembly and erection of a drilling rig and particularly, but not exclusively, to a method and apparatus for facilitating assembly and erection of a mast of a mobile land rig.

The prior art discloses a variety of rigs used in drilling and wellbore operations and methods of rig assembly; for example, and not by way of limitation, rigs and assembly methods as disclosed in U.S. Patents 2,857,993; 3,340,938; 3,807,109; 3,922,825; 3,942,593; 4,021,978; 4,269,395; 4,290,495; 4,368,602; 4,489,526; 4,569,168; 4,821,816; 4,831,795; 4,837,992; 6,634,436; 6,523,319; 6,994,171; 7,306,055; 7,155,873; and 7,308,953 and the references cited in these patents.

In many drilling operations, drilling rigs and related systems, equipment, and apparatuses are delivered to a site, assembled and then disassembled. It is important that drilling rigs and their components be easily transported and assembled. Costs associated with land rigs and associated equipment, can be calculated on a per hour or per day basis, and, therefore, efficient assembly, takedown, transport, and setup operations are desirable.

U.S. Patent 3,922,825 discloses a rig with a stationary substructure base and a movable substructure base mounted thereon which is coupled to the stationary base and swings upright into an elevated position on a series of struts that are connected to the stationary base with swivel connections at each end. The movable base is otherwise stationary since neither the stationary

base nor the movable base are mobile or repositionable without the use of an auxiliary crane or the like. The movable substructure base and the drill mast are raised with a winch mounted on an auxiliary winch truck.

U.S. Patent 3,942,593 discloses a mobile well drilling rig apparatus which has a trailerable telescoping mast and a separate sectionable substructure assembly with a rig base, a working floor, and a rail structure. The mast is conveyed to the top of the substructure by rollers and is raised by hydraulic raising apparatus to an upright position. With such a system the mast assembly can be relatively long when transporting it and the mast can be unstable during raising. This system uses drawlines and winch apparatus to raise the mast onto the working floor.

U.S. Patent 4,021,978 discloses a telescoping mast assembly adapted for use with drill rigs and the like. The mast assembly has multiple sections, said sections being adapted for nesting one within the other in the telescoped to the closed condition and each section has mutually convergent corner leg members which, when the mast assembly is extended, form concentric and in line arrangements of the corner leg members from the base to the crown of the mast. Means are provided for connecting each mast section to its neighboring mast section upon extension thereof. In addition, means are also provided for indexing of the connector means upon extension of the mast assembly from its telescoped to the closed condition.

U.S. Patent 4,821,816 discloses methods of assembling a modular drilling machine which includes a drilling substructure skid which defines two spaced parallel skid runners and a platform. The platform

supports a draw works mounted on a draw works skid, and a pipe boom is mounted on a pipe boom skid sized to fit between the skid runners of the drilling substructure skid. The drilling substructure skid supports four legs which in turn support a drilling platform on which is mounted a lower mast section. The legs are pivotably mounted both at the platform and at the drilling substructure skid and a pair of platform cylinders are provided to raise and lower the drilling platform. A pair of rigid, fixed length struts extend diagonally between the platform and the substructure skid away from the platform such that the struts do not extend under the platform and obstruct access to the region under the platform. The pipe boom skid mounts a pipe boom as well as a boom linkage, a motor, and a hydraulic pump adapted to power the pipe boom linkage. The substructure skid is formed in upper and lower skid portions, and leveling rams are provided to level the upper skid portion with respect to the lower skid portion. Mechanical position locks hold the upper skid in relative position over the lower skid. In one aspect such a method for assembling an earth drilling machine includes the steps of: (a) providing a modular earth drilling machine comprising a drilling substructure skid, a draw works skid, and a pipe boom skid, the drilling structure skid having a collapsible drilling substructure platform and means for receiving the draw works skid and the pipe boom skid, the draw works skid having a draw works winch, and the pipe boom skid having a pipe boom pivotably mounted to the pipe boom skid for rotation about a pivot axis, at least one hydraulic cylinder coupled between the pipe boom and the pipe boom skid to rotate the pipe boom about the pivot axis, a hydraulic pump mounted to the pipe boom

skid and coupled to the hydraulic cylinder by a closed hydraulic fluid circuit, and a pipe boom skid winch; the pipe boom skid, pipe boom, hydraulic cylinder and hydraulic pump forming a modular unit which is transportable as a single unit without any disconnection of the closed hydraulic fluid circuit; (b) positioning the substructure skid at a desired drilling position; (c) utilizing the pipe boom skid winch to pull the pipe boom skid into position with respect to the substructure skid; (d) utilizing the pipe boom skid winch to pull the draw works skid into position with respect to the substructure skid; and, in one aspect, the method further including raising the collapsible drilling structure platform, including utilizing the pipe boom skid winch to lift the drilling structure platform during at least an initial stage of the raising step.

U.S. Patent 4,831,795 discloses drilling derrick assemblies which provide for the elevation above ground level of the assembly's working floor which supports both the mast and the drawworks. Prior to erection, the elevatable equipment floor is carried on a supporting substructure, and a mast is pivotally connected to the elevatable floor in a reclining position. When the assembly is erected, the mast is pivotally raised and attached in place, and other rigging steps can be carried out. Through the use of an integrally mounted sling and winch assembly or, alternatively, through operation of the assembly's traveling block, the entire equipment floor is elevated to the desired level. In one aspect, a drilling structure is disclosed that has: a substructure for supporting the drilling structure on the surface through which drilling is to occur, an elevatable floor assembly which rests on the substructure in its lowered

position, a reclining mast pivotally connected to the elevatable floor, a gin pole assembly mounted on the elevatable floor assembly rearwardly of the point at which the mast is pivotally connected to the elevatable floor and arranged to receive line for raising the mast, whereby the mast is raised prior to raising the elevatable floor assembly, a collapsible vertically standing elevating frame assembly mounted on the substructure and forwardly of the mast, when raised, and the forwardmost end of the elevatable floor assembly, winch means rotatably mounted in and arranged adjacent the forwardmost end of the substructure, a first elevating block means mounted in the elevatable floor and rearwardly of the elevating frame assembly, a second elevating block mounted on the elevating frame assembly at a vertical point corresponding with the level to which the elevatable floor is to be raised, an elevating line extending from the winch means and reeved about the elevating block so that motion of the winch means in one direction causes the second elevating block to move toward the first elevating block raising the elevatable floor vertically and forwardly, motion of the winch means in another direction lowering the elevatable floor vertically and rearwardly, and a brace member on each side of the drilling structure, each brace member being pivotally connected at its ends, respectively, to the substructure and the elevatable floor, the brace members being arranged in pairs forming parallel linkages thereby causing the elevatable floor assembly to be raised in an arc like motion.

U.S. Patent 6,994,171 discloses two section masts with self aligning connections and methods with self aligning connections for a two section mast. The methods

include the steps of transporting the elongated bottom mast section to a guide frame adjacent to a well site, the bottom mast section having a pair of front legs and a pair of rear legs. An elongated top mast section is transported to the well site, the top mast section having a pair of front legs and a pair of rear legs. The legs of the bottom mast section are positioned slightly below a level of the legs of the top mast section. Thereafter, the bottom mast section is raised slightly to order to engage the top mast section while simultaneously aligning the mast sections together. The sections are thereafter pinned together. In one method of self aligning connections for a two section mast, the method includes: transporting an elongated bottom mast section to a guide frame adjacent to a well site, the bottom mast section having a pair of front legs and a pair of rear legs so that the bottom mast section is in a substantially horizontal orientation; thereafter transporting an elongated top mast section to the well site so that the top mast section is in a substantially horizontal orientation and so that the mast sections are substantially aligned lengthwise, the top mast section having a pair of front legs and a pair of rear legs; positioning the legs of the bottom mast section slightly below a level of the legs of the top mast section; raising the bottom mast section; and simultaneously engaging and guiding the mast sections together in a final connecting orientation.

U.S. Patent 7,155,873 discloses structural connectors for a drilling rig substructure; and a method and apparatus for connecting sections of a drilling rig substructure, in one aspect a structural connector is provided so that sections of a drilling rig substructure

can be connected together without the use of pins or pin type connectors. The structural connector utilizes specially shaped fixed members connected to, and extending through, support plates that are attached to sections of a drilling rig substructure that mate with specially shaped mating lugs that are mounted on mating lug plates that are attached to separate sections of the drilling rig substructure. When the sections of the drilling rig substructure to be connected are positioned together, the specially shaped mating lugs engage the specially shaped fixed members and form a high strength structural connection between the sections of the drilling rig substructure. In one aspect a structural connector is provided that has: a plurality of support plates each having a plurality of fixed support members extending therethrough, the fixed support members extending outwardly from both sides of the support plates and having side walls and contoured tops; a mating lug assembly having a plurality of mating lug plates and a plurality of mating lugs attached to each mating lug plate, each mating lug having a support notch therein; wherein the support notch of each mating lug has tapered guide surfaces at the entry point of the support notch, side walls, and a contoured top.

In accordance with the present invention, there is provided a method for facilitating assembly and erection of a drilling rig, the drilling rig comprising a structure and a mast, the mast comprising at least a first mast section and a second mast section, the method comprising the steps of connecting said first mast section to said structure, the first mast section having first connection apparatus, moving said second mast section adjacent the first mast section using a vehicle,

the second mast section having second connection apparatus, and moving the first section so that the first connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the first mast section to the second mast section. Preferably, the method of the invention is applicable to land drilling rigs, using trucks to facilitate assembly. Advantageously, the mast comprises a third section, which may be attached to the second section in accordance with the invention. Preferably, the mast comprises a fourth or fifth section.

In a preferred form, the structure has an open area therein and in the method the first mast section is moved into the open area and then connected to the structure.

Advantageously, the step of moving the first mast section is carried out using a structure raising apparatus. Preferably, the structure raising apparatus comprises a piston and cylinder. Preferably, the piston and cylinder is actuated using hydraulic fluid. Advantageously, the piston and cylinder is actuated using pneumatic fluid or a combination of pneumatic and hydraulic. Alternatively or additionally, the structure raising apparatus comprises a screw jack or a rack and pinion or any other suitable raising apparatus. Alternatively or additionally, the structure raising apparatus comprises a wireline and winch.

Preferably, the step of moving the first mast section is carried out using a mast raising apparatus. Advantageously, the mast raising apparatus comprises a piston and cylinder. Preferably, the piston and cylinder is actuated using hydraulic fluid. Advantageously, the piston and cylinder is actuated using pneumatic fluid or a combination of pneumatic and hydraulic. Alternatively or additionally, the structure raising apparatus comprises a screw jack or a rack and pinion or any other suitable raising apparatus. Alternatively or

additionally, the mast structure raising apparatus comprises a wireline and a winch.

Preferably, the method further comprises the step of releasing the second section from the vehicle, and moving the vehicle away from the second mast section.

Advantageously, the method further comprises the step of raising with first mast section with mast raising apparatus, raising the second mast section therewith. Preferably, the method further comprises the step of locking together the first connection apparatus and the second connection apparatus.

Advantageously, the first connection apparatus comprises a jaw member connected to the first mast section having a throat and a slot, the second connection apparatus comprises an insertion member with a bar, the insertion member sized and located for receipt in the throat of the jaw member and the bar sized and located for receipt within the slot, the method further comprising the step of moving the first mast section to move the insertion member into the throat and the bar into the slot.

Preferably, the jaw member has two spaced-apart plates each with a flared portion and the throat defined between the flared portions, further comprising the step of moving the insertion member into the throat.

Advantageously, the first and second connection apparatus comprise locking apparatus for locking together the first mast section and the second mast section.

Preferably, the first mast section further comprises four legs, the first connection apparatus further comprising a receiving member, each of two legs having a jaw member and each of two legs having the receiving member, the second mast section further comprises four legs, the

second connection apparatus further comprising a corresponding receiving member, each of two legs having a bar and each of two legs having the corresponding receiving member, the method further comprising the step of moving the first mast section to move the bar into the jaw member and connecting the receiving member with the corresponding receiving member. Preferably, the receiving member is connected to the corresponding receiving member with a pin.

Advantageously, the first mast section comprises at least one structural support member extending at an angle from the first mast section.

Preferably, an A-frame is arranged between the structure and the first mast section, the method comprising the step of connecting the A-frame to one of the A-frame and the first mast section. Advantageously, the structure comprises a drill floor, the A-frame arranged between the structure and the first mast section.

The present invention also provides a drilling rig comprising a structure and a mast, the mast comprising at least a first mast section and a second mast section, the first mast section having first connection apparatus, the second mast section having second connection apparatus, and a movement apparatus for moving the first section so that the first connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the first mast section to the second mast section. Preferably, the structure has an opening with the first mast section received in the opening and connected to the structure. Preferably, the second mast section has a racking board. Advantageously, the second mast section has a third mast section, which preferably telescopes from the second mast section to complete the mast. Advantageously, the third mast section has a crown block.

In certain aspects, the present invention discloses

a bottom mast section connectible to a midsection by moving a vehicle, e.g. a truck/trailer combination to place the two sections adjacent each other; connecting the bottom section to a support, e.g. but not limited to, a rig's substructure; raising, if necessary, the support or rig's substructure to which the bottom mast section is connected; and moving the vehicle to engage connections and, in one aspect, to align connections, of the bottom mast section and midsection. Once the connections have been engaged, the truck can move away and pins are used as a further securement to lock the two sections together and the truck moves away.

The present invention discloses, in certain aspects, a method for connection two parts of a mast of a drilling rig, the method including: connecting a bottom mast section to a support, the bottom mast section having bottom connection apparatus; moving a second mast section adjacent the bottom mast section, the second mast section releasably connected to a vehicle and said moving done by moving said vehicle, the second mast section having second connection apparatus; and moving the bottom mast section so that the bottom connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the bottom mast section to the second mast section, and, in certain aspects to facilitate connection engagement and align the mast sections as one mast section is lifted.

The present invention discloses, in certain aspects, a mast system for rig operations, the mast system including: a support, a bottom mast section connected to the support; the bottom mast section having bottom connection apparatus; a second mast section adjacent and connectible to the bottom mast section, the second mast

section releasably connected to a vehicle for moving the second mast section; the second mast section having second connection apparatus; and the bottom mast section movable on the support so that the bottom connection apparatus can contact the second connection apparatus and engage the second connection apparatus to secure the bottom mast section to the second mast section.

Such systems in which connections on a first mast section engage and become held in corresponding connections on a second mast section to secure the two sections together.

For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1A is a side view of part of a drilling rig to be assembled and erected;

Figure 1B is a top view of the part shown in Figure 1A;

Figure 1C is a side view of an apparatus in a first step in a method in accordance with the present invention for assembling and erecting a drilling rig mast;

Figure 1D is a side view of the apparatus shown in Figure 1C which illustrates a second step in the method in accordance with the present invention for assembling and erecting the drilling rig mast shown in Figure 1C;

Figure 1E is a top view of part of the apparatus as shown in Figure 1D;

Figure 1F is a side view of the apparatus shown in Figure 1C which illustrates a third step in the method in accordance with the present invention for assembling and erecting the drilling rig mast shown in Figure 1C;

Figure 1G is a side view of the apparatus shown in Figure 1C which illustrates a fourth step in the method in accordance with the present invention for assembling and erecting the drilling rig mast shown in Figure 1C;

Figure 1H is a side view of the apparatus shown in Figure 1C which illustrates a fifth step in the method in accordance with the present invention for assembling and erecting the drilling rig mast shown in Figure 1C;

Figure 1I is a top view of a bottom section of a drilling rig mast as shown in Figures 1C - 1H;

Figure 1J is a side view of the bottom section shown in Figure 1I;

Figure 1K is a bottom view of the bottom section

shown in Figure 1I;

Figure 1L is an end view along the bottom section shown in Figure 1I;

Figure 1M is a side view of a bottom midsection of the drilling rig mast as shown assembled in Figures 1F;.

Figure 1N is a side view of the bottom midsection shown in Figure 1M;

Figure 1O is a bottom view of the bottom midsection shown in Figure 1M;

Figure 1P is an end view along the bottom section of Figure 1N;

Figure 2 is a perspective view of a bottom section of a drilling rig mast in accordance with the present invention connected to rig substructure (shown partially);

Figure 3 is a perspective view of a midsection of a drilling rig mast in accordance with the present invention;

Figure 4A is a perspective view illustrating a bottom section as shown in Figure 2 and a midsection as shown in Figure 3, shown in a step in a method in accordance with the present invention;

Figure 4B shows the bottom section shown in Figure 4A connected to the midsection shown in Figure 4A;

Figure 4C is a perspective view illustrating a further step in a method of connecting the sections shown in Figure 4A;

Figure 4D is a side view illustrating a further step in a method of connecting the sections shown in Figure 4A;

Figure 4E is a perspective view of a further step in a method of connecting the sections shown in Figure 4A;

Figure 4F is a side view of the step shown in Figure

4E;

Figure 4G is a perspective view illustrating a further step in a method of connecting the sections shown in Figure 4A; and

Figure 4H is a side view of the step shown in Figure 4G.

Figure 1A shows a drilling rig's substructure 11 supporting a drill floor 12 with a drawworks 14 positioned on the drill floor 12. The substructure 11 is in a collapsed state, ready for erection. The substructure 11 and drill floor 12 have an open area A (Figure 1B) into which a flat bed of a truck can be moved.

As shown in Figure 1C, a truck T has trailer FB with a bottom section 20 of a mast thereon. The truck T is shown reversing the trailer FB into area A. An A-frame 13 is connected to the bottom section 20 of the mast. Mast raising cylinders 22 are shown in a first position.

As shown in Figure 1D, the truck T has stopped moving. The bottom section 20 is now located in the area A, with the A-frame 13 on the drill floor 12. The A-frame 13 is connected to the bottom section 20 of the mast and is fixed to the drill floor 12. The mast raising cylinders 22 are moved about pivot P. The bottom section 20 is then connected to the mast raising cylinders 22 (arranged each side of the area A). The substructure raising cylinders 18 are adjusted and the A-frame 13 is connected to the drill floor 12.

As shown in Figure 1E, upper structural members 21 of the bottom section 20 of the mast are swung open for bolting to mast shoes 23 of the drill floor 12. The mast raising cylinders 22 are then extended a small distance and the truck T is moved away. The mast raising

cylinders 22 are then retracted to lower the bottom section 20.

As shown in Figure 1F, a truck R has moved a midsection 30 of a mast in accordance with the present invention toward the bottom section 20. Figure 1G shows the truck R stopped after moving the midsection 30 adjacent a projecting end of the bottom section 20. The substructure raising cylinder 18 and the mast cylinder 22 are extended a small distance to raise jaw members in accordance with the present invention of the bottom section 20 adjacent corresponding connection members 32 in accordance with the present invention of the midsection 30.

Figures 1I to 1L show the bottom section 20 and Figures 1M to 1P show a part of the midsection 30. The bottom section 20 has two upper structural members 21 each with a jaw member 29. Each jaw member 29 comprises two spaced apart plates 24, each with a slot 23. The two spaced apart plates may be steel plates welded to the structural members or may be continuously formed therewith. A space 25 is formed between ends of the plates 24. A throat 25a is formed between flared out portions 25b of the plates 24 (or separate pieces 25b are used connected to the plates). Two lower structural members 20r each of which have a connection member 26 comprising two spaced-apart plates 27 and holes 28. A throat 27a is formed between flared out portions 27b of the plates 27. A throat 27c is formed between flared out portions 27d of the plates 27. In certain aspects of the present invention, any one or two throats described above may be deleted, or they may all be deleted.

As shown in Figures 1M to 1P, the midsection 30 has two upper structural members 31 each with a connection

member 32 having a transverse bar 33. Two lower structural members 31 a each has a connection member 35 with a holes 38, upon section connection, to the location of the holes 28 of the connection members 26.

Ends of the connection members 32 are sized for movement into the spaces 25 of the jaw members 29 and the transverse bars 33 are sized for receipt in the slots 23. The connection members 35 are sized for receipt between the plates 27 of the connection members 26 and pins are insertable through the holes 28, 38 to lock the two mast sections together. If one jaw member connects to one connection member and the other jaw-member/connection/member connection has not been fully effected, raising of the bottom section will force the other connection member into contact with and engagement with the other jaw member, facilitating alignment of the two sections and their connection.

The truck R moves the midsection 30 adjacent the bottom section 20 so that ends of the connection members 32 move into the spaces 25 of the jaw member 29 and the bars 33 then move into the slots 23. The connection members 35 are moved through the throats 27a between the plates 27 and pins are inserted through the holes 28, 38 to lock the two sections together.

It is within the scope of this invention to delete one of the jaw members 29 and to releasably connect the two sections of the mast together at the location of the deleted jaw member 29 in any suitable fashion (e.g., but not limited to) with bolt(s) bolting the two sections together.

Upon interengagement of the connection members of the sections 20, 30, as shown in Figure 1H, and insertion of locking pins through the holes 28, 38, the mast

raising cylinders 22 are partially extended so the truck R can move away. A racking board B is opened and the mast raising cylinders 22 are then further extended such that the bottom section 20 and the mid section 30 assume a vertical position on the drill floor. A top section is then telescopically extended from the mid section 30.

Figure 2 shows a bottom section 120 of a mast in accordance with the present invention (like the bottom section 20); and Figure 3 shows a midsection 130 of a mast in accordance with the present invention (like a midsection 30).

As shown in Figure 2, the bottom section 120 has four structural members 122 and a series of interconnecting beams 121. A square tube 123 spans two of the structural members 122. Each of two of the structural members 122 has a jaw member 126 like the jaw members 29, Figure 1F and the two opposite legs 122 have end connection members 127 (like the connection members 27, Figure 1F).

A jaw member 126 has a body 126a which includes two spaced-apart plates 126p secured to a leg 122; a slot 126b; an upright projection 126c; and a throat 126d (like the throat 25a, Figure 1L) between two flared out parts which decreases in width from an outer end to an inner end.

An end connection member 127 has a body 127a with two spaced-apart plates 127p each with a flared end 127e so that the plates 127p together form an open throat 127t which decreases in width from the outer end to the inner end. Each plate 127p has a hole 127h for receiving a removable locking pin. A throat 127x is formed between parts 127y. The throat 127t is like the throat 27c, Figure 1L and the throat 127x is like the throat 27a,

Figure 1L.

As shown in Figure 3, the midsection 30 has four structural members 132 and a series of interconnecting beams 131. Each of two of the structural members 132 has a connection member 136 and the two opposite legs have a connection member 137.

Each connection member 136 has a body 136a made of two plates 136p. A bar 136b is held by and projects slightly from the plates 136p.

Each connection member 137 has a body 137a made of two plates 137p. Each plate 137p has a hole 137h for receiving a removable locking pin.

As shown in Figures 4A to 4C the midsection 130 has been moved on a truck into position adjacent the bottom section 120 (e.g. as in Figures 1F and prior to Figure 1G). The truck moves the midsection 130 directly above the bottom section 120 (Figure 4C). The raising cylinders 18 raise the substructure (e.g. like the substructure 11) which raises the bottom section 120. For mating of the upper mast section initially to the lower mast section, both sections are oriented so that they are sloping downwards towards each other to insure that the upper jaws 126 come to a mating position before the opposite connections. The jaws 126 are then brought into contact with the mating bars 136b of the lower connection members by raising the lower mast section 120 using the raising cylinder, which may be hydraulic.

Continued raising then forces the mating ends of the mast sections upwards rotating them so that the gap between the lower connections is forced closed. The flared design on the lower connections forces them into alignment as they are forced closed. As shown in Figures 4F and 4G, the hydraulic cylinders (substructure raising

cylinders and mast raising cylinders) have been raised to raise the bottom section 120 level with the midsection 130, moving the connection member 137 fully into the connection member 127. Pins 129 have not yet been inserted into and through the holes 127h, 137h. The bars 136b are in the slots 126s. The two sides of the mast can be misaligned when the connection method starts which can result in a jaw and bar on one side being tensioned while the opposite jaw and bar are floating - but this is self-corrected as the raising process continues and the total mast begins to be lifted.

As shown in Figures 4G and 4H, the substructure raising cylinders 18 and the mast raising cylinders 22 have been extended to install the pins 129 have been inserted through the connection member 127, 137. Pins 139 have not yet been inserted into the slots 126b. Each pin 139 has a body 139a with a lower projection 139c which is sized and configured to fit into a space 131 formed by surfaces of the connection member 126 and of the bars 136b.

Once the pins 139 have been inserted and the two mast sections 120, 130 are connected, the mast is ready to be raised.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a method for connection two parts of a mast of a drilling rig, the method including: connecting a bottom mast section to a support, the bottom mast section having bottom connection apparatus; moving a second mast section adjacent the bottom mast section, the second mast section releasably connected to a vehicle and said moving done by moving said vehicle, the second mast section having second connection apparatus; and moving the bottom mast section

so that the bottom connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the bottom mast section to the second mast section. Such a method may one or some, in any possible combination, of the following: releasing the second mast section from the vehicle, and moving the vehicle away from the second mast section; raising with mast raising apparatus the mast comprising the bottom mast section secured to the second mast section; wherein the support is a substructure with raising apparatus, the method further including: raising the substructure with the raising apparatus to move the bottom mast section with respect to the second mast section to facilitate engagement of the bottom connection apparatus with the second connection apparatus; locking together the bottom connection apparatus and the second connection apparatus; the bottom mast section comprises a jaw member connected to the bottom mast section with a throat and a slot, the second connection apparatus comprises an insertion member with a bar, the insertion member sized and located for receipt of an end thereof in the throat of the jaw member and the bar sized and located for receipt within the slot, the method further including moving the bottom mast section to move the end of the insertion member into the throat and to move the bar into the slot; the jaw member has two spaced-apart plates each with a flared portion and a throat defined between the flared portions, the method further including moving an end of the insertion member into the throat; the bottom mast section is two legs each with a jaw member connected thereto, each with a throat and a slot, the second connection apparatus comprises an insertion member with a bar, the insertion member sized and located for receipt of an end

thereof in the throat of the jaw member and the bar sized and located for receipt within the slot, the method further including moving the bottom mast section to move the ends of the insertion members into the throats and to move the bars into the slots; the jaw member has two spaced-apart plates each with a flared portion and a throat defined between the flared portions, the method further including moving an end of the insertion member into the throat; wherein the bottom mast section has a primary connection member connected thereto and spaced-apart from the jaw member, the second mast section has a secondary connection member connected thereto, the method further including securing the secondary connection member to the primary connection member; the primary connection member has two spaced-apart plates each with an outwardly flared portion and includes a throat between the outwardly flared portions of the two spaced-apart plates for facilitating entry of part of the secondary connection apparatus between the two spaced-apart plates; the bottom mast section has two legs each with a primary connection member connected thereto and spaced-apart from a jaw member, the second mast section has two legs each with a secondary connection member connected thereto, the method further including securing the secondary connection members to the primary connection members; the primary connection members each have two spaced-apart plates each with an outwardly flared portion and include a throat between the outwardly flared portions of the two spaced-apart plates for facilitating entry of part of the secondary connection apparatuses between the two spaced-apart plates; and/or wherein the support is a substructure with raising apparatus, the method further including raising the substructure with the raising

apparatus to move the bottom mast section with respect to the second mast section to engage the bottom connection apparatus with the secondary connection apparatus, and said raising aligning the bottom mast section with the second mast section as the substructure is raised.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a mast system for rig operations, the mast system including: a support, a bottom mast section connected to the support; the bottom mast section having bottom connection apparatus; a second mast section adjacent and connectible to the bottom mast section, the second mast section releasably connected to a vehicle for moving the second mast section; the second mast section having second connection apparatus; and the bottom mast section movable on the support so that the bottom connection apparatus can contact the second connection apparatus and engage the second connection apparatus to secure the bottom mast section to the second mast section. Such a mast system may one or some, in any possible combination, of the following: wherein the support is a substructure with raising apparatus, the substructure with the raising apparatus able to raise the bottom mast section with respect to the second mast section prior to facilitate engagement of the bottom connection apparatus with the second connection apparatus; locking apparatus for locking together the bottom connection apparatus and the second connection apparatus; the bottom mast section having a jaw member connected to the bottom mast section, the jaw member having a throat and a slot, the second connection apparatus comprising an insertion member with a bar, the insertion member sized and located for receipt of an end thereof in the throat of the jaw member and the bar sized

and located for receipt within the slot, and the bottom mast section movable to move the end of the insertion member into the throat and to move the bar into the slot; the jaw member has two spaced-apart plates each with a flared portion and a throat defined between the flared portions, the throat for receipt therein of an end of the insertion member into the throat; the bottom mast section having two legs each with a jaw member connected to a leg and each with a throat and a slot, the second mast section having two legs each with a second connection apparatus comprising an insertion member with a bar, the insertion member sized and located for receipt of an end thereof in the throat of a jaw member and the bar sized and located for receipt within a slot of the jaw member, and the bottom mast section movable to move the ends of the insertion members into the throats and to move the bars into the slots; the bottom mast section having a primary connection member connected thereto and spaced-apart from the jaw member, the second mast section having a secondary connection member connected thereto, and the secondary connection member securable to the primary connection member; and/or the bottom mast section has two legs each with a primary connection member connected thereto and spaced-apart from a jaw member, the second mast section has two legs each with a secondary connection member connected thereto, and each secondary connection member securable to an adjacent primary connection member; the primary connection member has two spaced-apart plates each flared out and including a throat defined between the two spaced-apart plates for facilitating entry of part of the second connection apparatus between the two spaced-apart plates.

THE EMBODIMENTS OF THE PRESENT INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method for facilitating assembly and erection of a drilling rig, the drilling rig comprising a structure and a mast, the mast comprising at least a first mast section and a second mast section, the structure having an open area therein, the method comprising the steps of moving said first mast section in said open area and connecting said first mast section to said structure, the first mast section having first connection apparatus, moving said second mast section adjacent the first mast section using a vehicle, the second mast section having second connection apparatus, and moving the first section so that the first connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the first mast section to the second mast section.

2. The method in accordance with Claim 1, wherein the step of moving the first mast section is carried out using a structure raising apparatus.

3. The method in accordance with Claim 2, wherein the structure raising apparatus comprises a piston and cylinder.

4. The method in accordance with any one of Claims 1 to 3, wherein the step of moving the first mast section is carried out using a mast raising apparatus.

5. The method in accordance with Claim 4, wherein the mast raising apparatus comprises a piston and cylinder.

6. The method in accordance with any one of Claims 1 to 5, further comprising the step of releasing the second section from the vehicle, and moving the vehicle away from the second mast section.

7. The method in accordance with Claim 1, further comprising the step of raising the first mast section with mast raising apparatus, and raising the second mast section therewith.

8. The method in accordance with any one of Claims 1 to 7, further comprising the step of locking together the first connection apparatus and the second connection apparatus.

9. The method in accordance with any one of Claims 1 to 8, wherein the first connection apparatus comprises a jaw member connected to the first mast section having a throat and a slot, the second connection apparatus comprises an insertion member with a bar, the insertion member sized and located for receipt in the throat of the jaw member and the bar sized and located for receipt within the slot, the method further comprising the step of moving the first mast section to move the insertion member into the throat and the bar into the slot.

10. The method in accordance with Claim 9, wherein the jaw member has two spaced-apart plates each with a flared portion and the throat defined between the flared portions, further comprising the step of moving the insertion member into the throat.

11. The method in accordance with any one of Claims 1 to 10, wherein the first and second connection apparatus comprise locking apparatus for locking together the first mast section and the second mast section.

12. The method in accordance with any one of Claims 1 to 11, wherein the first mast section further comprises four legs, the first connection apparatus further comprising a receiving member, each of two legs having a jaw member and

each of two legs having the receiving member, the second mast section further comprises four legs, the second connection apparatus further comprising a corresponding receiving member, each of two legs having a bar and each of two legs having the corresponding receiving member, the method further comprising the step of moving the first mast section to move the bar into the jaw member and connecting the receiving member with the corresponding receiving member.

13. The method in accordance with Claim 12, wherein the receiving member is connected to the corresponding receiving member with a pin.

14. The method in accordance with any one of Claims 1 to 13, wherein the first mast section comprises at least one structural support member extending at an angle from the first mast section.

15. A drilling rig comprising a structure and a mast, the mast comprising at least a first mast section and a second mast section, the structure having an opening with said first mast section received in said opening and connected to said structure, said first mast section having first connection apparatus, the second mast section having second connection apparatus, and a movement apparatus for moving the first section so that the first connection apparatus contacts the second connection apparatus and engages the second connection apparatus to secure the first mast section to the second mast section.

16. The drilling rig as claimed in Claim 15, wherein the first mast section has at least one structural support member extending at an angle from the first mast section.

17. The drilling rig as claimed in Claim 15, wherein the first mast section has two structural support members extending at an angle from the first mast section.

18. The drilling rig as claimed in Claim 16, wherein said at least one structural support member is bolted to mast shoes of the structure.

19. The drilling rig as claimed in any one of Claims 15 to 18, wherein said structure comprises a rig floor.

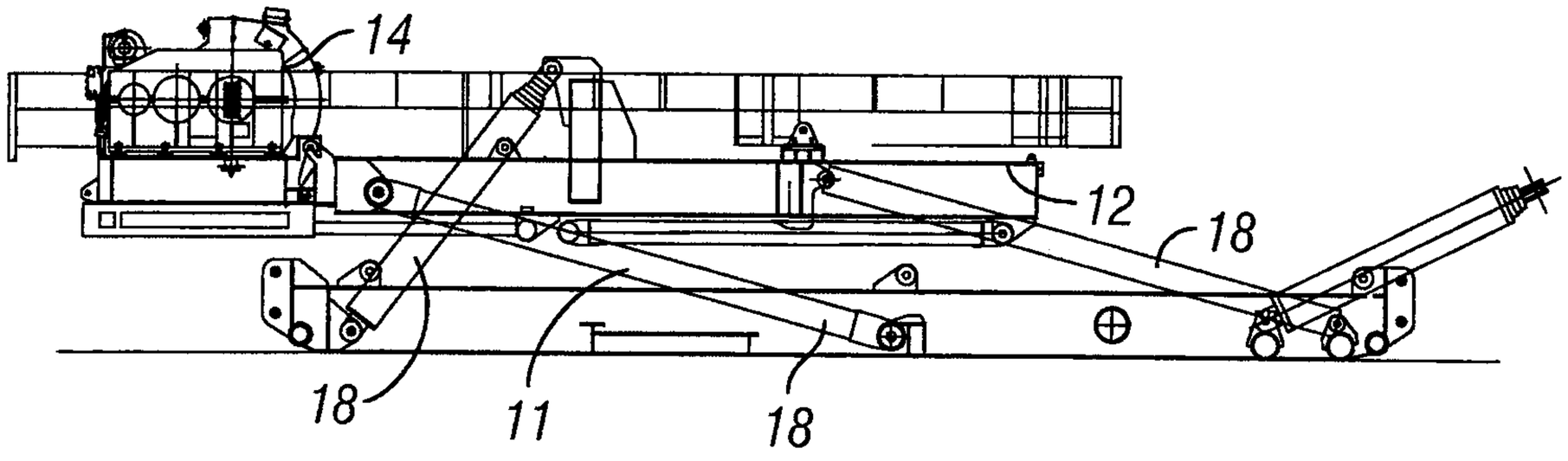


FIG. 1A

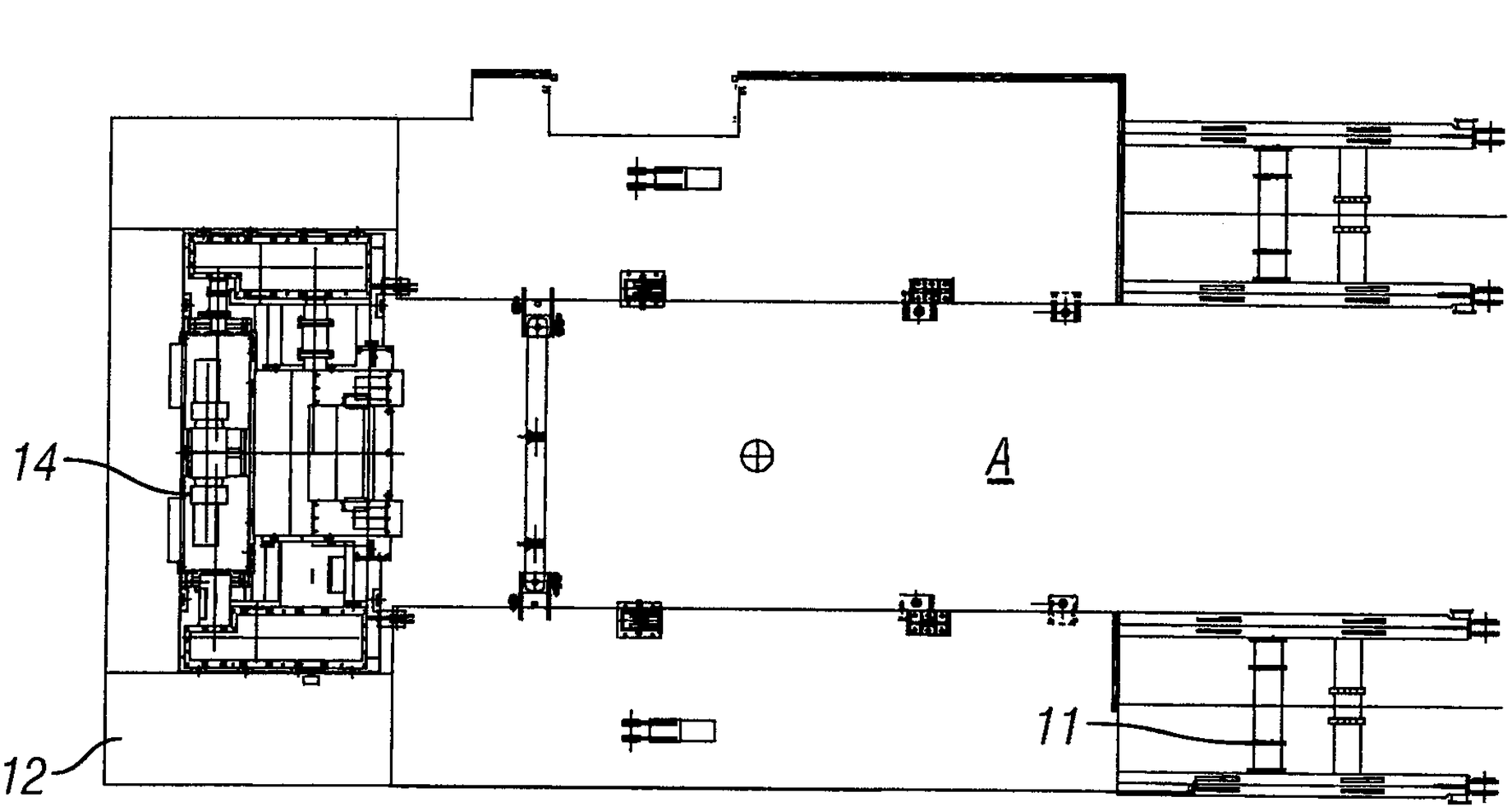


FIG. 1B

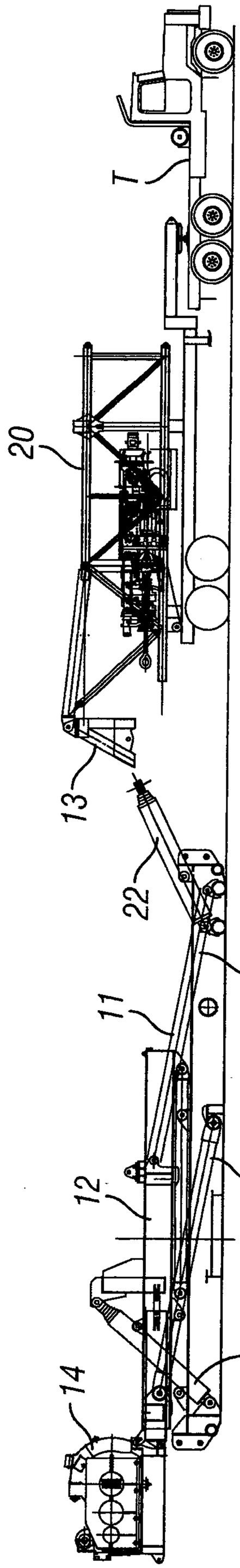


FIG. 1C

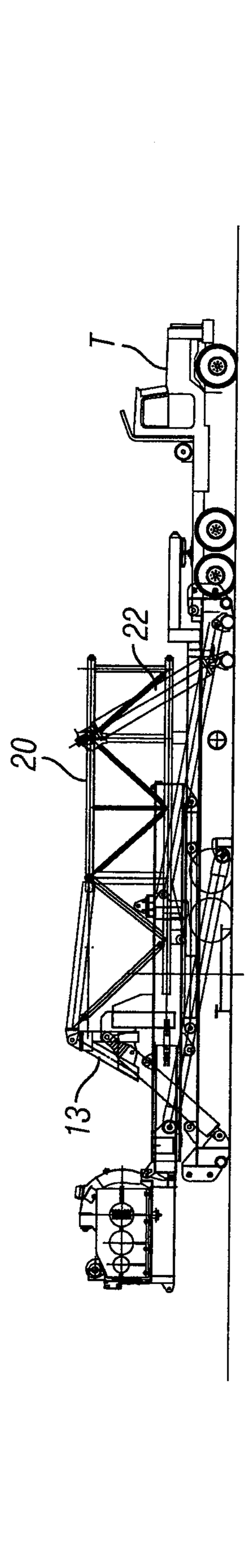


FIG. 1D

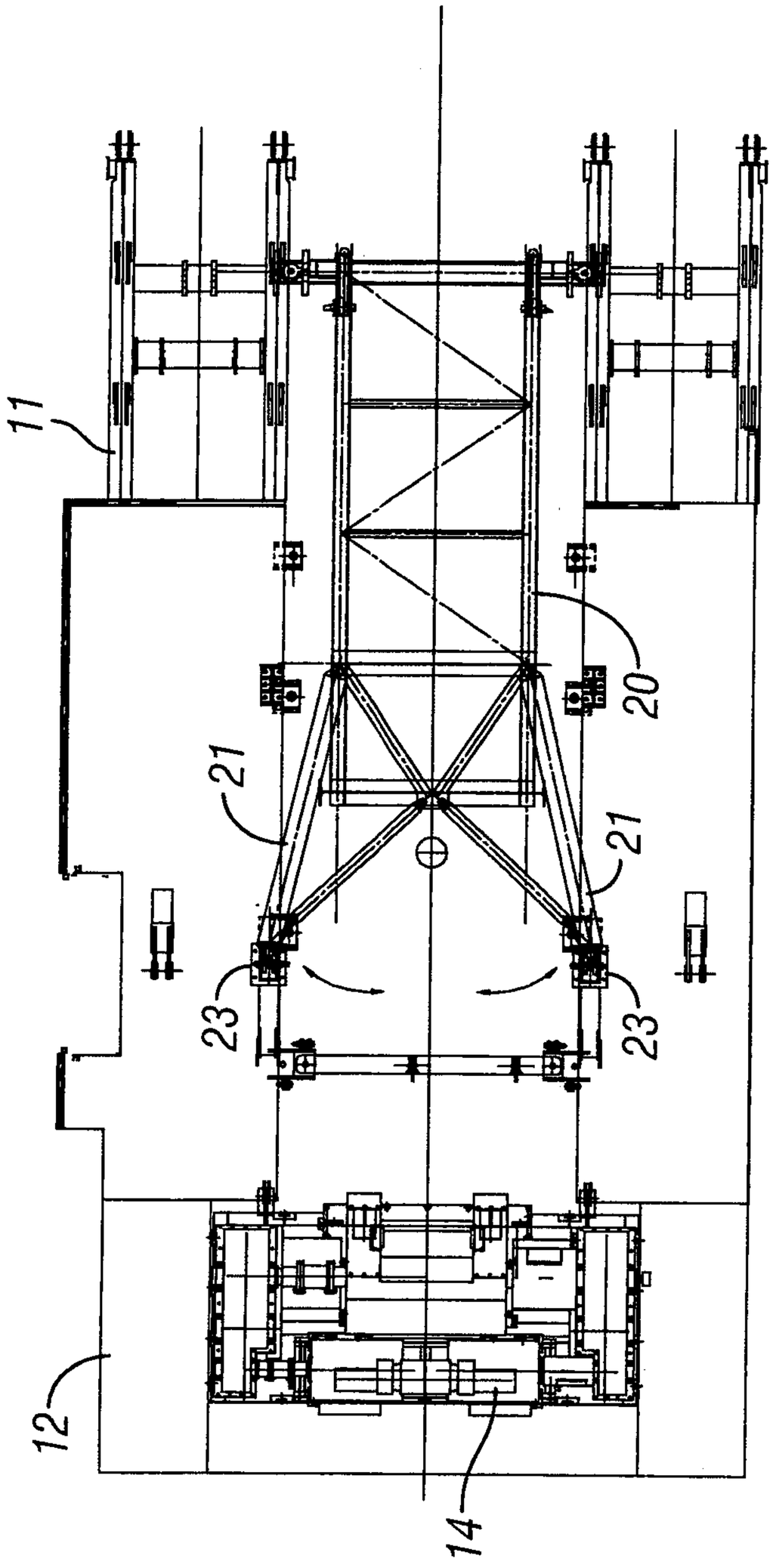


FIG. 1E

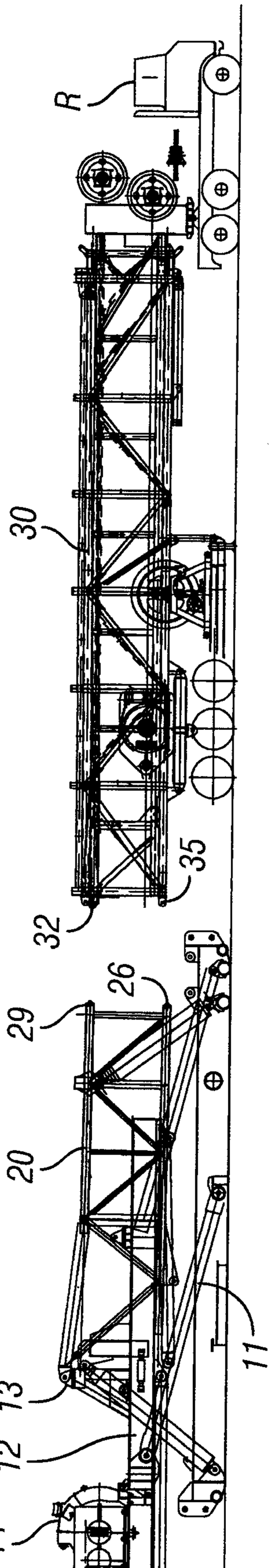


FIG. 1F

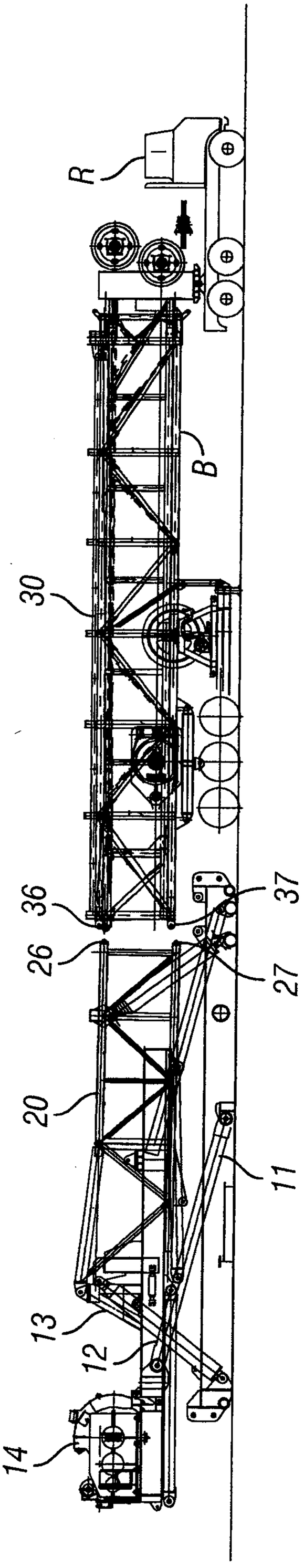


FIG. 1G

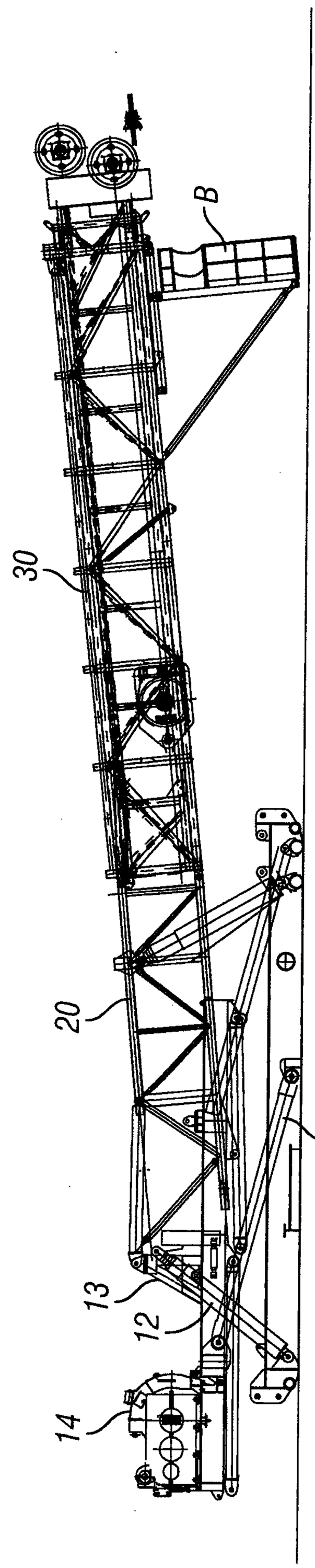
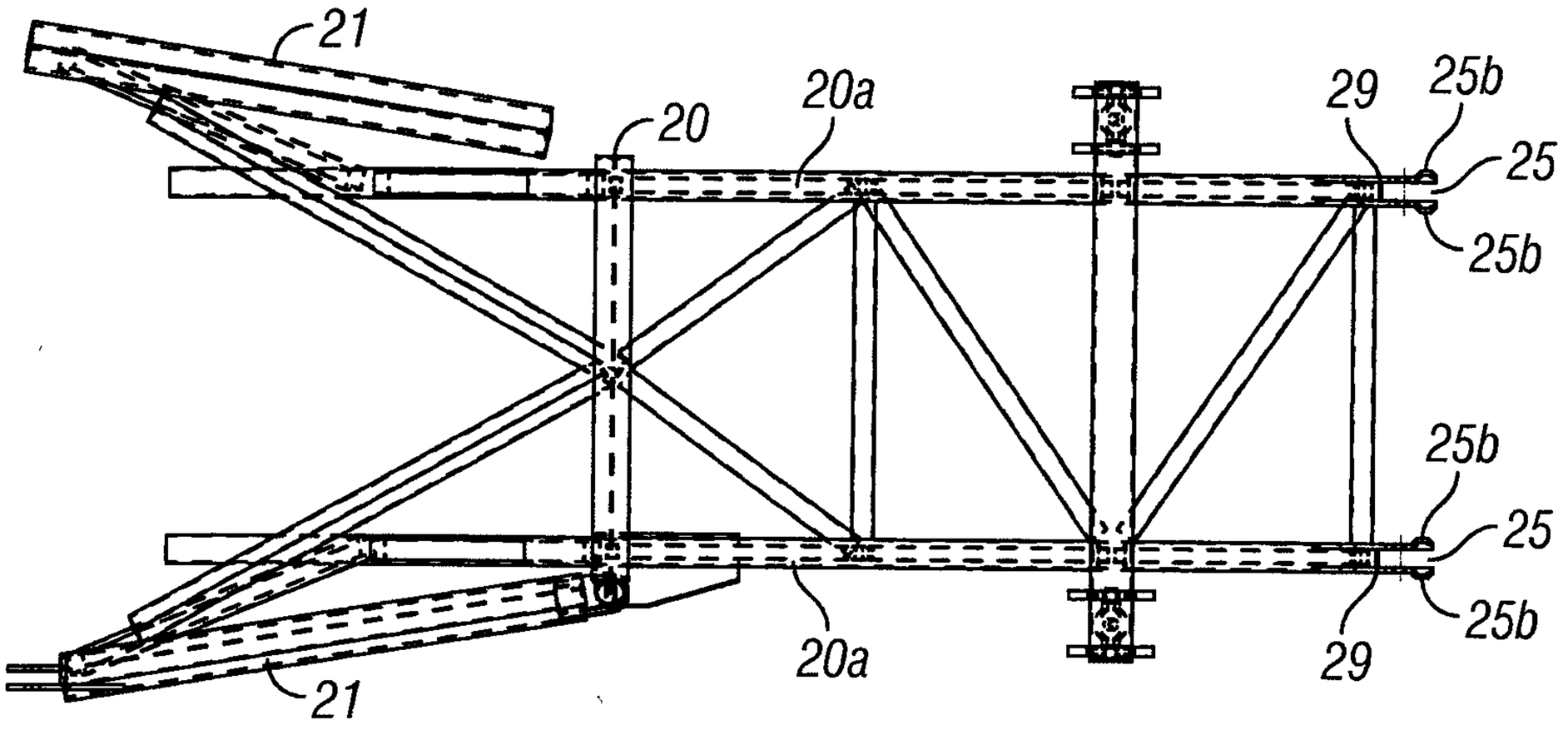


FIG. 1H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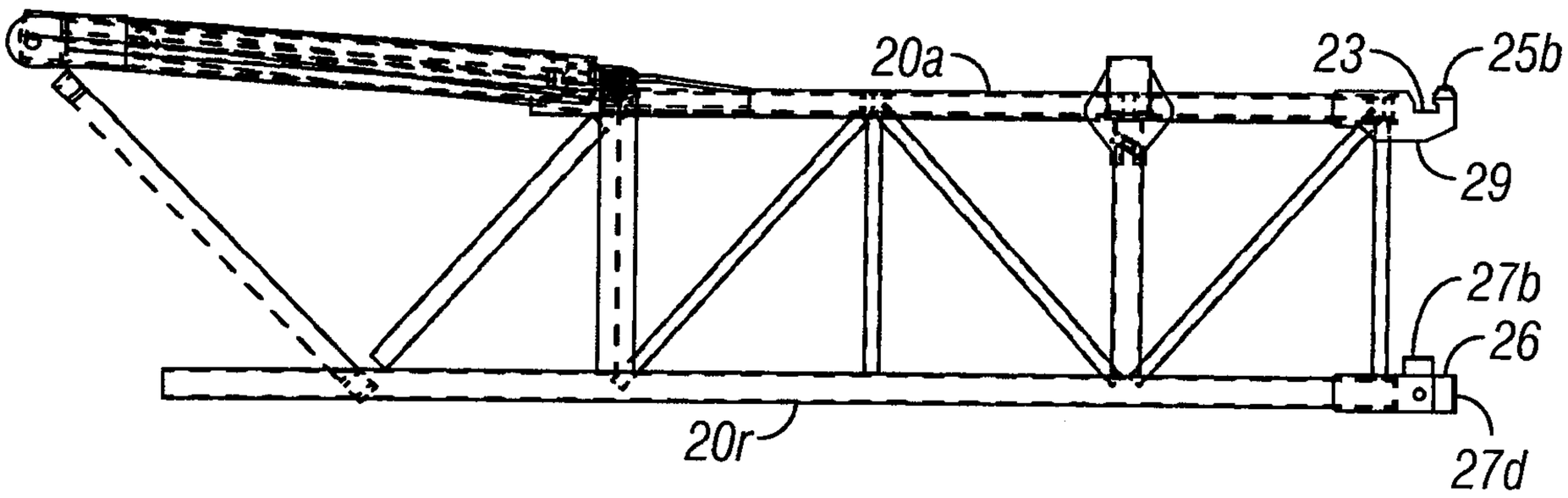
25b
25b
25
25b
20a
29
21

FIG. 1I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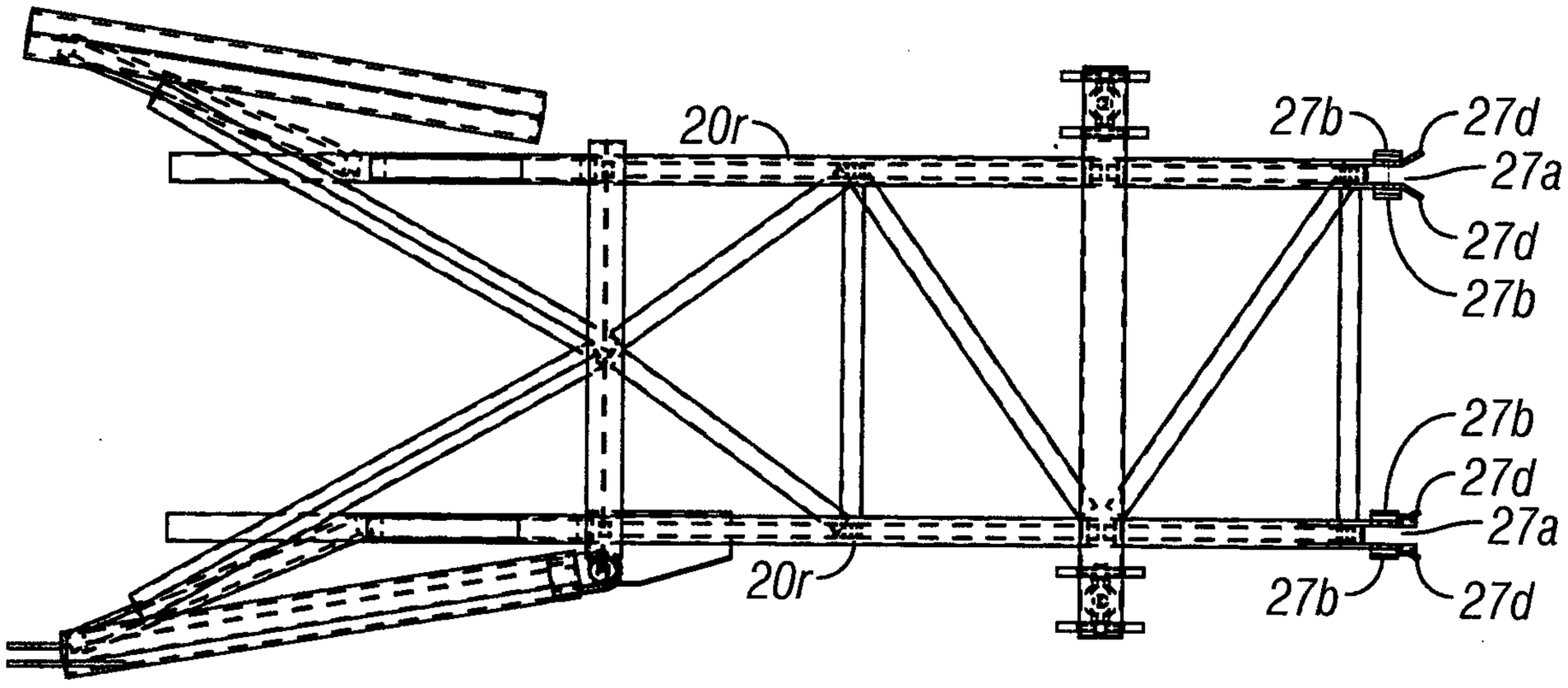
26
20r
27d

FIG. 1J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27b
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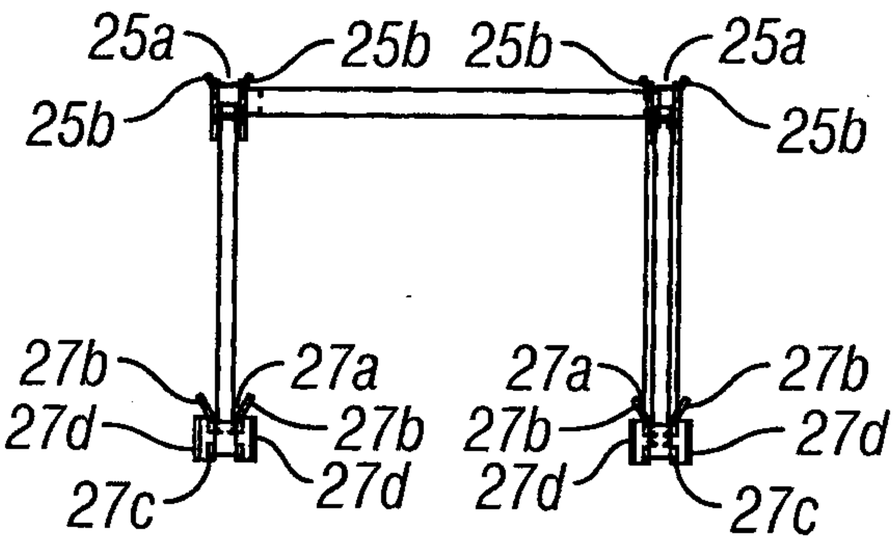
20r
27b

FIG. 1K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27d
27c

FIG. 1L

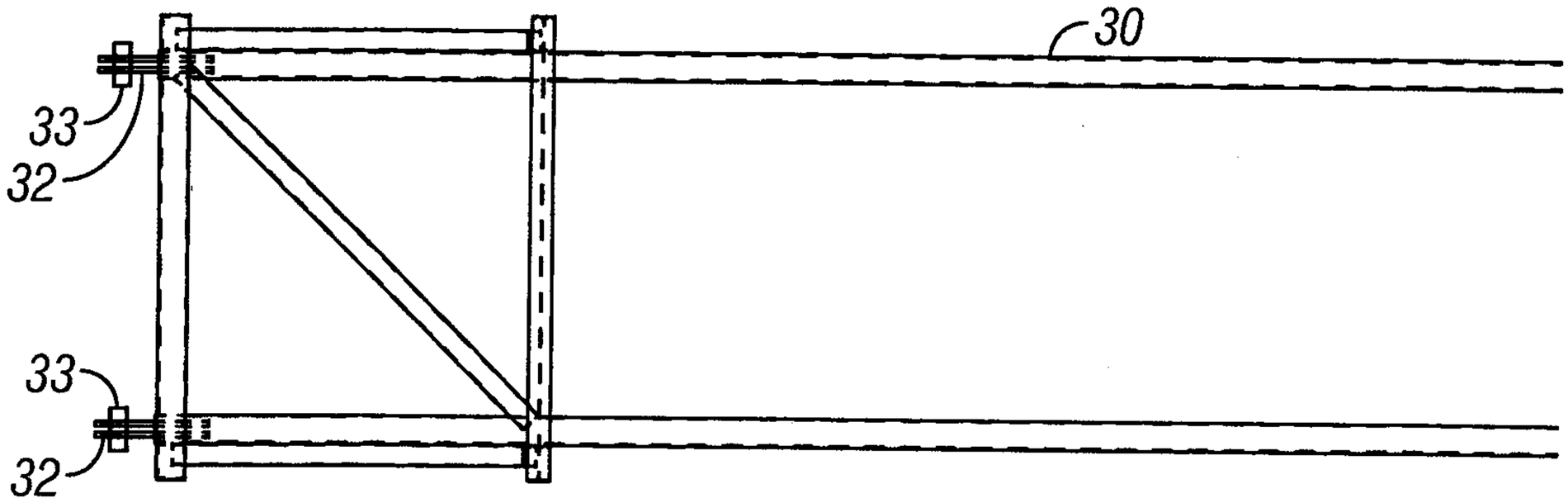


FIG. 1M

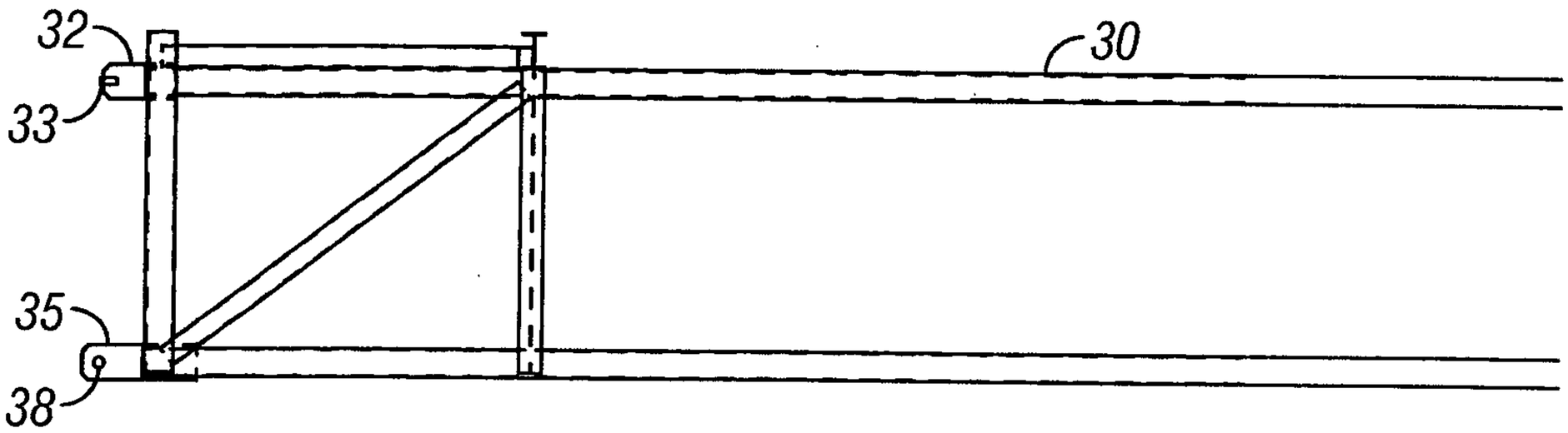


FIG. 1N

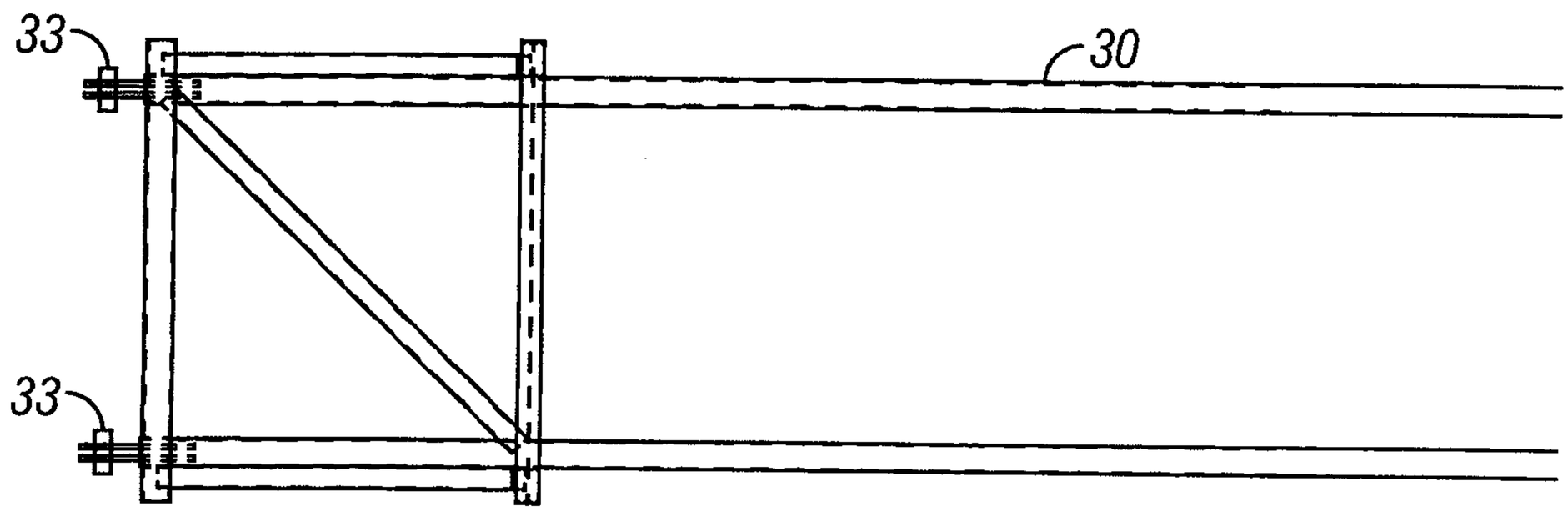


FIG. 1O

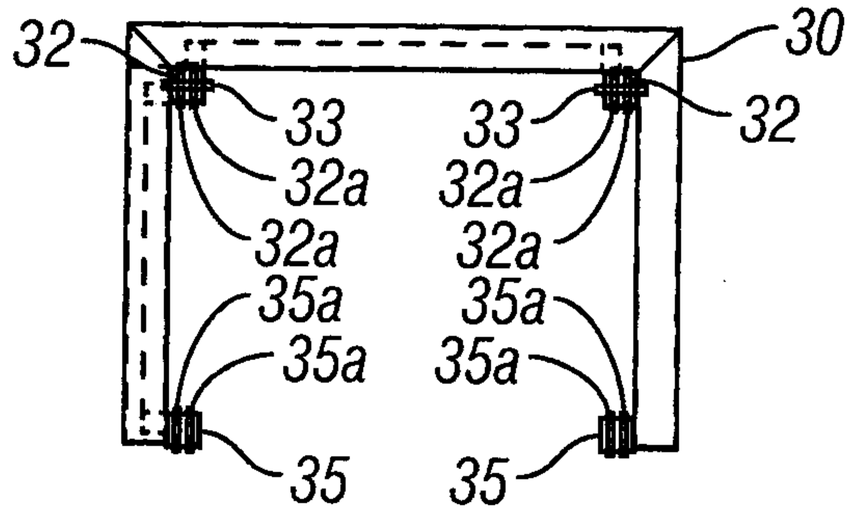
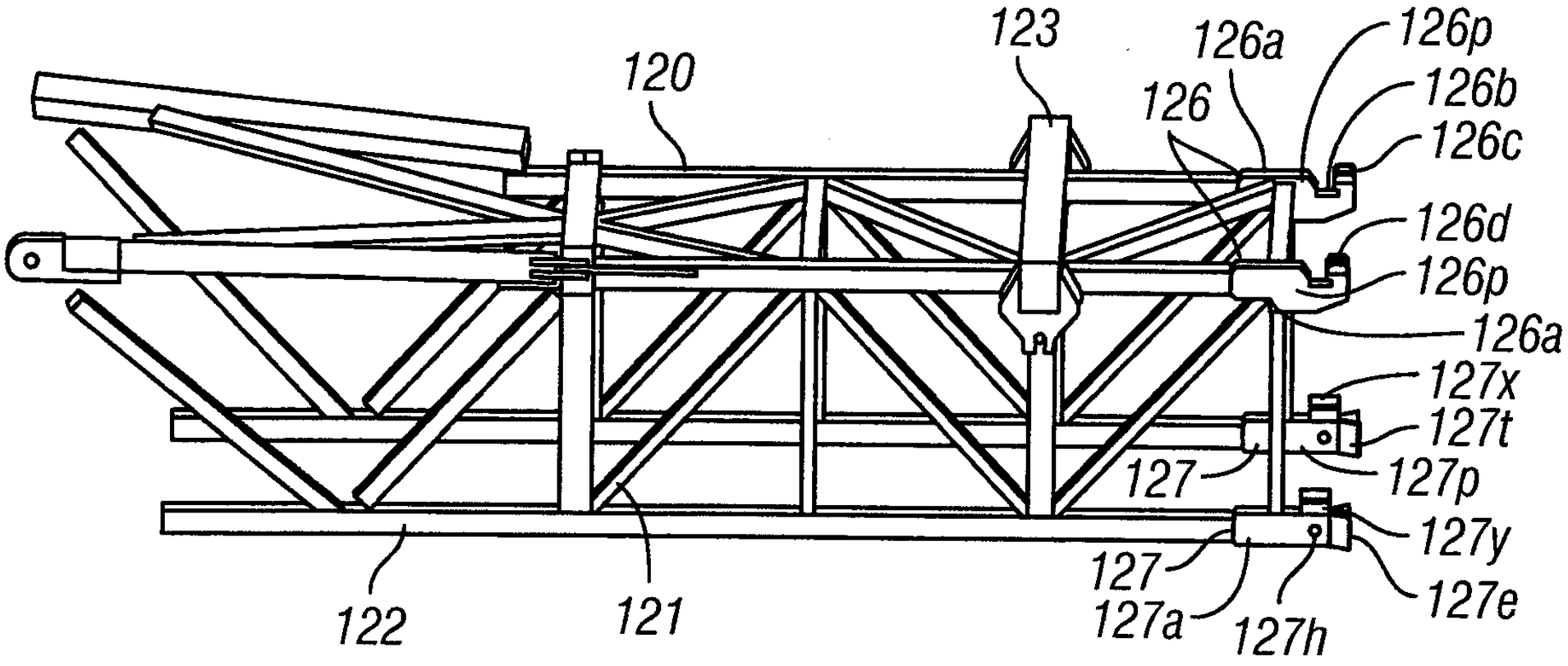


FIG. 1P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127e
127a
127h
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121

FIG. 2

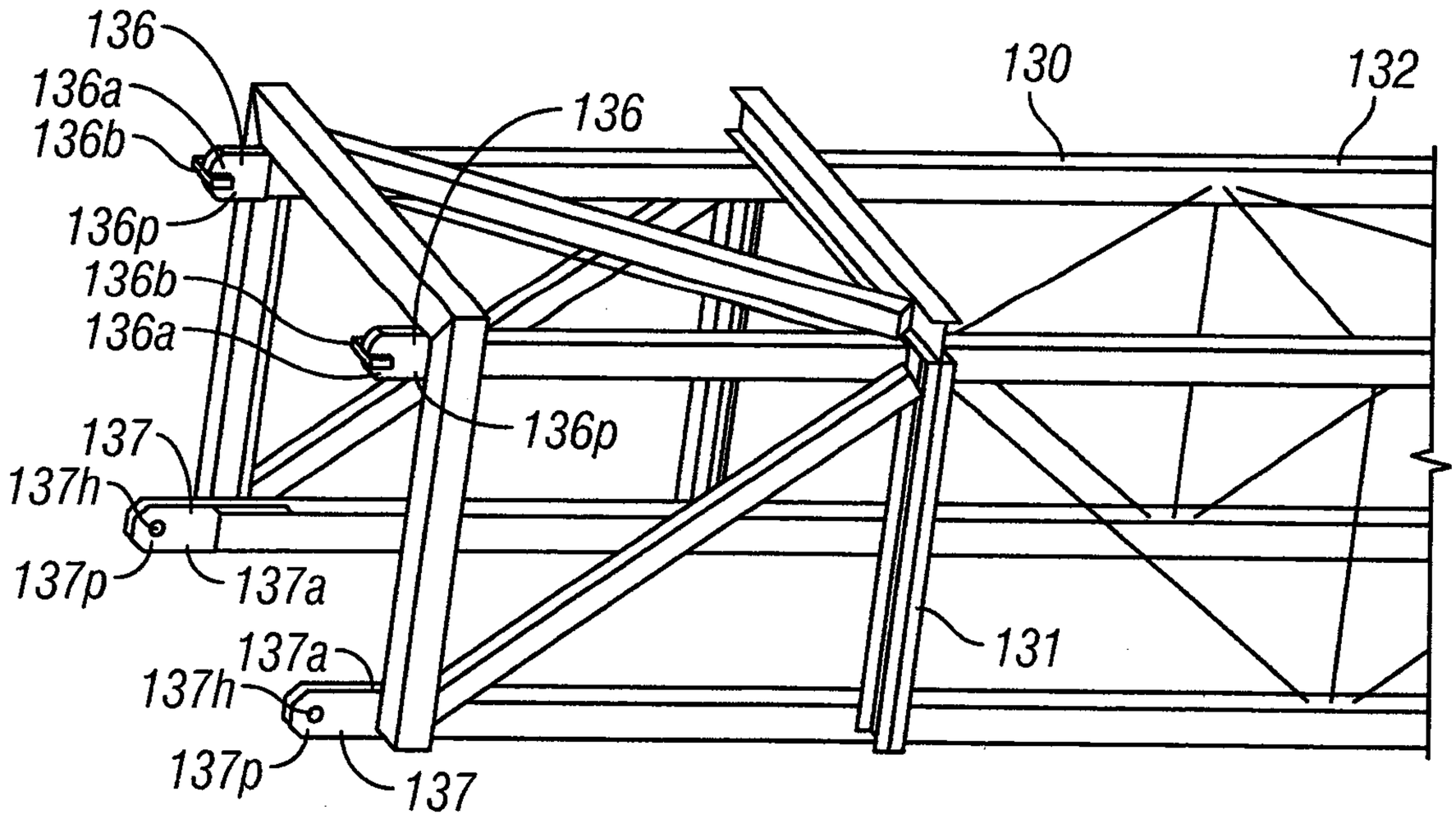
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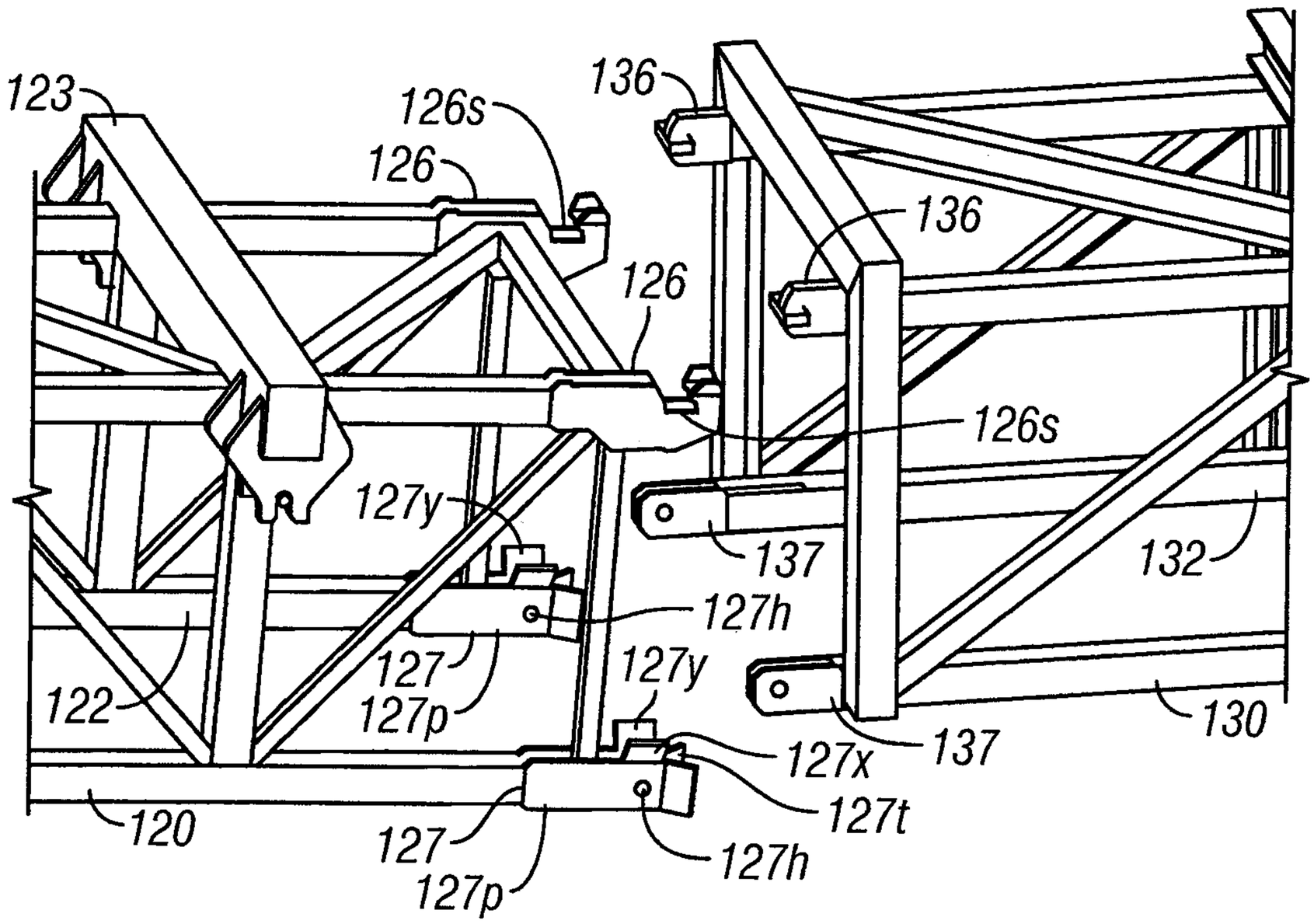
FIG. 3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127p

FIG. 4A

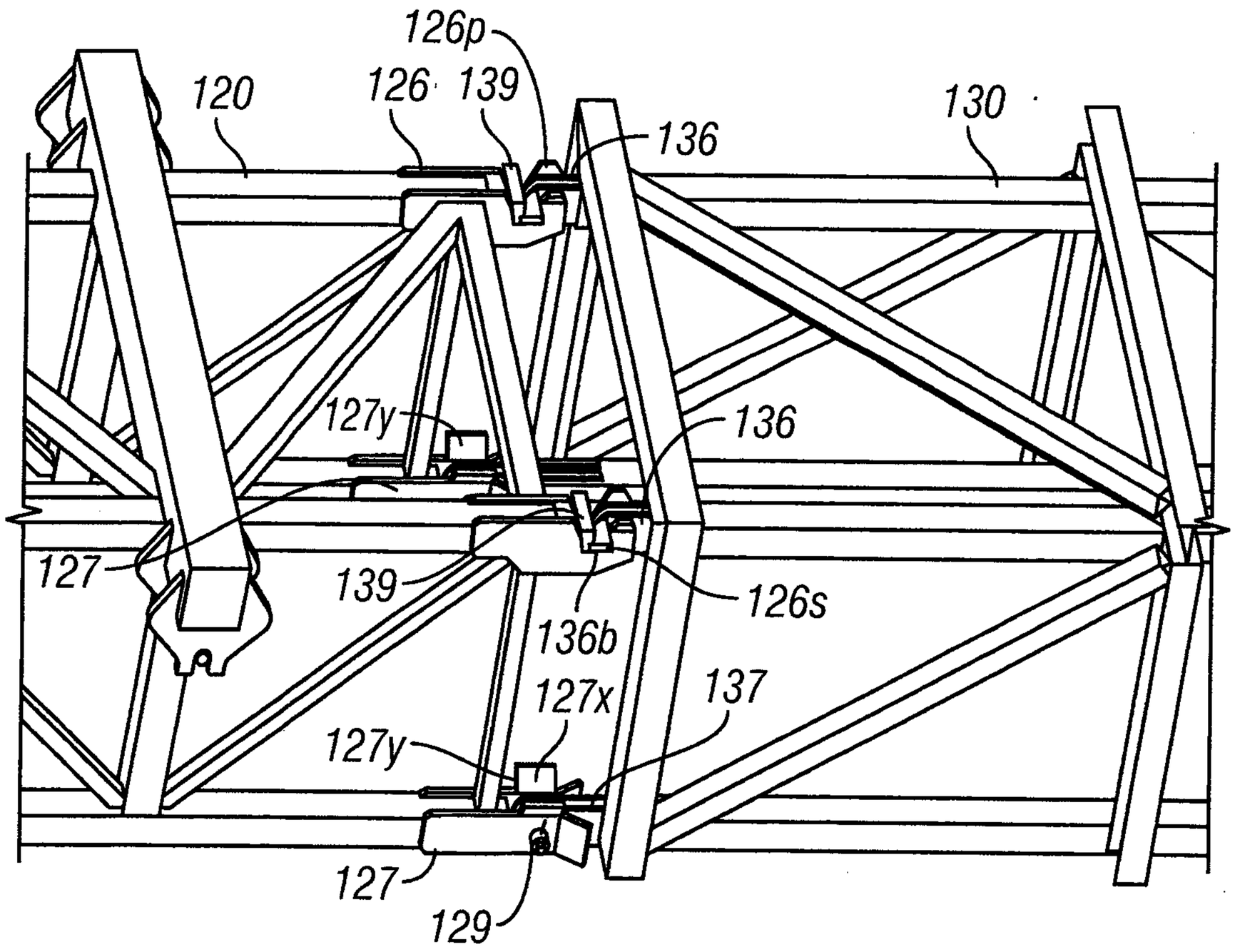
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FIG. 4B

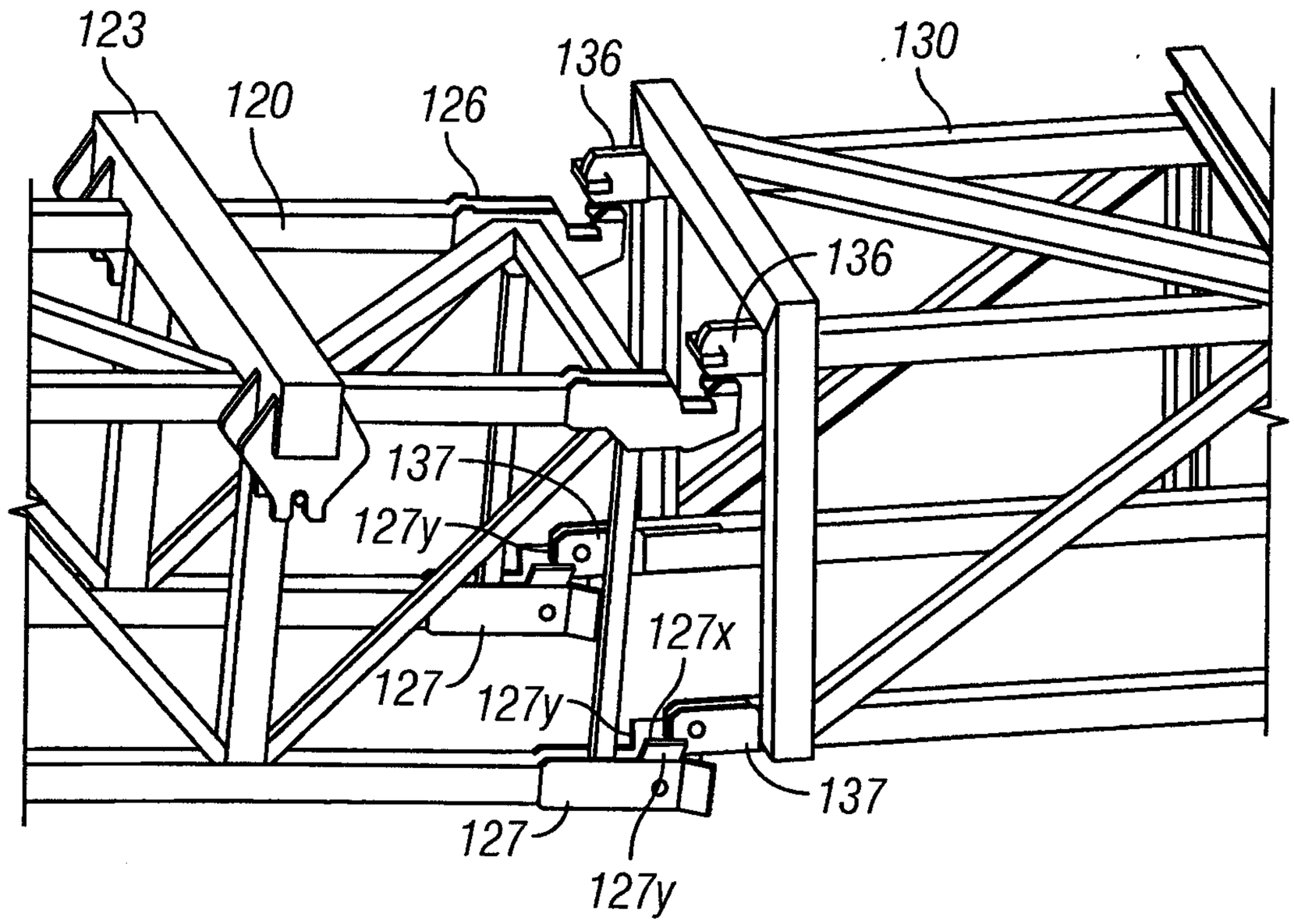
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FIG. 4C

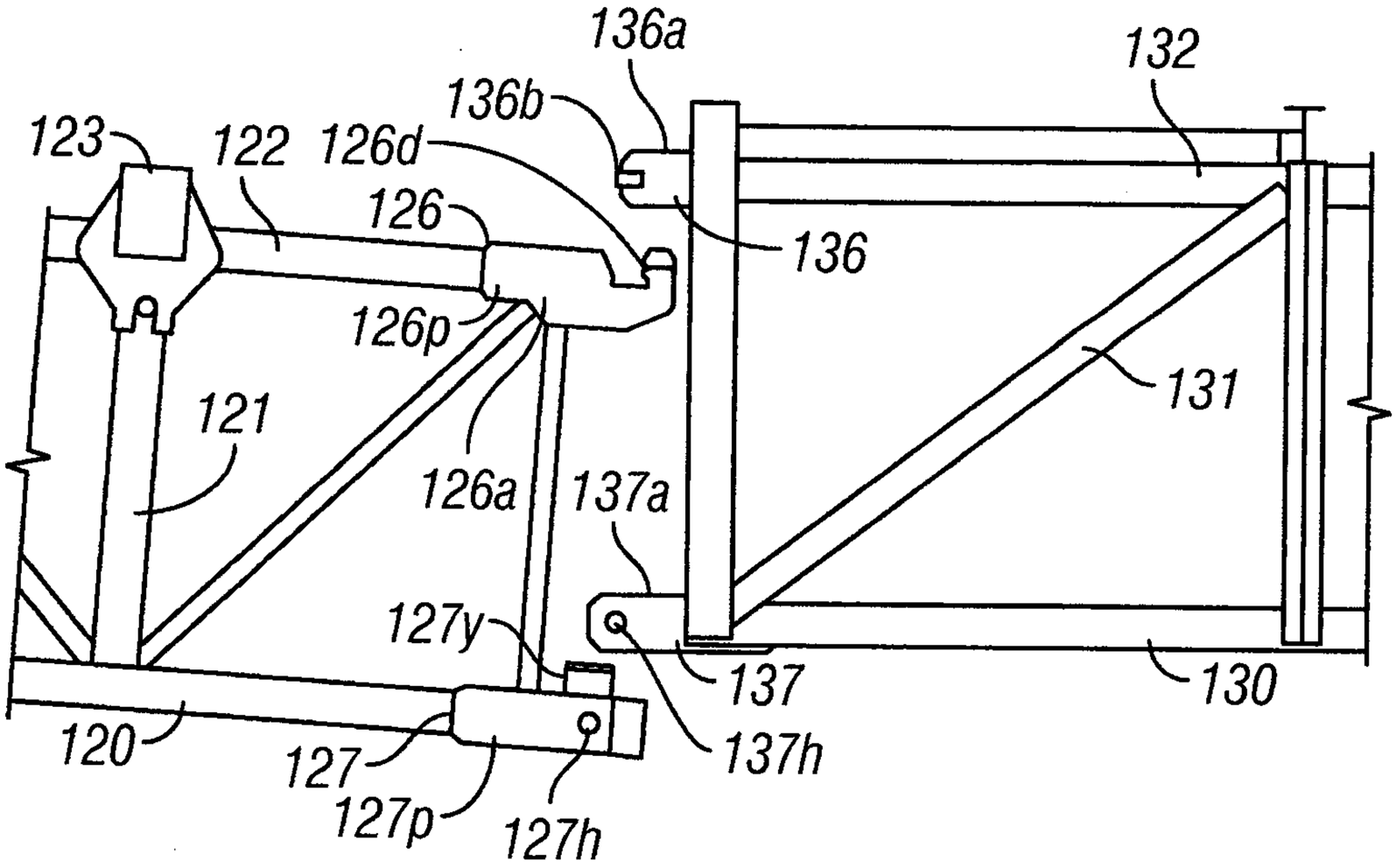
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FIG. 4D

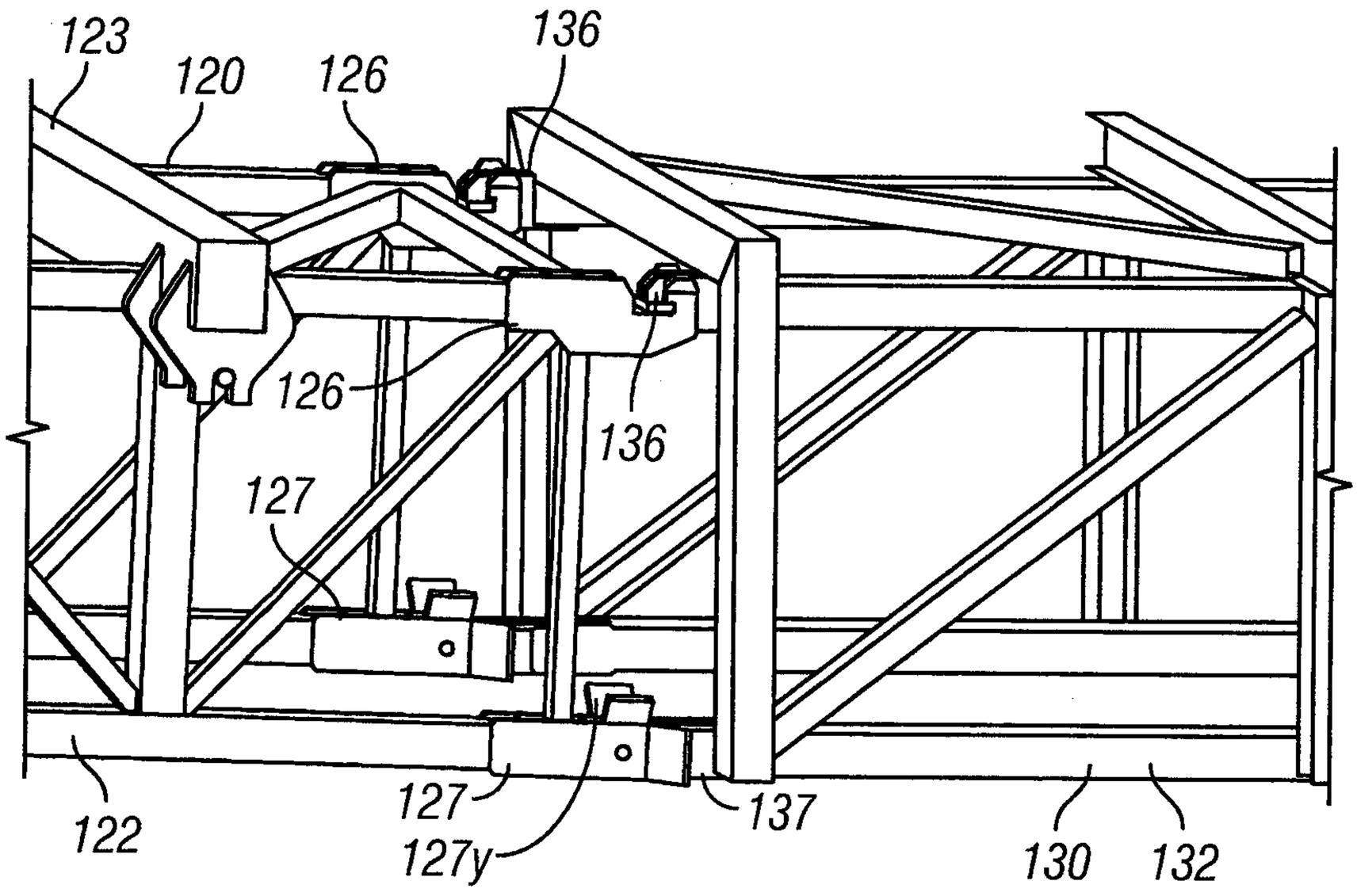
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FIG. 4E

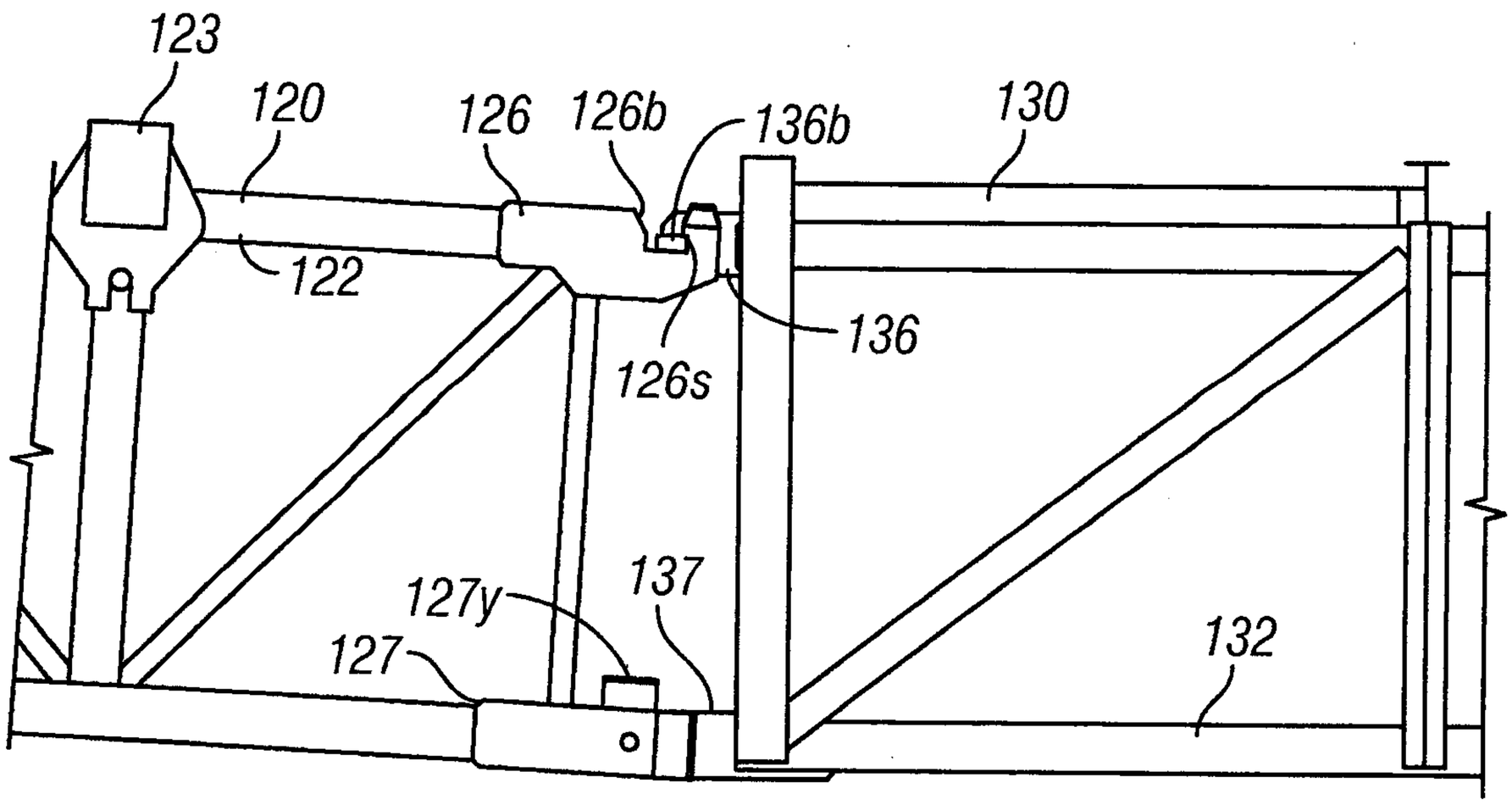
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FIG. 4F

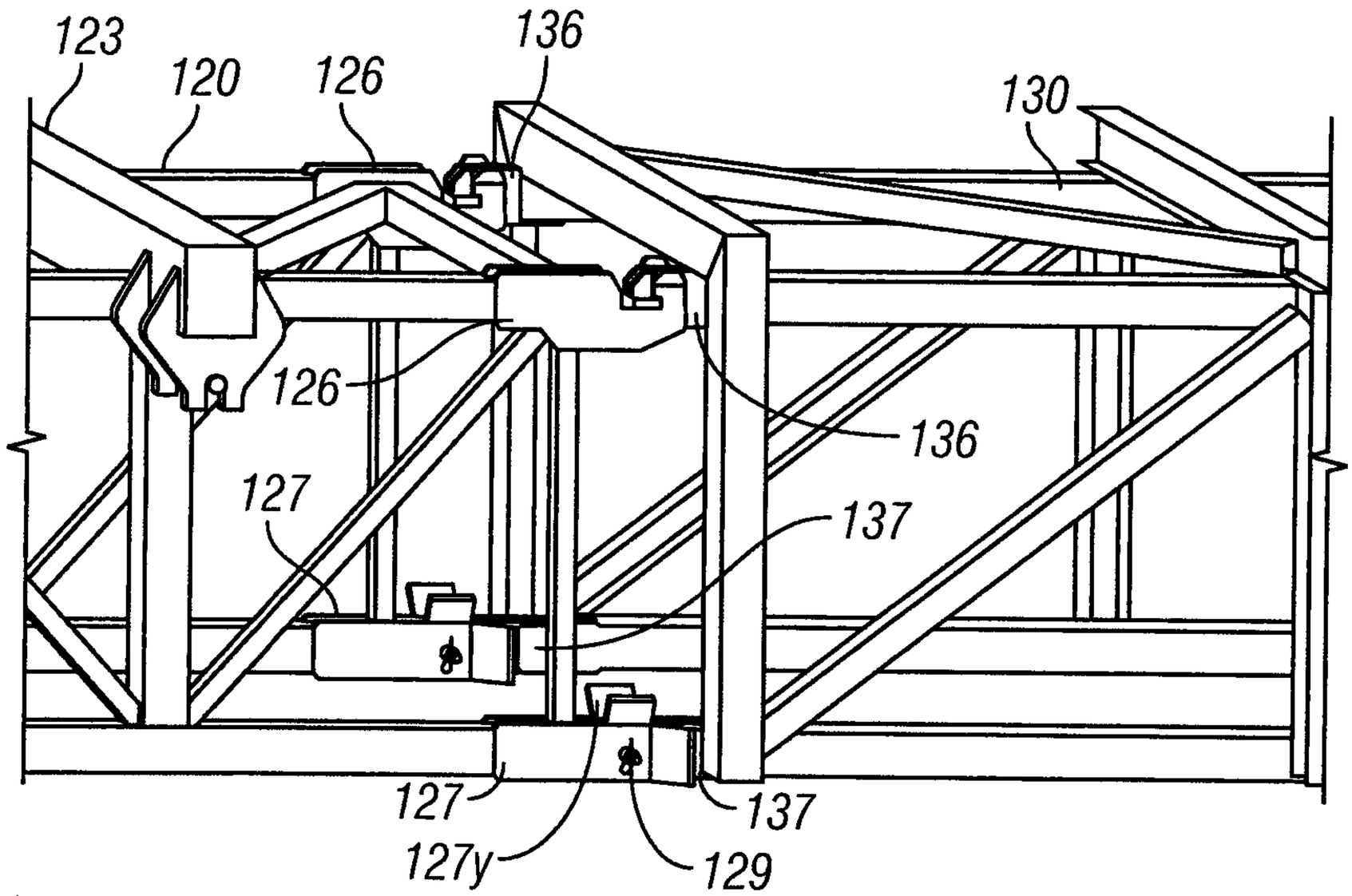
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FIG. 4G

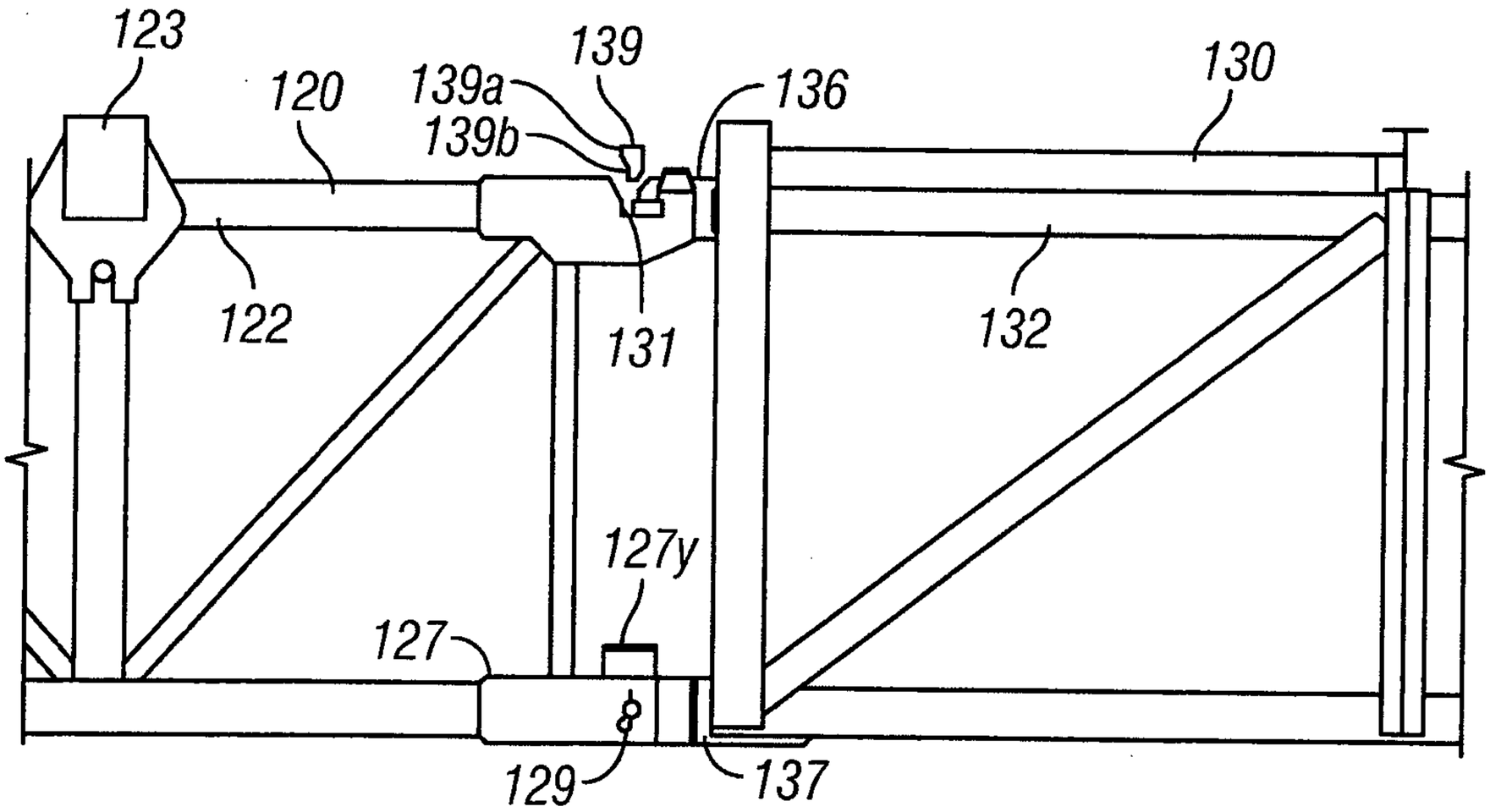
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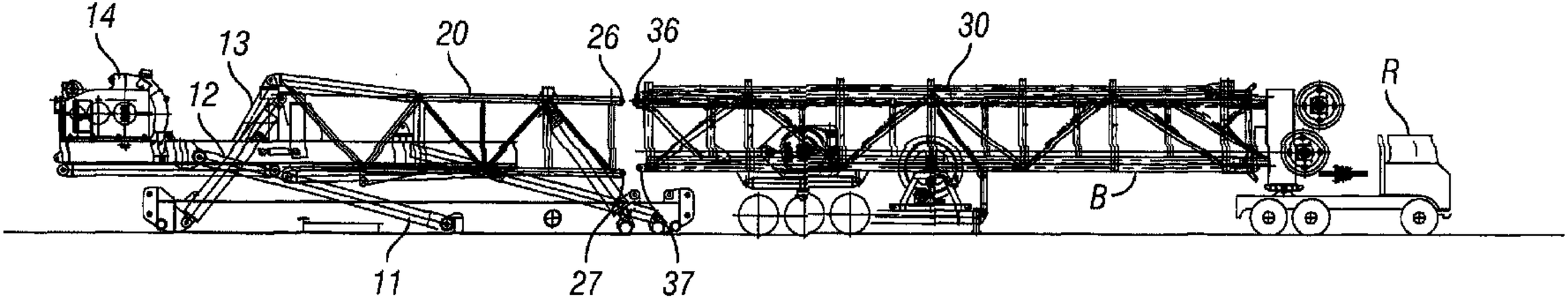
FIG. 4H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B
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