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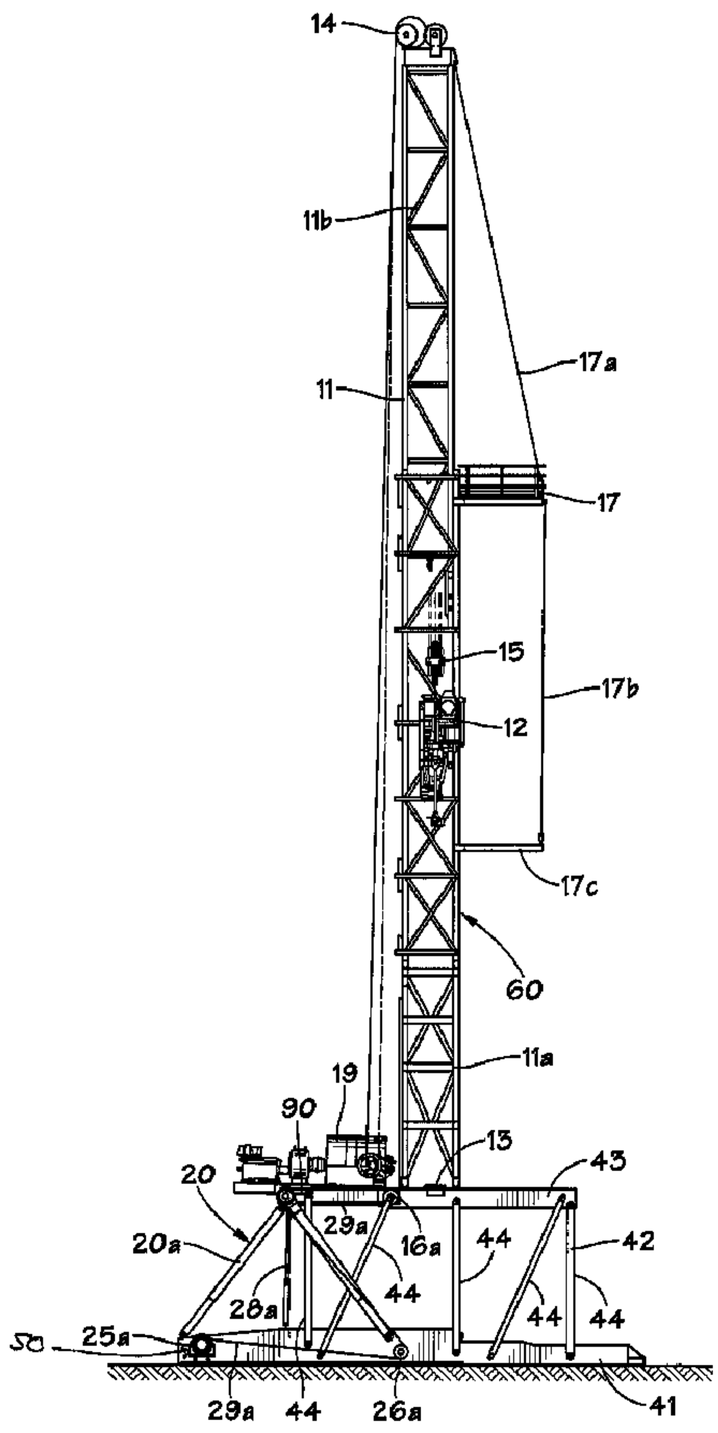

(57) **Abrégé/Abstract:**
A land rig comprising a mast (11), a substructure (40) beneath the mast (11), the substructure (40) having a top part (43: rig floor carrying drawworks 19, rotary table 13), movement apparatus comprising a winch (25a), A-frame (20a), cable (29a) running from

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(57) **Abrégé(suite)/Abstract(continued):**
winch over sheaves (26a, 27a) to sheave (16a) movably attached to the mast. For raising the mast (fig. 5B), sheave (16A) remains attached to the mast, for raising the top part (43), sheave (16a) is lowered on guide tracks on the mast and connected to the top part (fig. 5C).

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FIG. 5B

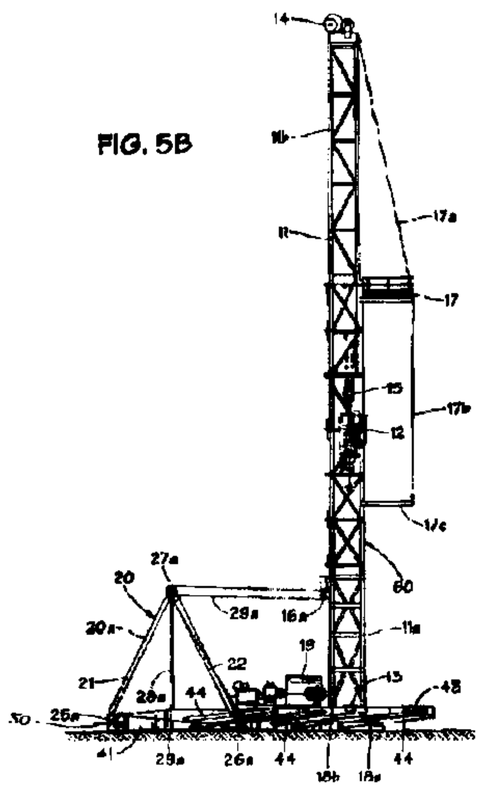
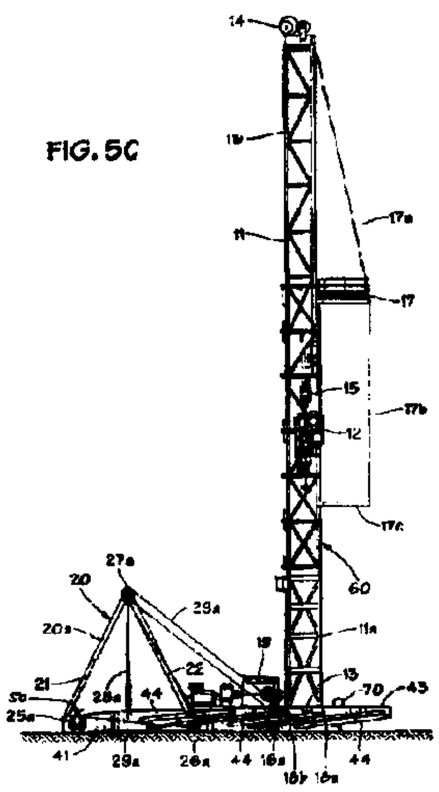


FIG. 5C



(57) Abstract: A land rig comprising a mast (11), a substructure (40) beneath the mast (11), the substructure (40) having a top part (43: rig floor carrying drawworks 19, rotary table 13), movement apparatus comprising a winch (25a), A-frame (20a), cable (29a) running from winch over sheaves (26a, 27a) to sheave (16a) movably attached to the mast. For raising the mast (fig. 5B), sheave (16A) remains attached to the mast, for raising the top part (43), sheave (16a) is lowered on guide tracks on the mast and connected to the top part (fig. 5C).

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LAND RIG

This invention relates to a land rig, and particularly, but not exclusively, to land rigs for drilling and servicing oil and gas wellbores.

The prior art discloses a variety of drilling rigs used in drilling and various wellbore operations; for example, and not by way of limitation, U.S. Patents 3,340,938; 3,807,109; 3,922,825; 3,942,593; 4,269,395; 4,290,495; 4,368,602; 4,489,526; 4,569,168; 4,837,992; 6,634,436; 6,523,319 and the references cited in these patents.

In many land drilling operations, land rigs are delivered to a site, assembled and then disassembled. It is important that land rig 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 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 6,634,436 discloses a mobile land drilling apparatus and method. The rig has a mobile telescoping substructure box. A lifting apparatus selectively supports the mobile telescoping substructure box unit in a raised position and lowered position. An extension cylinder further extends the mobile telescoping substructure box unit in telescopic extension. A stationary frame member and a telescoping frame member have a plurality of cables attached thereto for supporting the telescoping frame member when extended. A trolley winch allows completion of the rig assembly without an external crane.

In accordance with the present invention, there is provided a land rig comprising a mast, a substructure beneath the mast, the substructure having a top part , movement apparatus connectable to the substructure, and the mast, the movement apparatus for moving the mast and for moving the top part of the substructure. Advantageously, the top part comprises a drilling floor. Preferably, the drilling floor comprises a platform. The mast is raised to a position suitable for drilling a well, which would usually be vertical, but may be any suitable angle for drilling a well. Preferably, the well to be formed will be an oil or gas well. The mast may have a top drive mounted a track in the mast for rotating

a drill string. The mast may also comprise a stabbing board, racking board and/or a belly board. The movement apparatus may comprise winch apparatus, one, two, or more winches; hydraulic cylinder apparatus, electrical movement apparatus, powered screw jacks, or air/hydraulic apparatuses. A preferable type of winch is a model No. 750-123 from Lantec Company.

Advantageously, the mast is pivotably connected to the top part of the substructure. Preferably, the movement apparatus comprises at least one winch line and at least one winch for winching said at least one line.

Preferably, the land rig further comprises movable line apparatus connected to the mast and movable up and down on a portion of the mast. Preferably, the movable line apparatus comprises a sheave arranged on a track running along a portion of the mast and advantageously, on to the top part of the substructure. Preferably, the sheave is movable and repositionable.

Preferably, the movable line apparatus is movable down toward the top of the substructure and connectible to the top of the substructure and is advantageously, no longer connected directly to the mast. Preferably, the substructure further comprises a base connected to said top part, the movable line apparatus positionable at a point on the mast to facilitate erection of the mast by the winch, and the movable line apparatus positionable adjacent the top part of the substructure, the movable line apparatus releasably connectible to the top part to facilitate raising of the top part with respect to the base. Advantageously, the land rig further comprises a support structure connecting the top part to the base. Preferably, the support structure comprises a plurality of spaced-apart support members each support member with

a first end pivotably connected to the top part and a second end pivotably connected to the base.

Advantageously, the land rig further comprises at least one A-frame structure having an A-frame top with a top sheave apparatus for the at least one winch line, and an A-frame movement device for moving the A-frame top up and down so that the at least one winch line is alternately positionable for movement of the mast and for movement of the top part of the substructure. Preferably, the at least one A-frame structure is a plurality of spaced-apart A-frame structures. Advantageously, the at least one A-frame structure has a plurality of lockable telescoping legs.

Preferably, the at least one winch apparatus is a plurality of spaced-apart winch apparatuses each with associated winch lines. Advantageously, the at least one winch line is connected to or near to a centre of said top part.

Preferably, the at least one winch line remains connected to the movable line apparatus during drilling by the land rig.

Advantageously, the substructure comprises a drilling end and a second end spaced-apart from the drilling end, the movement apparatus closer to the second end than to the drilling end. Thus the apparatus for erecting a mast and raising part of a substructure are located apart from a drilling area of the rig once the mast is erected so that the apparatus does not interfere with rig operations.

The present invention also provides a method for erecting a land rig, the land rig comprising a mast, a substructure beneath the mast he substructure having a top part, movement apparatus connected to the

substructure and to the mast, the movement apparatus for raising the mast and for moving the top part of the substructure, the method comprising the steps of raising the mast with the movement apparatus, and raising the top part of the substructure with the movement apparatus.

Preferably, the substructure comprises a drilling end and a second end spaced-apart from the drilling end, the movement apparatus closer to the second end than to the drilling end, and wherein the winch lines can remain connected to movable line apparatus during drilling by the land rig, the top part having a top part centre, the method comprising the steps of drilling with the land rig while the winch lines are connected to the movable line apparatus, the movable line apparatus connected to the top part near the top part centre during drilling. Preferably, the winch lines need not be unhooked and repositioned during raising operations. Thus rig winch lines used for mast erection and raising of part of a substructure need not be unpinned or moved during drilling operations.

The present invention also provides a method for erecting a land rig, the land rig comprising a mast, a pivot, a movement apparatus and a substructure, the mast lying substantially horizontally and pivotably attached to the substructure about the pivot, the substructure having a top part and at least one collapsible leg, the method comprising the steps of activating the movement apparatus to raise the mast about the pivot to a substantially vertical position and activating the movement apparatus to raise the top part on the at least one collapsible leg.

Preferably, the land rig further a height adjustable apparatus having a top portion, said movement apparatus

arranged to act between top portion and said mast to raise the mast and the top part, the method further comprising the steps of setting the top portion of the height adjustable apparatus to a first height and activating the movement apparatus to raise the mast and setting the height of the top portion of the height adjustable apparatus to a second height and activating the movement apparatus to raise the top on the at least one collapsible leg.

Advantageously, the height adjustable apparatus comprises an A-frame having at least two legs meeting at an apex wherein the top portion is the apex. Preferably, the legs are extendible. Advantageously, the legs are extendible legs and a telescopic cylinder is used to raise and lower the apex of the A-frame, extending the extendible legs.

Preferably, the movement apparatus is selectively movable between the mast and the top part, wherein after the step of raising the mast, the method further comprises the step of moving at least part of the movement apparatus to the top part and activating the movement apparatus to raise the top part on the at least one collapsible leg. Advantageously, the movement apparatus comprises at least one line and at least one winch for reeling the at least one winch line, the method comprising the step of activating the at least one winch to raise the mast and the top. Preferably, the movement apparatus further comprises at least one sheave over which said at least one winch line passes.

Advantageously, the substructure comprises a base on to which said at least one leg sits, the at least one winch arranged on said base.

The present invention, in certain aspects, provides

a land rig with an erectable mast and substructure, with part of the upper substructure and the mast raised by movement apparatus.

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

Figure 1 is a front perspective schematic view of a land rig in accordance with the present invention, the land rig shown erected;

Figure 2 is a rear perspective schematic view of a land rig shown in Figure 1;

Figure 3 is a side view of the land rig shown in Figure 1, the land rig shown lying horizontally;

Figure 4A is an enlarged view of part of the land rig shown in Figure 1;

Figure 4B is a top view of part of the land rig shown in Figure 1;

Figure 4C is a perspective view of part of the land rig shown in Figure 1;

Figure 4D is a cross-section view taken along line 4D-4D of Figure 4A;

Figure 5A is a side view showing a step in a method for constructing part of the land rig shown in Figure 1;

Figure 5B is a side view showing a step in a method for constructing part of the land rig shown in Figure 1;

Figure 5C is a side view showing a step in a method for constructing part of the land rig shown in Figure 1;

Figure 5D is a side view showing a step in a method for constructing part of the land rig shown in Figure 1;

Figure 5E is a side view showing a step in a method for constructing part of the land rig show in Figure 1; and

Figure 5F is an enlarged view of part of the land rig shown in Figure 5A.

Figures 1, 2 and 3 show a land rig 10 in accordance with the present invention which includes an A-frame

apparatus 20 mounted on a substructure 40 and a mast system 60 (with a mast 11) movable from a generally horizontal position (as shown, for example, in Figures 3 and 5A) to an erect, upright position (as shown, for example, in Figures 5D, 5E). The mast and part of the substructure 40 are raised and lowered with a movement apparatus, generally identified by reference numeral 50.

The land rig 10 may include any and all the typical associated equipment, controls, hoists, drawworks, apparatuses, devices and systems used with any known land rig. As shown the land rig 10 includes tubular rotation apparatus (for example, a top drive system 12 and/or a rotary apparatus 13, such as a rotary table) on the mast 11; a crown sheave or block 14; a travelling block 15 (see Figure 3); a raising sheave 16; an optional racking board 17; mast ends 18, two of which, 18a, pivot on a top 43 of a substructure 40 and two of which, 18b, are selectively connectible to the top 43; and a drawworks system 19.

The mast 11 may be any suitable known mast (single-piece, multi-piece, and/or telescoping). As shown the mast 11 includes two parts 11a and 11b with part 11b movable up from part 11a.

The substructure 40 includes a base 41; movable support apparatus 42; and the top 43 (the rig floor) supported in certain positions by the movable support apparatus 42. The movable support apparatus 42 includes a series of spaced-apart support beams or struts 44 each of whose ends are pivotably connected to the top 43 and the base 41 of the substructure 40. There are two A-frame apparatuses 20, one on each side of the rig as shown in Figure 2 with a total of four winches. It is within the scope of the present invention to use one or

at least one winch; for example, a single winch centered in the rig, for example, useful in smaller, lighter and/or mobile rig systems.

Each A-frame apparatus 20 includes two A-frame sections 20a, 20b each with two legs (21, 22, A-frame 20a; 23, 24, A-frame 20b) each with two parts (21a, 21b and 22a, 22b, 23a, 23b and 24a, 24b; 23a, 23b, 24a, 24b). The parts telescope with respect to each other, one inside the other, to provide height adjustability for the A-frame apparatus 20.

Each A-frame 20 has a winch 25a, 25b; an idler sheave 26a, 26b; a frame sheave 27a, 27b, raising apparatuses 28a, 28b which raise and lower the A-frame 20 as the legs (21, 22; 23, 24) extend (raising) or retract (lowering). Any suitable raising apparatus may be used, for example, hydraulic cylinders, air cylinders, piston/cylinder apparatuses, and electric screw jacks. As shown, the raising apparatuses 28a, 28b are telescoping hydraulic piston/cylinder apparatuses. The raising apparatus may be telescoping and may have several concentric telescoping members.

Lines 29a, 29b from the winches 25a, 25b, respectively, extend around the idler sheaves 26a, 26b, to the frame sheaves 27a, 27b and to and around movable sheaves 16a, 16b (movable sheave 16a shown; movable sheave 16b not shown) on the mast 11 for raising the mast 11.

The movable sheaves 16a, 16b are movable in trolley guide tracks 39 on the mast. Figure 4D shows the movable sheave 16a with wheels 81 connected to a sheave body 82. The wheels 81 move in the trolley guide track 39 of the mast 11. Pins 84 releasably pin the sheave body 82 to lugs 11p on the mast 11. Similarly, pins through holes

86 in the body 82 releasably connect the body 82 to the top 43 of the substructure 40. As shown the movable sheave 16a has recesses 16r for six lines.

Figure 5F shows a typical kickover cylinder apparatus 90 which provides starting force to move the top 43 toward a lowered position. The apparatus 91 has a mounting structure 92 for mounting a movement apparatus 91 to the body 82. Via a member 93 force from the movement apparatus 91 is transferred to the top 43 of the substructure 40. The kickover cylinder apparatus 90 exerts force against the top 43 moving the top 43 forward, resulting in certain of the legs 44 (which are initially vertical) moving so that they are at an angle to the top 43.

As shown in Figure 5A, the raising apparatus 28a has raised the A-frame 20 (as shown). The legs 21, 22, 23, 24 have been extended with parts pinned or otherwise locked together. The A-frame apparatus is now in position to raise the mast 11.

As shown in Figure 5B the winches 25a, 25b have raised the mast 11 (by taking in lines 29a, 29b), the mast has pivoted on the mast ends 18a, and the mast ends 18b have been connected to the top 43 of the substructure 40 (for example, wi th removable pins extending through the mast ends 18b into eyes on the top 43. The legs 21, 22, 23, and 24 have been locked in an extended position with pins through the leg parts.

The racking board 17 has moved into the position shown in Figure 5B and is held in place by lines 17a, 17b connected between the racking board 17 and the mast 11 (line 17a) and between the racking board 17 and a belly board 17c. The racking board 17 can be movably attached to the mast 11 initially (for example, before the step of

Figure 5A) or it can be connected to the mast 11 at any time.

As illustrated in Figure 5C, the movable sheaves 16a, 16b have been moved down on trolley guide tracks 39 (see Figure 4A) to the position shown in Figure 5C and are then releasably connected to the top 43 of the substructure 40. The sheaves 16a, 16b are moved up and down, for example, by an auxiliary winch 70. It is within the scope of the present invention to move the movable sheaves 16a, 16b along the trolley guide track 39 using any suitable movement apparatus, including, but not limited to, hydraulic cylinder apparatus, pneumatic cylinder apparatus, and/or electric motor(s).

As shown in Figure 5D, the raising apparatuses 28a, 28b have lowered the A-frames 20 (so the angle for the lines 29 is correct so that the winches 25a, 25b can raise the top 43 of the substructure 40 to the position of Figure 5E. The lower ends of the raising apparatuses pivotably connected to the top 43 of the substructure 40. Also the winches 25a, 25b are located relatively far away from the mast 11 and from operations associated with the rig.

The winches 25a, 25b then take in lines 29 to raise the top 43 of the substructure 40 as shown in Figure 5E. In this position the lines 29 are positioned as shown in Figure 5E relative to the items on the top 43, i.e., out of the way of a variety of items on the top 43 so that movement on and operations on the top 43 are not impeded by the lines 29, and so that operations of the rig, particularly around the mast, are not impeded.

As shown in Figure 5E, for efficiency of movement and for efficient lifting forces when the movable sheaves 16a, 16b are moved down on the mast and then connected to

the top 43 of the substructure 40, the movable sheaves 16a, 16b are connected at a point on the top 43 of the substructure 40 which is closer to the centre of the top 43 (centre as viewed in 5E) than to the end (left end as viewed in Figure 5E) of the top 43. Also as shown in Figure 5E, the A-frames remain in place during rig operations, with lines attached and extending between sheaves 26a, 26b, 27a, 27b and winch 25a, 25b so that systems are in place to lower the top 43 and lower the mast 11 when desired. The movable sheave assemblies move down on the tracks until eyes in them are aligned with corresponding eyes of the mast through which pins are releasably inserted while the wheels remain connected to the movable sheave assemblies.

The land rig may be disassembled by reversing the steps as set out above.

As shown in the various drawings the winches 25a, 25b are located away from a drilling end of the rig (platform and mast) (for example, Figures 1, 3) so that the winches, lines, and associated apparatuses and parts are subjected to less corrosion and contamination as compared to a location closer to the drilling end of the rig.

CLAIMS:

1. A land rig comprising a mast (11), a substructure (40) beneath the mast (11), the substructure (40) having a top part (43), movement apparatus (50) connectable to the substructure (40), and the mast (11), the movement apparatus (50) comprising at least one winch line (29a,29b) and at least one winch (25a,25b) for winching said at least one line (29a,29b) for moving the mast (11) and for moving the top part (43) of the substructure (40) characterised in that the land rig further comprises at least one A-frame structure (20) having an A-frame top with a top sheave apparatus (27a) for the at least one winch line (29a), and an A-frame movement device (28a) for moving the A-frame top up and down so that the at least one winch line is alternately positionable for movement of the mast (11) and for movement of the top part (43) of the substructure (40).

2. The land rig as claimed in Claim 1, wherein the mast (11) is pivotably connected to the top part (43) of the substructure (40).

3. The land rig as claimed in Claim 1 or 2, further comprising movable line apparatus (16a) connected to the mast (11) and movable up and down on a portion of the mast (11).

4. The land rig as claimed in Claim 3, wherein the movable line apparatus (16a) is movable down toward the top part (43) of the substructure (40) and connectible to the top part (43) of the substructure (40).

5. The land rig as claimed in Claim 3 or 4, wherein the substructure (40) further comprises a base (41) connected

to said top part (43), the movable line apparatus (43) positionable at a point on the mast (11) to facilitate erection of the mast (11) by the winch (25a,25b), and the movable line apparatus (16a) positionable adjacent the top part (43) of the substructure (40), the movable line apparatus (16a) releasably connectible to the top part (43) to facilitate raising of the top part (43) with respect to the base (41).

6. The land rig as claimed in Claim 5, further comprising support structure (42) connecting the top part (43) to the base (41).

7. The land rig as claimed in Claim 6, wherein the support structure (42) comprises a plurality of spaced-apart support members (44) each support member with a first end pivotably connected to the top part (43) and a second end pivotably connected to the base (41).

8. A land rig as claimed in any one of Claims 1 to 7, wherein the at least one A-frame structure (20) is a plurality of spaced-apart A-frame structures (20a,20b).

9. The land rig as claimed in Claim 8 wherein the at least one A-frame structure (20) has a plurality of lockable telescoping legs (21,22).

10. The land rig as claimed in any one of Claims 1 to 9, wherein the at least one winch apparatus (25a,25b) is a plurality of spaced-apart winch apparatuses (25a,25b) each with associated winch lines (29a,29b).

11. The land rig as claimed in any one of Claims 1 to 10, wherein the at least one winch line (29a,29b) is connected to or near to a centre of said top part (43).

12. The land rig as claimed in any one of Claims 3 to 11, wherein the at least one winch line (29a) remains connected to the movable line apparatus (16a) during drilling by the land rig.

13. The land rig as claimed in any one of Claims 1 to 12, wherein the substructure (40) comprises a drilling end and a second end spaced-apart from the drilling end, the movement apparatus (50) closer to the second end than to the drilling end.

14. A method for erecting a land rig, the land rig comprising a mast (11), a substructure (40) beneath the mast (11), the substructure (40) having a top part (43), movement apparatus (25a) connected to the substructure and to the mast, the movement apparatus (50) for raising the mast (11) and for moving the top part (43) of the substructure (40), wherein the substructure (40) comprises a drilling end and a second end spaced-apart from the drilling end, the movement apparatus (50) closer to the second end than to the drilling end, and wherein the winch lines (29a) can remain connected to movable line apparatus (16a) during drilling by the land rig, the top part (43) having a top part center, the method comprising the steps of raising the mast (11) with the movement apparatus (50), and raising the top part (43) of the substructure (40) with the movement apparatus (50), drilling with the land rig while the winch lines (29a) are connected to the movable line apparatus (16a), the movable line apparatus (16a) connected to the top part (43) near the top part centre during drilling.

15. A method for erecting a land rig, the land rig comprising a mast (11), a pivot (18a), a movement apparatus (50) and a substructure (40), the mast (11)

lying substantially horizontally and pivotably attached to the substructure (40) about the pivot (18a), the substructure (40) having a top part (43) and at least one collapsible leg (44), the method comprising the steps of activating the movement apparatus (50) to raise the mast (11) about the pivot (48) to a substantially vertical position and activating the movement apparatus (50) to raise the top part (43) on the at least one collapsible leg (44) characterised by a height adjustable apparatus (20) having a top portion, said movement apparatus (50) arranged to act between top portion and said mast (11) to raise the mast (11) and the top part (43), the method further comprising the steps of setting the top portion of the height adjustable apparatus (20) to a first height and activating the movement apparatus (50) to raise the mast (11) and setting the height of the top portion of the height adjustable apparatus (20) to a second height and activating the movement apparatus (50) to raise the top part (43) on the at least one collapsible leg (44).

16. The method in accordance with Claim 15, wherein the height adjustable apparatus (20) comprises an A-frame having at least two legs (20a,20b) meeting at an apex wherein the top portion is the apex.

17. The method in accordance with Claim 15 or 16, wherein the movement apparatus (50) is selectively movable between the mast (11) and the top part (43), wherein after the step of raising the mast (11), the method further comprises the step of moving at least part of the movement apparatus (16a) to the top part (43) and activating the movement apparatus (50) to raise the top part (43) on the at least one collapsible leg (44).

18. The method in accordance with Claim 17, wherein the

movement apparatus (50) comprises at least one line (29a,29b) and at least one winch (25a,25b) for reeling the at least one winch line (29a,29b), the method comprising the step of activating the at least one winch (25a,25b) to raise the mast (11) and the top part (43).

19. The method in accordance with Claim 18, wherein the movement apparatus (50) further comprises at least one sheave (16a,26a,27a,26b,27b) over which said at least one winch line (29a,29b) passes.

20. The method in accordance with any one of Claims 15 to 19, wherein the substructure (40) comprises a base (41) on to which said at least one leg (44) sits, the at least one winch (25a,25b) arranged on said base (41).

21. A land rig comprising a mast (11), a substructure (40) beneath the mast (11), the substructure (40) having a top part (43), movement apparatus (50) connectable to the substructure (40), and the mast (11), the movement apparatus (50) for moving the mast (11) and for moving the top part (43) of the substructure (40), wherein the movable line apparatus (16a) is movable up and down on trolley guide tracks (39) on a portion of the mast (11), down toward the top part (43) of the substructure (40) and connectible to the top part (43) of the substructure (40).

22. The land rig as claimed in Claim 21, wherein said movable line apparatus (16a) is at least one movable sheave.

23. The land rig as claimed in Claim 21 or 22, wherein movement apparatus (70) is provided to move said movable line apparatus (16a) along said trolley guide tracks (39).

24. The land rig as claimed in Claim 23, wherein movement apparatus comprises at least one of: hydraulic cylinder apparatus; pneumatic cylinder apparatus; and electric motor.

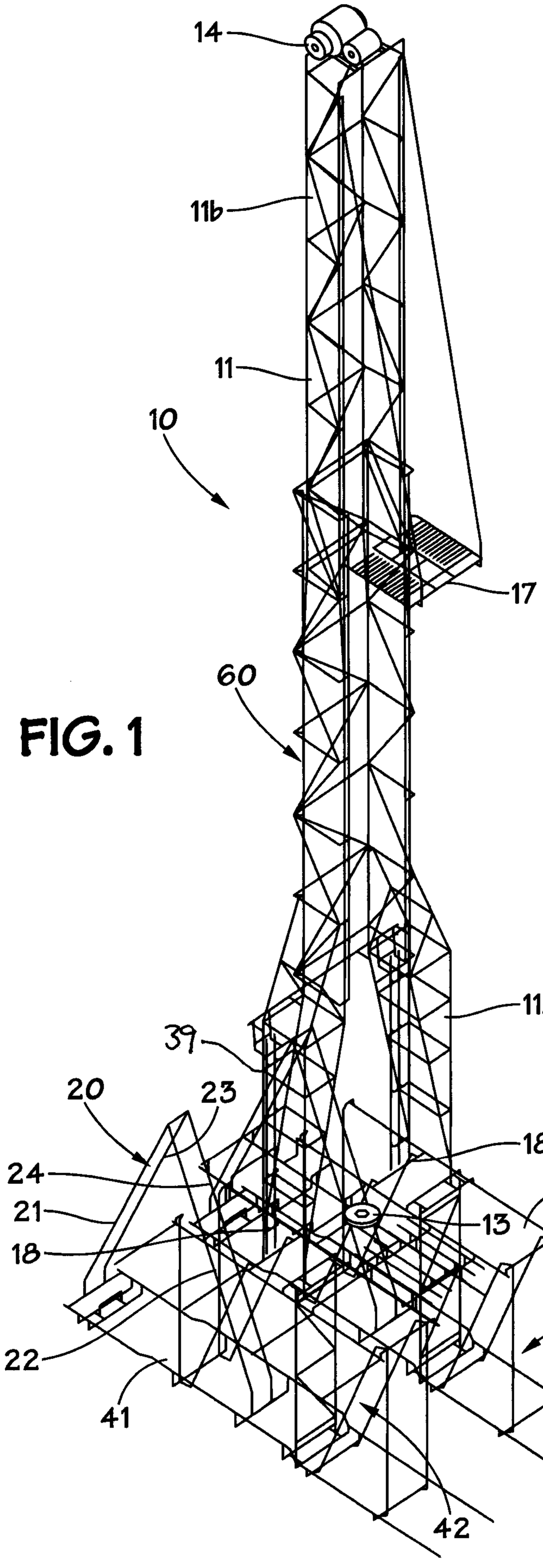


FIG. 1

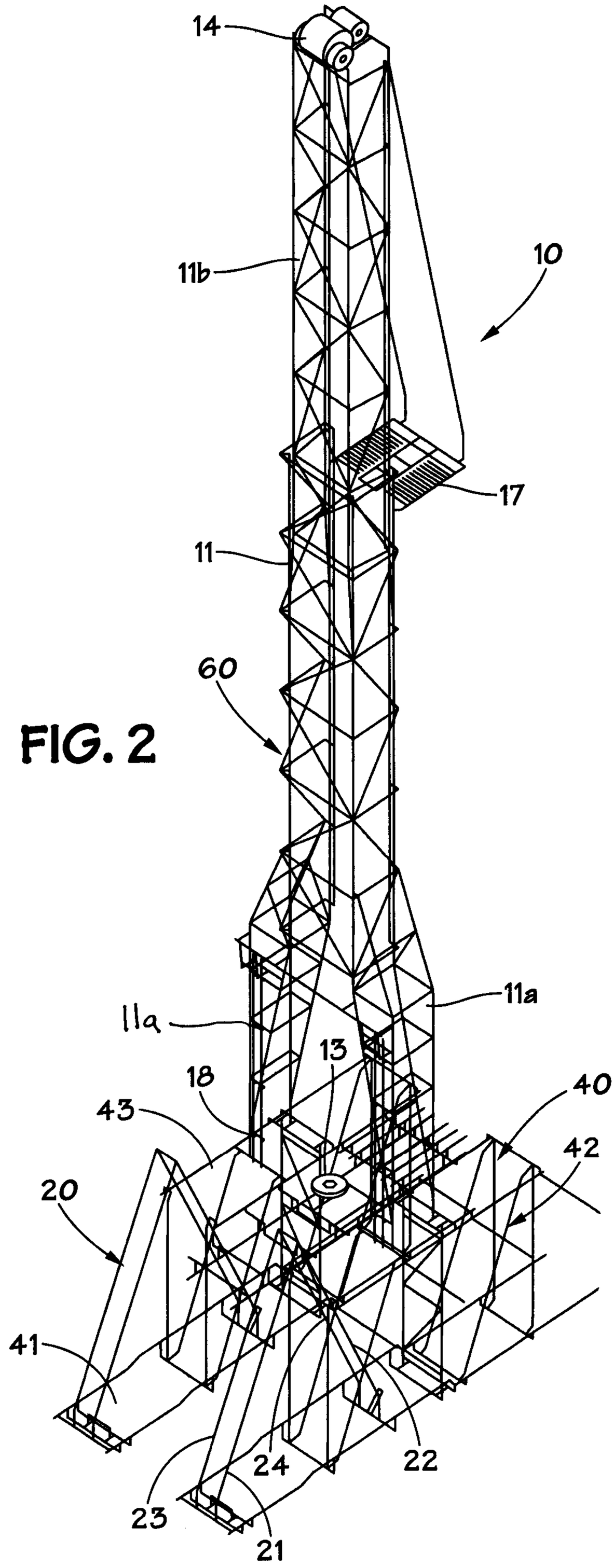
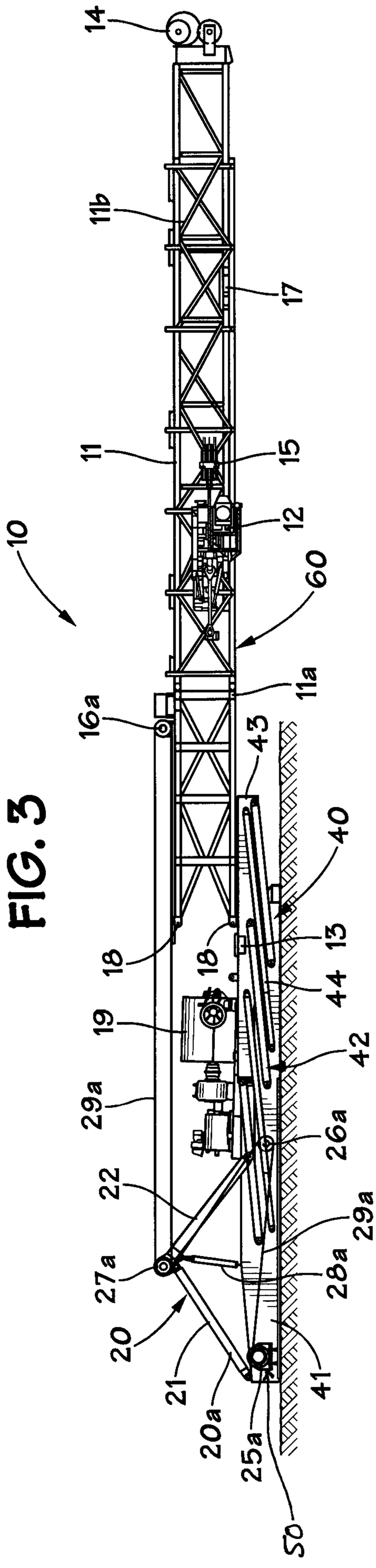


FIG. 2

FIG. 3


14
11b
17
11
15
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60
11a
16a
43
40
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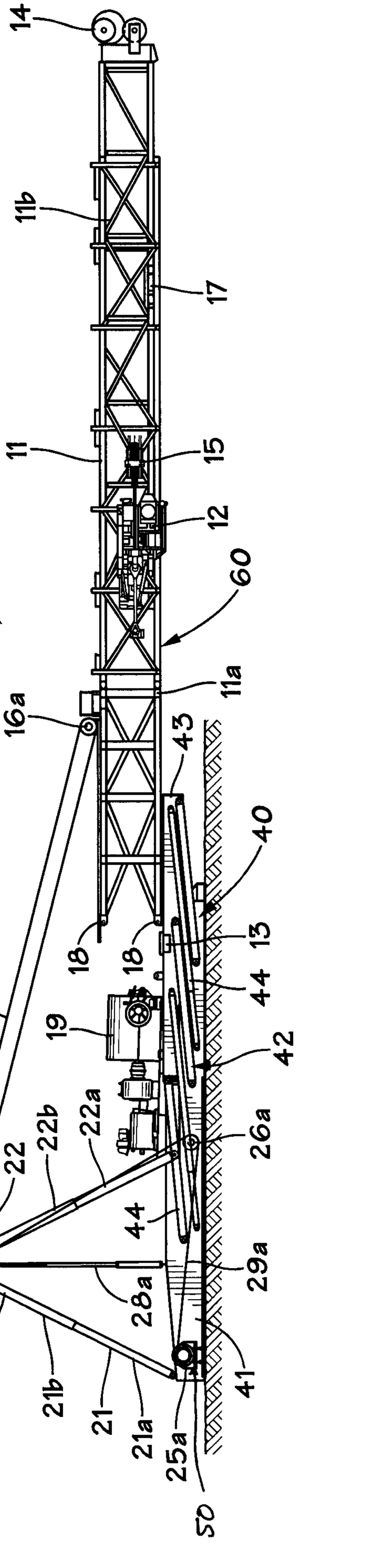
13
44
19
42
29a
26a
22
22b
22a
27a
29a
28a
20
21
20a
25a
41
50

FIG. 5A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22a
27a
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28a
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20a
21b
21a
25a
41
50

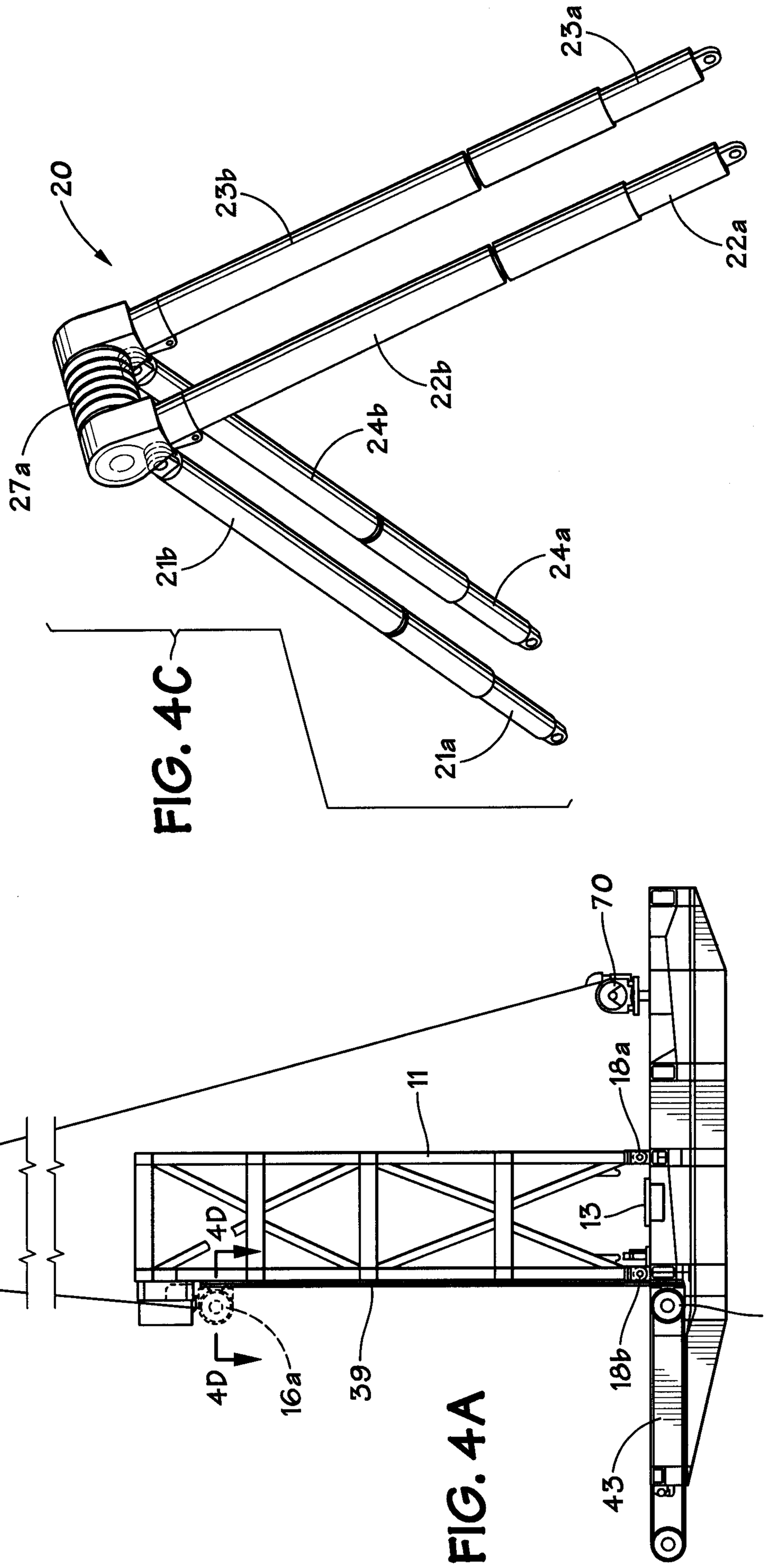
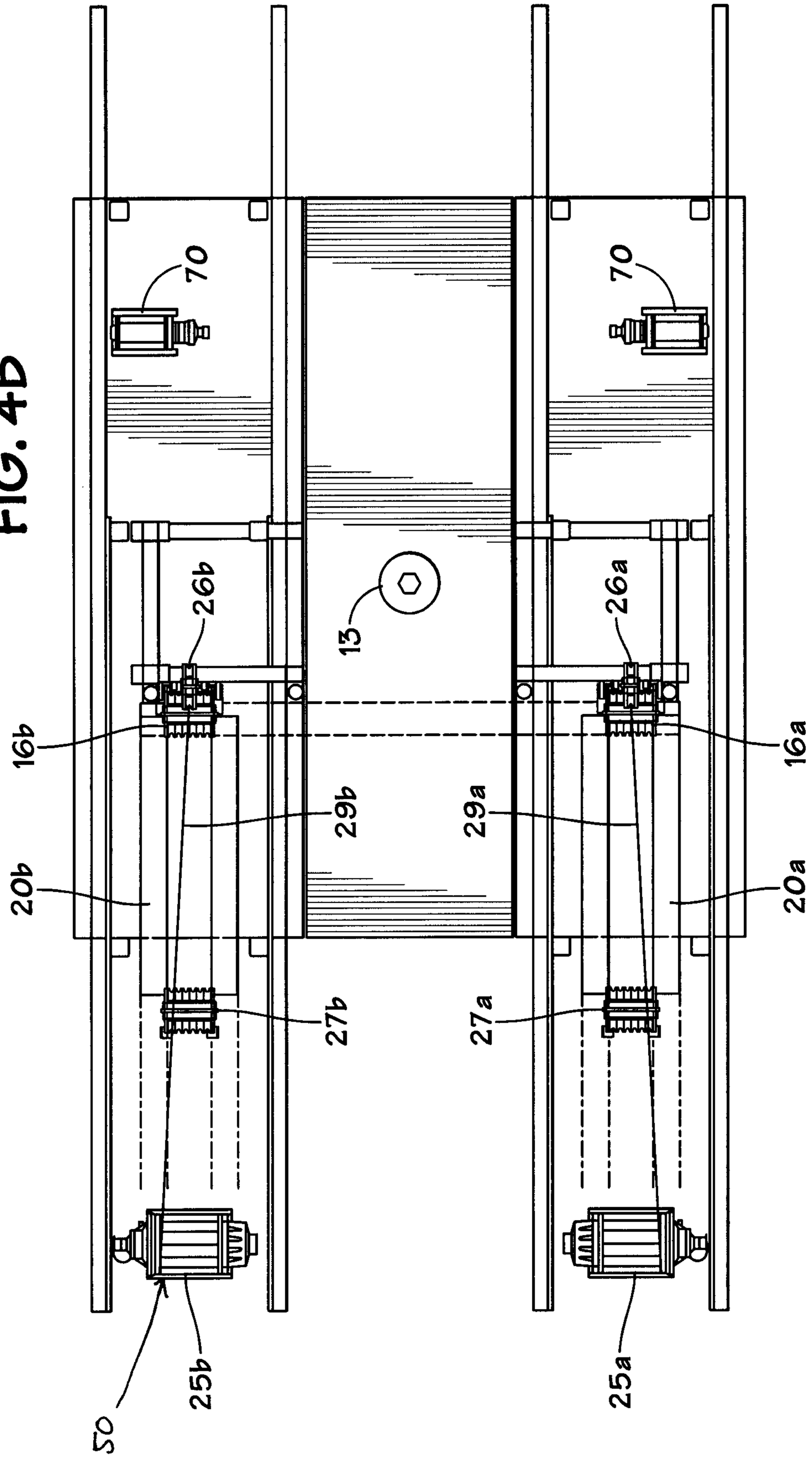

20
23b
23a
22a
22b
24b
24a
27a
21b
21a
70
11
18a
13
4D
4D
16a
39
18b
43
16a

FIG. 4C

FIG. 4A

FIG. 4B



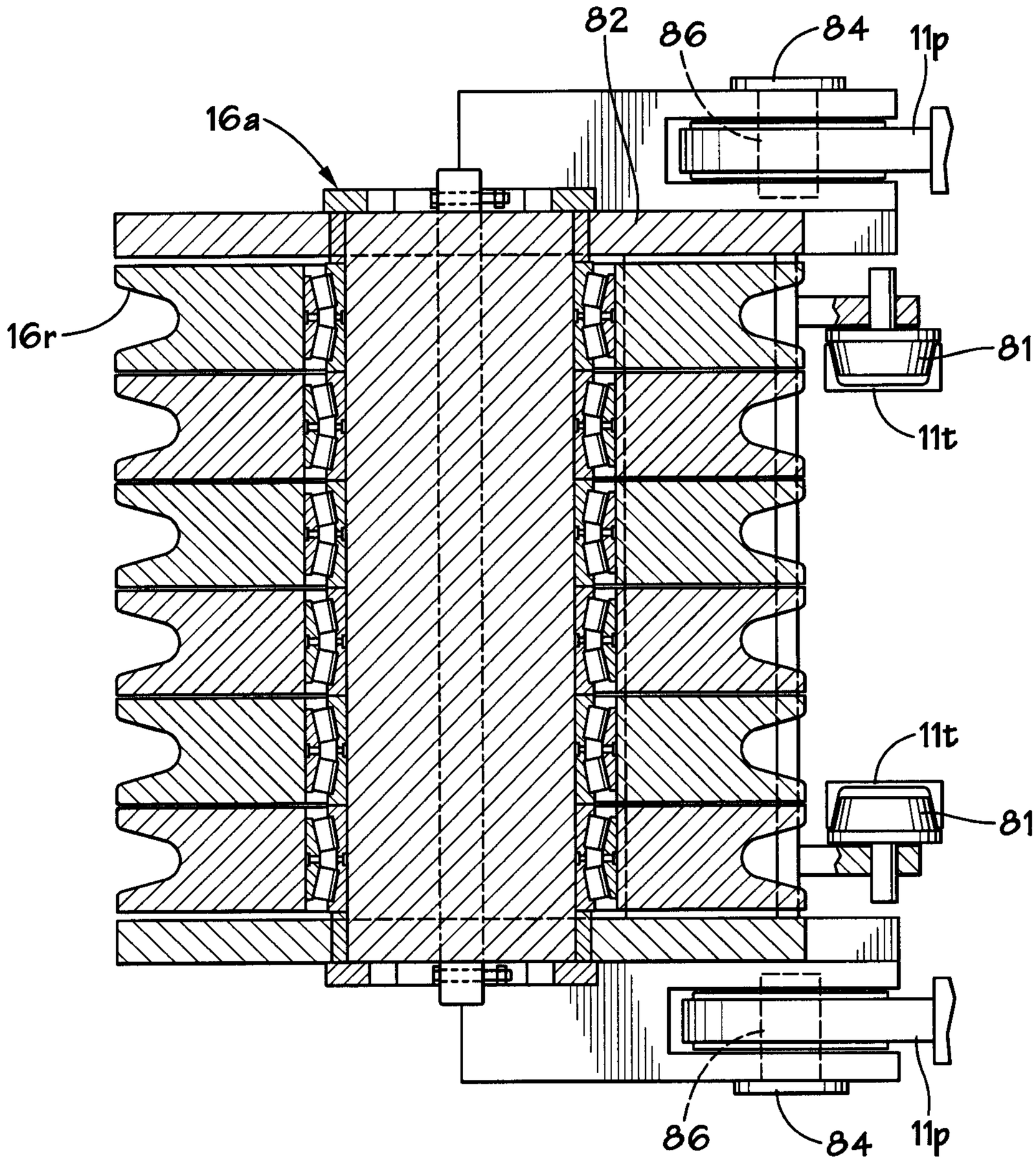
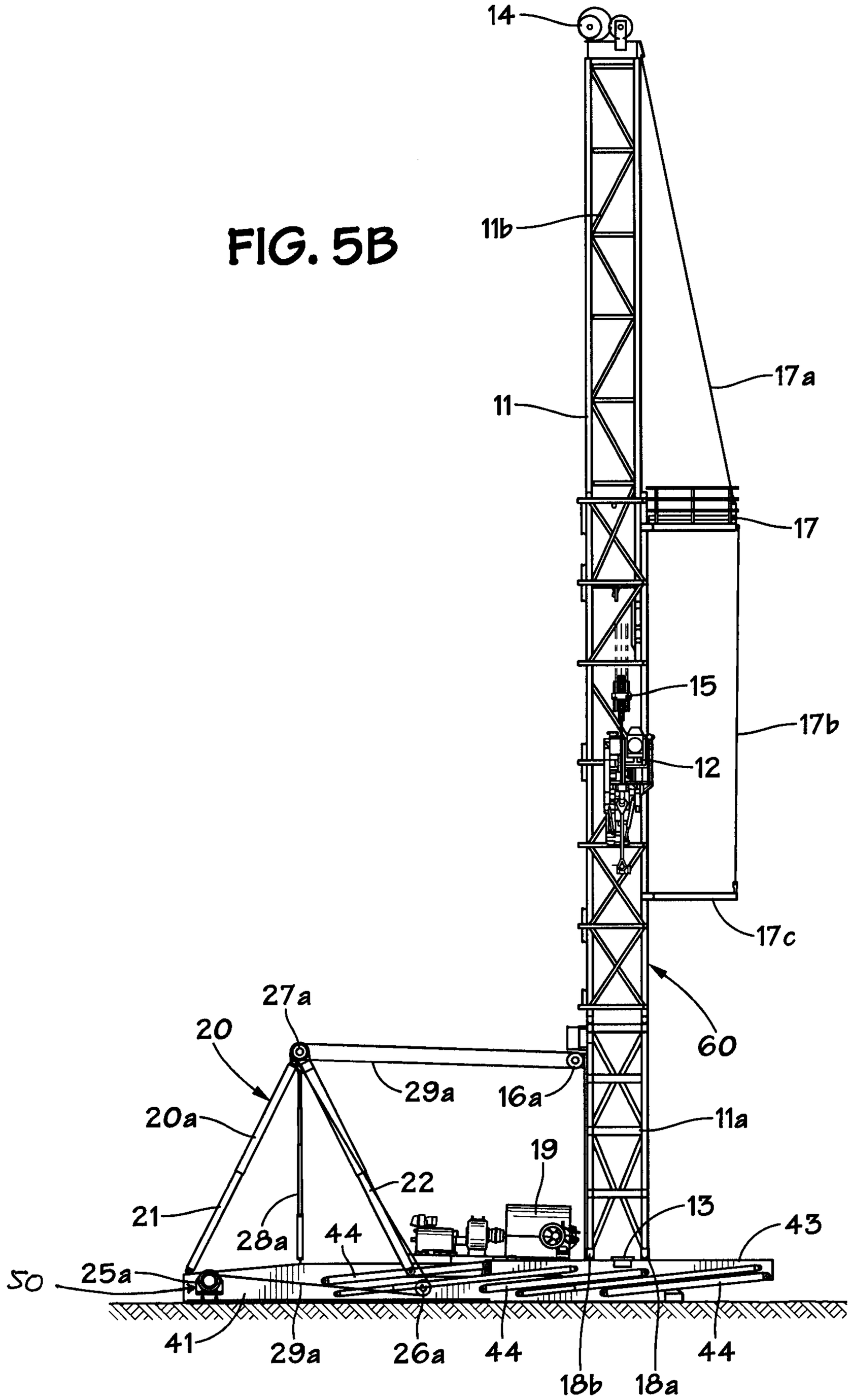


FIG. 4D

FIG. 5B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11b
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17a
17
15
17b
12
17c
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27a
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29a
16a
20a
11a
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22
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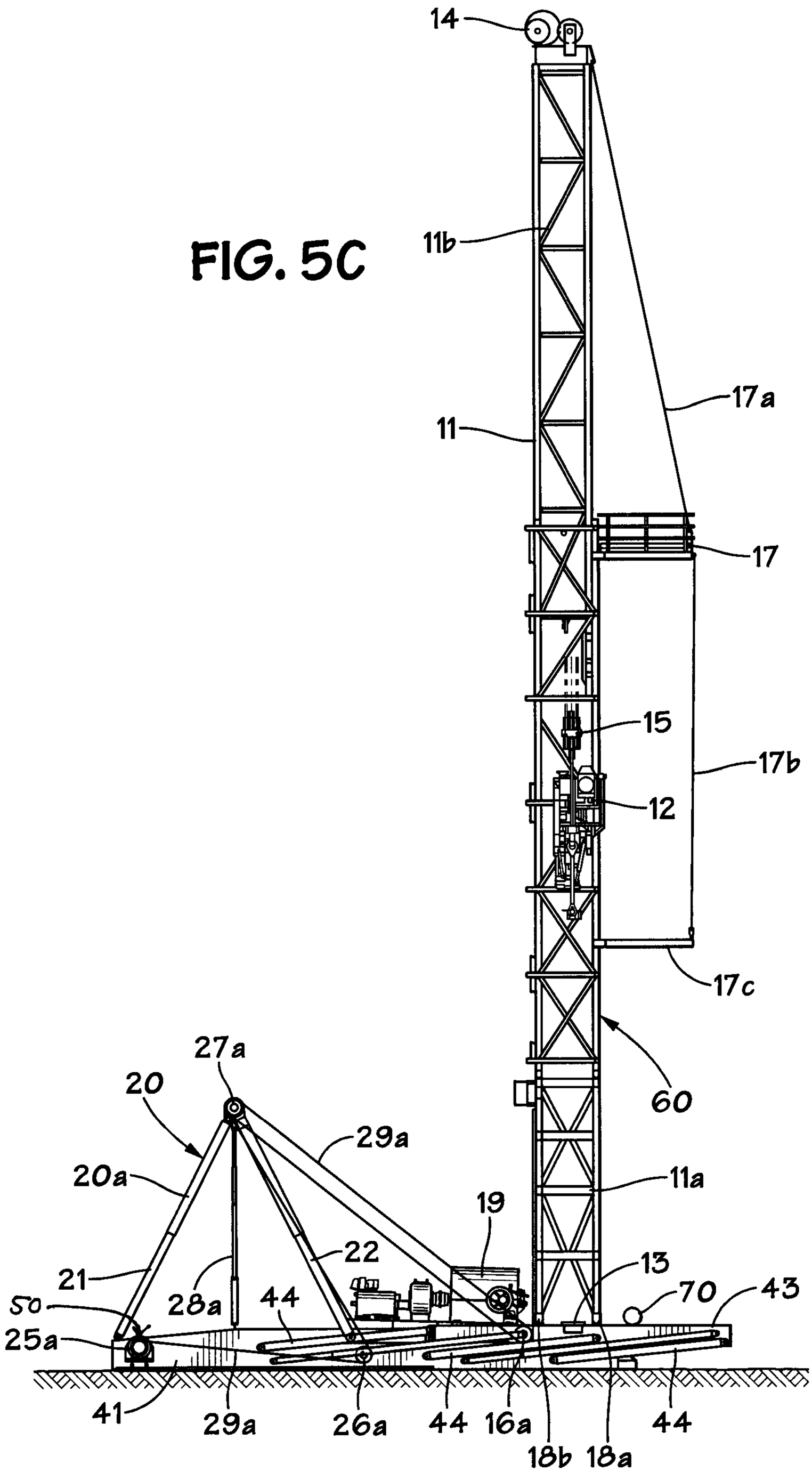
21
28a
44
43
50
25a
41
29a
26a
44
18b
18a
44

FIG. 5C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16a
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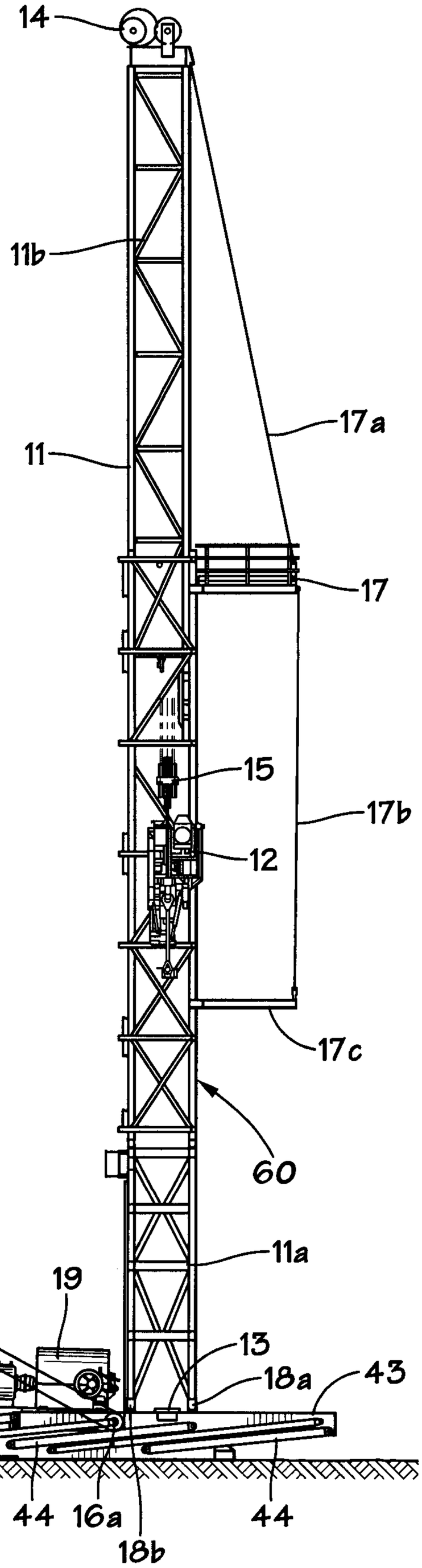
18b
18a

FIG. 5D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18a
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25a
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29a
26a
44
16a
44
18b

FIG. 5E


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91

FIG. 5F

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17b
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17c
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25a
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29a
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26a
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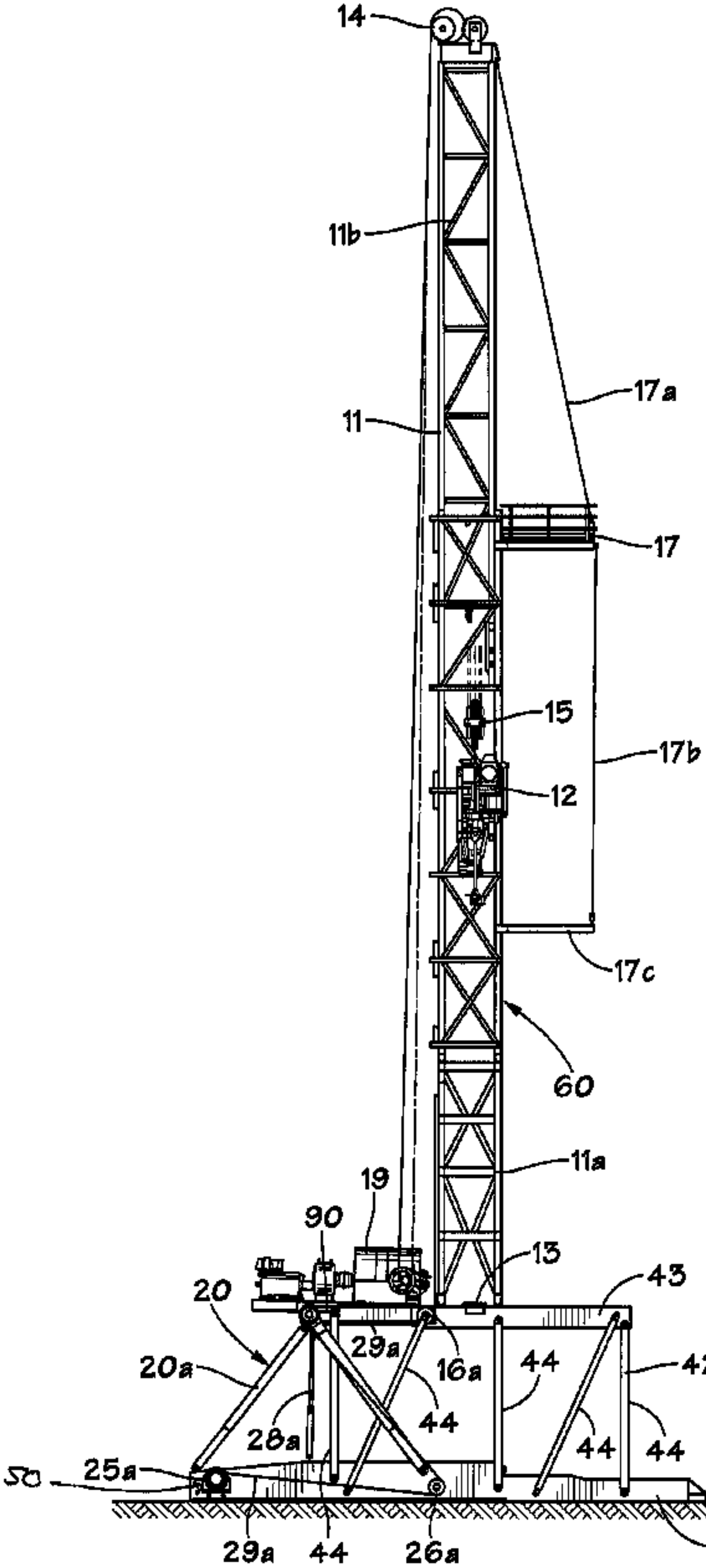
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25a
29a
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26a
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