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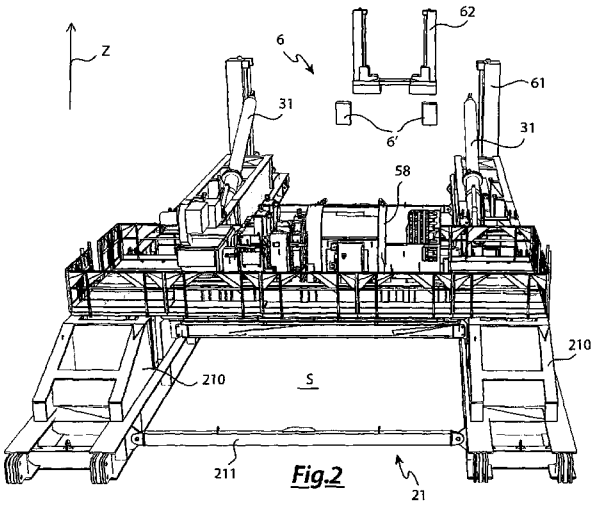

Fig.2

(57) Abstract: Well drilling apparatus (2) and method associated therewith, which is able to shift from a first assembly operating configuration to a second use operating configuration and vice versa. Said apparatus (2) comprises a sub-structure (21), which supports said apparatus (2), a mast (23), which is pivoted to said sub-structure (21), around which it rotates so as to shift from said assembly operating configuration, which is substantially horizontal, to said use operating configuration and vice versa; a drill floor (22), which is able to be lifted and is connected to the mast (23); an actuating device (3), which is adapted to allow the drilling apparatus (2) to shift between said two operating configurations. The actuating device (3) is a hydraulic device, which is directly connected to the mast (23). The drill floor (22) comprises a first portion (22a), projects with respect to said mast (23), and a second portion (22b), which is constrained to said mast (23) and rotates with it. A draw-works (58) is installed, in a permanent manner, on the sub-structure (21).

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TITLE: WELL DRILLING APPARATUS AND ASSEMBLING AND DISASSEMBLING METHOD.

The present invention is relative to a drilling apparatus or land rig, which can be moved, and is relative to the relative assembling method.

In particular, the present invention is relative to a well drilling apparatus for the search and the extraction of fossil fuels, such as oil and fuel gases.

Said drilling apparatus assumes an assembly operating configuration, in which it is completely assembled in a horizontal position, at the level of the ground, and, when it is raised in a vertical position, it assumes a use operating configuration for the drilling, all of this in one single operation.

Furthermore, the apparatus according to the present invention is modular and can be easily assembled and disassembled, thus allowing said apparatus to be moved from a drilling spot to the next one in a quick manner, hence reducing the amount of time needed to disassemble and re-assemble it.

Projecting masts, which are comprised in said drilling apparatuses or structures, are widely used in ground drilling operations.

In the structures or apparatuses described in the prior art, different mast assembly or erection devices are used in order to allow said mast to be positioned, after having been assembled, above the drilling well.

In its use operating configuration, the drilling structure or apparatus comprises a sub-structure. Normally, said sub-structure comprises sub bases, which lay on the ground. The sub-structure is adapted to support a drill

floor. Said drill floor and the mast, which is arranged in a vertical position, are raised at a predetermined height from the ground.

Normally, the drill floor comprises different devices, such as: at least one pair of power tongs, a rotary table, and a draw-works, which are typically used during the drilling phases. The mode of operation and the features of the above-mentioned devices comprised in the drill floor are known to a skilled person.

Normally, the processes needed by the apparatus to shift from an assembly operating configuration to a use operating configuration comprises a first step in which the mast is raised in a vertical position, substantially keeping the drill floor at the level of the ground. Subsequently, the drill floor is raised at the desired hight, positioning the rotary table above the drilling well, aligned with said well.

In the prior art, prior to raising the drilling structure or apparatus, the sub-structure, the drill floor and the mast are assembled at the level of the ground and connected to one another. Finally, the fast line of the draw-works is inserted into the fast line shave, which is arranged at the top pf the mast, and through the travelling block, thus becoming the drilling line. Said line is fixed, in correspondence to a first deadline of its, to the corresponding deadline anchor.

Normally, in oder for the apparatus to shift from the assembly operating configuration to the use operating configuration, two consecutive steps have to be performed, in particular a first step of raising the mast from the horizontal position, parallel to the ground, to the

vertical position, and a subsequent step of raising the drill floor.

Said step of raising the mast is performed by using said draw-works, which exerts the necessary raising force. Normally, when the mast is in a horizontal position, two feet of the mast are hinged to the drill floor and, subsequently, when the mast itself is arranged in the vertical position, the two remaining feet are secured as well.

Normally, in the known art, in order for the mast to be raised, a traction force is applied so as to erect the mast itself in a vertical position.

In the second step, on the other hand, the drill floor supporting the mast in the vertical position, in turn, is raised up to the desired height above the drilling well, thus obtaining two movements that are distinct from one another and mutually independent.

Normally, in order to raise the mast from the horizontal position to the vertical position, besides using the draw-works, a so-called A-frame is used. The raising or tilting movement of the mast is performed by connecting the travelling block to a line tie, which, in the rear part, extends around sheaves that are supported by said A-frame and, in the front part, is anchored to the mast. When the draw-works pulls in the line, the travelling block and the line tie raise the mast and tilt it in a vertical position against said A-frame.

The greater the height and the weight of the mast, the greater the stress to which the line is subject during the mast raising phase, in particular during the first part of the raising movement, when the mast is in a substantially horizontal position.

For this reason, the line system used to raise the mast is usually replaced by a direct raising movement by means of hydraulic actuators. The use of hydraulic actuators allows users to reduce rig-up times, since one does not need any longer to install an A-frame for the sheaves and sling lines for the raising movement. Furthermore, the use of hydraulic actuators allows users to raise the mast only by means of a low-power hydraulic control unit, if necessary with a diesel motor. Therefore, the generators of the work site do not need to be started and the the draw-works does not need to be supplied with power.

As mentioned above, the use of hydraulic actuators allows users to eliminate the A-frame and, therefore, to save the time needed for its installation and removal.

In the technical field, well drilling apparatuses often need to be moved; in particular they have to be moved from one well to the next one together with all the complementary equipments needed for the operation of a drilling plant. In the prior art, in order to move a drilling apparatus or land rig, the drilling apparatus has to be disassembled. In order to do so, the drilling apparatus has to be disconnected from the auxiliary devices, the mast has to be lowered from a vertical position to a horizontal position, the whole drilling plant has to be moved towards the next well to perform the drilling operation and, finally, the entire system has to be re-assembled and the auxiliary structures have to be re-connected.

Therefore, it is important for the drilling structure or apparatus and, thus, for the entire plant, to be easy to be transported and assembled. In the field of drilling in

search for oil, in order to maximize the extraction, a very deep drilling in the ground is often required, so as to re-activate oil wells that are apparently exhausted. This led to the construction of drilling structures that are more and more imposing in terms of dimensions, power and weight.

Currently, drilling plants are produced which are able to develop a power up to 3000 HP or 2300 kW and feature a height of the drill floor from the ground of approximately 17 ft or 11 meters, a maximum total height of 156 ft or 47.5 m, 1,500,000 pounds or 681 tons for the hook load, 1,300,000 pounds or 590 tons for the rotary load, and 1,000,000 pounds or 454 tons for the setback load.

Some constructors of drilling structures mainly develop land rigs with 2000 hp, which can easily be moved and are produced as the type called box substructure.

This type of structure is characterized by the presence of hydraulic raising devices with plates of large dimensions.

Normally, instead of only using traditional kellies and rotary tables to rotate the series of drill rods, a top drive is used as well.

The top drive normally is a rotary device provided with an electric or hydraulic motor, which is suspended and connected to the mast. Said top drive is able to move along a vertical axis inside the mast strong back.

Therefore, the series of drill rods are caused to rotate by said top drive, which reduces the manual work needed for rod addition operations as well as the risk for operators.

Normally, the top drive and the mast are separate during the transportation phases and are coupled to one another during the assembling phases or even, in some

cases, when the mast is already in the vertical position, thus causing the operations to be very complicated, besides requiring a larger amount of time to perform the operations aimed at installing the structure.

In order to cause the raising phase to be quicker and, thus, reduce the time needed to install the drilling plant or apparatus, it is advisable that the top drive is associated with a portion of the mast already during the assembling phase. This solution allows users to facilitate the transportation and to reduce the assembling times.

Furthermore, a mast is known, to which a top drive is directly fixed, so as to cause the two of them to be integral, so that the top drive is always fitted to the mast, even when the land rig is disassembled to be transported. The top drive always remains coupled to the mast, even during the rig up phases or during the ring down phases or when it is transported towards the next drilling well.

Therefore, the mast is advantageously provided with the top drive already arranged inside the mast strong back.

The object of the present invention is to solve the drawbacks mentioned above by providing a drilling apparatus in which, in a first assembly operating configuration, the different components are assembled in a horizontal position, substantially at the level of the ground, and, subsequently, said apparatus is raised so as to reach a second use operating configuration, in which the mast is vertical.

All the steps and the operations needed to raise and/or lower the well drilling apparatus according to the present invention and, in particular, the mast and the sub-structure, are performed by means of a hydraulic actuating

device, which pushes said apparatus. The drilling apparatus, when shifting from one operating configuration to the other, is pushed by said hydraulic actuating device and performs a continuous movement in time, without interruptions or intermediate positions.

Furthermore, said drilling apparatus is modular and can be quickly assembled and disassembled, so as to be transported from one drilling well to the next one. The transportation of the apparatus according to the present invention takes place in a quick manner, with no need for complicated disassembling procedures, which also require a lot of time.

One aspect of the present invention is relative to a drilling apparatus having the features set forth in appended claim 1.

A further aspect of the present invention is relative to the drilling apparatus assembling method according to claim 11.

Finally, a further aspect of the present invention is relative to the disassembling method according to claim 15.

The additional features and advantages of the drilling apparatus and of the assembling method will be best understood upon perusal of the following detailed description of at least one embodiment with reference to the accompanying drawings, which respectively show what follows:

- figure 1 shows the positioning of the sub-structure and of the actuating device of the drilling apparatus according to the present invention;
- figure 2 shows the positioning of the draw-works on said sub-structure and of the actuating stands in the spots suited for the assembly of the mast;

- figure 3 shows the positioning of the mast base sections on the right and on the left, directly on the sub base, and of the draw-works;
- figure 4 shows the positioning of the set-back drill floor on suitable stands, the set-back drill floor being coupled to the mast base sections by means of connecting rods;
- figure 5 shows the positioning, on suitable trunnions, of the mast starter section, in a horizontal position, and the addition of the mast bottom section provided with boards, which are connected to the set-back, as well as the fixing of the second portion of the drill floor to said bottom section;
- figures 6A and 6B show the positioning and the fixing of the mast strong back to the bottom section and the fixing of the actuating device to the mast strong back; in particular, figure 6A shows the fixing of the mast strong back and figure 6B shows a detail of the fixing of the actuating device to the mast strong back;
- figures 7A and 7B show the assembling operations of the intermediate section of the mast, in a horizontal position, which is assembled on said actuating stands;
- figures 8A and 8B show the assembling operations of the top section of the mast, in a horizontal position, which is assembled on said actuating stands, and the fixing to said intermediate section of the mast itself;
- figures 9A and 9B show, in sequence, the images of the movement actuated by the actuating stands along the vertical and longitudinal axes in order to connect the end sections of the mast to the mast strong back;

- figure 10 shows a freeze-frame of the drilling apparatus during the passage between the two operating configurations, the movement being performed in a continuous manner in time;
- figure 11 shows the lower part of the drilling apparatus in the use operating configuration;
- figure 12 shows the release of the actuating device from the mast;
- figure 13 shows an overall view of the drilling apparatus in the use operating configuration.

With reference to the figures mentioned above, well drilling apparatus 2 is adapted to shift from a first assembly operating configuration to a second use operating configuration and vice versa. Said apparatus 2 comprises a sub-structure 21, which lies on ground "S" and supports said apparatus 2, a mast 23, which comprises pivoting points 23a and fixing points 23a' and is pivoted to said sub-structure 21 by means of said pivoting points 23a, around which it rotates so as to shift from said assembly operating configuration, which is substantially horizontal, to said use operating configuration, which is vertical, and vice versa.

The apparatus comprises, furthermore, a drill floor 22, which can be raised and is connected to the mast, and an actuating device 3, which is adapted to allow the drilling apparatus to shift from an assembly configuration to a use configuration. Said actuating device 3 is a hydraulic device, which is directly connected to mast 23, preferably by means of a pivot hinge, is adapted to push said mast in order to raise it, and is adapted to hold said mast 23 during the lowering movement with a continuous movement, as shown in figure 10.

Said actuating device 3 is permanently connected to the apparatus and, in particular, to mast 23 during the passage between the two operating configurations. Indeed, during the passage between the two operating configurations, the connection point between actuating device 3 and apparatus 2 remains unchanged.

Said drill floor 22 comprises a first portion 22a, which is pivoted to said mast 23 and projects with respect to said mast 23, and a second portion 22b, which is constrained to said mast 23 and rotates with it.

Said first portion 22a, which is always kept parallel to ground "S" during the raising or rig up and/or the lowering or rig down of drilling apparatus 2, comprises a rotary table 56 and a driller cabin 24, which, during the apparatus assembling steps, can be directly installed on drill floor 22 without causing problems in the following assembling steps, since said portion is always parallel to ground "S", as shown in figures 4, 5, 10 and 11.

The second portion 22b, which in the use operating configuration mainly serves as walkway for the operators during the drilling phases, is directly fixed to mast 23 perpendicular to ground "S", as shown in figures 4, 5, 10 and 11.

In particular, the first portion 22a of drill floor 22 comprises, besides rotary table 56 shown in figure 7B and driller cabin 24, a dead line anchor and a pair of power tongs, which are known to a skilled person.

If necessary, said drill floor 21, in order to help the automation of the entire drilling apparatus according to the present invention, besides a well center, where the drilling takes place along a first axis parallel to a vertical axis "Z", comprises a secondary well or mouse

hole, not shown, where the drill rods are temporary arranged and which defines a second axis, parallel to said first axis, and a secondary clamp or mouse hole clamp, not shown, which is adapted to hold the drill rods when they are arranged in the mouse hole.

Said mast 23, which extends along a longitudinal axis "A", is modular and comprises a starter section 231, which is adapted to be constrained to sub-structure 21, a bottom section 232, which is constrained to said starter section 231 and to which the first portion 22a of said drill floor 22 is pivoted and the second portion 22b is constrained; a strong back, to which actuating device 3 is connected and which is pivoted to said starter section 231.

Said strong back comprises suited attachment housings 233a, where actuating device 3 is pivoted.

Said mast strong back is connected to at least one further section (234, 235), on which a top drive 51 is fixed in a sliding manner, as shown in the accompanying drawings, and which is constrained to said mast strong back.

In particular, mast 23 comprises an intermediate section 234, which is constrained to said mast strong back, and a top section 235, which is constrained to said intermediate section 234. In said top section 235 there are arranged the top drive, a travelling block 50 and a crown block, as one single assembly, as well as a powered drill line spooler 54, so as to keep the line on the respective pulleys of the crown block and of travelling block 50, thus saving time both in the ring-up phase and in the rig-down phase. Said devices are preferably constrained to top section 235 of the mast by means of pins.

Furthermore, during the apparatus transportation phases, top drive 51 is engaged/locked in top section 235 of mast 23 for the entire duration of the transportation. In order to do so, top section 235 comprises a locking device, not shown, which is adapted to lock top drive 51 to the top section itself, for example at least one pin that is inserted in a suited housing and, when it is inserted, prevents top drive 51 from moving in top section 235.

Said intermediate section 234 and said top section 235 are assembled and fixed to one another in a horizontal position at the level of the ground, so as to help operators perform these operations, thus causing the operations to be carried out more quickly.

Said intermediate section 234 comprises a first shoulder 234a and a second shoulder 234b, on which a back 234c is hinged. Said back 234c, after having been arranged perpendicular to said second shoulder 234b, is fixed to the first shoulder 234a assuming the shape of a truncated cone with a "U"-shaped section, so as to be fixed to said mast strong back 233.

Top section 235 also has the shape of a truncated cone with a "U"-shaped section, so as to be able to be fixed to intermediate section 234. Said top section 235 comprises two shoulders 235a, which are hinged to an end of the top of top section 235, where travelling block 50 and the crown block are comprises, and a back 235b, which is arranged between said two shoulders 235a. Said back 235b is adapted to reduce its longitudinal extension in a telescopic manner, preferably by means of telescopic crosspieces, so as to reduce the transverse extension of entire top section 235, as shown in figures 8A and 8B; indeed, in figure 8A shoulders 235a are parallel to one another, whereas in

figure 8B two shoulders 8B are spread, thus causing top section 235 to assume the shape of a truncated cone as mentioned above. The reduction of the transverse extension of upper part 245 facilitates the transportation of said section, especially in case of transportation on wheel, when national and international roads have to be used.

Said shoulders (234a, 234b, 235a) and said back (234c, 235b) are connected to one another by means of four stringers, two front stringers and two rear stringers. Said rear stringers delimit the back (234c, 235b) of said mast 23, thus causing it to assume the typical shape of a truncated cone with a square base.

Preferably, the different sections of the mast are connected to one another by means of suitable pins, which are inserted into suitable connection hinges. This aspect is not described in detail, since it is known to a skilled person.

On said back (234c, 235b) of mast 23 there is arranged a guide 511, which is adapted to allow top drive 51 to slide along said longitudinal axis "A" in the use operating configuration.

Said guide 511 is assembled during the assembly of sections (231, 234, 235) of mast 23, which comprise a respective portion of guide 511.

In an alternative embodiment, said top drive 51 comprises a pantograph mechanism, not shown, which is adapted to allow the top drive to move from the well center to a drawing point identified in the mouse hole, thus moving from a first axis of the well center to said second axis of the mouse hole.

The assembly consisting of intermediate portion 234 and of upper portion 235 is subsequently fixed to mast

strong back 233, which, in turn, is fixed to starter section 231.

In the preferred embodiment of drilling apparatus 2, said sub-structure 21 comprises at least two sub-bases 210, which are arranged parallel to one another and are adapted to support entire apparatus 2, and two base sections 214, each one constrained to a sub-base 210. As shown in the accompanying drawings, mast 23 is pivoted on said base sections 214.

The sub-structure comprises, furthermore, the boards and stairs, the dog house and the grass hopper, which are shown in figures 12 and 13 but will not be described in detail, since they are known to a skilled person.

Said sub-structure 21 supports, preferably on sub-bases 210 of sub-structure 21, preferably in the rear part of the sub-bases themselves, a draw-works 58, which is provided with a support structure, parapets and accessories. Said draw-works 58, during the passage from the assembly operating configuration to the user operating configuration of apparatus 2 and vice versa, remains in a low position, arranged on sub-bases 210 of sub-structure 21.

Actuating device 3 is adapted to cause drilling apparatus 2 to be subject to a rig-up step and to a rig-down step.

Said actuating device 3, in its preferred embodiment, comprises a pair of telescopic hydraulic raising cylinders 31, each of which is connected to mast 23. In particular, said pair of cylinders 31 is connected to the arms of mast strong back 233, for example they are pivoted in the suited attachment housings 233a mentioned above. Actuating device 3 and, in particular, cylinders 31 are fixed to the mast,

preferably by means of a pivot hinge, each cylinder in one single point, during the passage from one operating configuration to the other. In particular, each cylinder of said pair 31, at one end, is pivoted to sub-structure 21, in particular to sub-bases 210, and, at the opposite end, is pivoted to mast strong back 233, in corresponding attachment housing 233a. The point of mast 23 in which single cylinder 31 is pivoted remains unchanged during the passage from one operating configuration to the other. The present solution does not require, for the passage from one operating configuration to the other, a change of the fixing point in which actuating device 3 is fixed to apparatus 2.

Preferably, said pair of cylinders 31 are telescopic with three sections.

A further aspect of the present invention is the assembling method for a drilling apparatus 2. Said assembling method comprises the following steps:

- positioning sub-structure 21 in the desired site;
- assembling drill floor 22;
- pivoting mast starter section 231 to said sub-structure 21 in a substantially horizontal position;
- fixing actuating device 3, so as to allow structure 2 to be lifted;
- lifting structure 2, so as to cause it to shift from the assembly operating configuration, which is substantially horizontal, to the use operating configuration, which is vertical;
- fixing apparatus 2 in the use operating configuration in a vertical position.

In an equivalent alternative embodiment, the step of fixing actuating device 3 is performed prior to the step of pivoting starter section 231 of mast 3.

The step of positioning sub-structure 21 in the desired site is carried out by positioning the right and left sub-bases 210 and by connecting them to beams 211, as shown on figure 1. During said step of positioning sub-structure 21, the relative position of sub-bases 210 with respect to the given well center has to be controlled. Each sub-base 210 houses, in a suited cradle 212, a hydraulic cylinder 31 of actuating device 3, which is adapted to move apparatus 2 from one operating configuration to the other.

Hydraulic cylinders 31, during the transportation from one well to the next one, are held in said cradles 212 and then they are set free and tilted towards the well center during the steps of the assembling method, preferably during the step of positioning sub-structure 21, as shown in figure 1. Furthermore, during said step, the support structure of draw-works 58 is installed in the rear part of sub-bases 210, together with its parapets and accessories, as shown in figure 2. Furthermore, during this step, one also installs the right and left structures making up base section 214, directly lying on sub-bases 210, to which starter section 231 of mast 23 will be directly pivoted, as shown in figure 3.

Preferably, still during the step of positioning sub-structure 21, the beams needed for the installation of the blow out preventer, also known as BOP, not shown, are laid on the ground, in the central area.

Subsequently, the step of assembling drill floor 22 is performed. In order to assemble drill floor 22, two stands are provided, on which the beams of the first portion or

set-back 22a of the drill floor, coupled to the lateral board, are laid, as shown in figure 4.

Subsequently, the beams of the first portion or set-back 22a are coupled to mast base section 214 by means of trestle connecting rods 22c.

Subsequently, the raising beams of the BOP, not shown, are connected under the beams of the first set-back portion 22a by means of the fixing pins provided.

Subsequently, the support beams of rotary table 56 are coupled to the beams of the first set-back section 22a, thus temporarily projecting.

Subsequently, the step of pivoting starter section 231 of the mast is performed by positioning said starter section 231 on pivoting points 23a for the connection of mast 23 in a horizontal position with respect to ground "S". Subsequently, a further mast bottom section 232 is coupled to said starter section 231. Preferably, the two steps of assembling drill floor 22 and pivoting mast starter section 231 are performed at the same time; in fact, the second section 22b, together with the board support, is fixed, in turn, to the second section 22b.

Said first portion 22a and said second portion 22b, together, make up drill floor 22.

Preferably, at this point of the assembling procedure, driller cabin 24 is laid on the first portion or set-back 22a and, at the same time, the rear board is installed on the second portion 22b of drill floor 22, as shown in figure 5.

Subsequently, mast strong back 233 is placed and fixed, for example by means of pivots, to mast starter section 231. This strong back comprises, as mentioned

above, suited attachment housings 233a, where actuating device 3 is pivoted.

Subsequently, the step of fixing actuating device 3 is performed, during which actuating device 3 is fixed to mast 23.

In the embodiment shown, actuating device 3 and, in particular, raising cylinders 31, are pivoted to said mast strong back 233 in the suited attachment housings 233a. In order to fix said cylinders 31, the respective pivots are inserted into the suited holes comprised in attachment housings 233a for cylinders 31, as shown in figures 6A and 6B.

Said mast strong back 233 is in a horizontal position, parallel to ground "S", at a predetermined height "Z2" from the ground, at which mast 23 will be fixed.

At the end of the step of fixing actuating device 3, the next step of raising apparatus 2 can be performed.

Preferably, prior to the step of raising apparatus 2, an assembling step is provided to assemble mast 23, during which different sections 234, 235 of mast 23 are prepared and assembled. Before performing the mast assembling step mentioned above, actuating stands 6 comprising hydraulic raising devices are positioned in front of sub-bases 210, in the spots suited for the assembly of mast 23, as shown in figure 2. Preferably, a front stand 61 is positioned close to intermediate section 234, for example at the end of the extension of sub-bases 210, and a rear stand 63 is positioned at a distance from said front stand 61 that is smaller than the maximum extension of mast 23, preferably substantially equal to the longitudinal extension of mast 23 from the center of intermediate section 234 to the center of top section 235. Preferably, furthermore, an

intermediate stand 6' is positioned between said front stand 61 and said rear stand 63, substantially in the point of junction between intermediate section 234 and top section 235 of mast 23. Normally, said intermediate stand 6' is not an actuating stand, but is only fulfills the function of supporting mast 23 during its assembly.

The actuation of the assembling step, during which the connection of sections (234, 235) of the mast is performed, is carried out by the operators at a first height "Z1" from ground "S", which is lower than height "Z2" mentioned above, thus horizontally building mast 23, parallel to ground "S".

The assembly of mast 23 at height "Z1" allows the personnel responsible for the assembly to work more easily on said mast 23.

For the purposes of the present invention, the expression "horizontally building mast 23" means that mast 23, by means of said stands 6, is built parallel to ground "S" where said drilling apparatus 2 is assembled.

Preferably, said first height "Z1" from ground "S" is equal, for example, to 1.5 m.

In detail, the assembling step for assembling mast 23 is preferably carried out as follows; belly board 71 and racking board 70 are laid on the ground in the suitable areas, in order to be subsequently coupled to mast 23, as shown in figure 7A.

After that, the first shoulder 234a of intermediate section 234 is positioned, for example by means of the crane of the work site. Said first shoulder 234a is placed between front stand 61 and an intermediate stand 6'.

Subsequently, the second shoulder 234b of intermediate section 23 of mast 23 is positioned, for example by means

of the crane of the work site. Said second shoulder 234 is deposited on stands (61, 6'), as well. Said second shoulder 234b also comprises back 234c. Said back 234c is hinged to said second shoulder 234b. During the assembling step for assembling mast 23, said back 234c is raised by means of hydraulic cylinders and coupled to the first shoulder 234a, thus creating intermediate section 234 with a pyramid frustum structure with a U shape facing downwards, as shown in figure 7B. Said back 234c, during the transportation from one drilling well to the next one, is arranged parallel to the second shoulder 234b, to which it is hinged.

After that, mast top section 235 is positioned, inside which there are locked the crown block, travelling block 50, top drive 51 and powered drill line spooler 54. Top section 235 is deposited on one single rear stand 63, in the closed configuration, so as to minimize the width. In said configuration, the two shoulders 235a are parallel to one another, as shown in figure 8A. Preferably, after having deposited top section 235 on rear stand 63 keeping it suspended, for example by means of a crane, powered drill line spooler 54 is detached and arranged at the base of mast 23.

Preferably, in order to shift from the closed configuration to the open configuration, the hydraulic cylinders comprised in said actuating stands 6 are used so as to open the shoulders, spacing them apart, keeping top section 235 suspended by means of raising straps. When top section 235 is in the open configuration, the telescopic crosspieces of back 235b, which are not shown in detail, are fixed.

Subsequently, mast top section 235, which is always kept suspended, is brought into contact with mast intermediate section 234, the attachment hinges between one section and the other are caused to coincide and the pins are inserted into the respective hinges.

Rear stand 63, which is arranged in correspondence to the top of top section 235, where the crown block and travelling block 50 are arranged, is suited to level mast 23 and facilitate the insertion of the pins to connect sections (234, 235) of mast 23, as shown in figure 8B.

Intermediate section 234 and top section 235 of the mast lie on three stands: front stand 61, intermediate stand 6' and the rear stand, as shown in figure 8B.

By means of a service winch, which is not shown, top drive 51 is dragged towards the base of the mast, so as to reduce the overall tilting moment of must 23, sliding along partially assembled guide 511.

Subsequently, racking board 71 and belly board 70 are coupled to respective sections (234, 235) of the mast, which are so connected.

Subsequently, in order to complete the assembling step for assembling mast 23, a moving step is provided, during which at least part of mast 23 is moved by means of actuating stands 6, so as to allow the actuation of the following steps of the method and, in particular, of the step of pivoting mast 23 and of the subsequent rig-up step. In detail, during said moving step intermediate section 234 and top section 235 of mast 23, which have been so assembled, are raised, in a leveled manner, by means of front stand 61 and of rear stand 63 until they reach predetermined height "Z2" from ground "S", so that the heights of the hinges between intermediate section 234 and

mast strong back 233 coincide. Said height "Z2" is approximately 4 meters from ground "S".

Subsequently, the two sections of mast 23 are translated backwards, by means of stands (61, 63), along longitudinal axis "A" of mast 23 towards the hinges, until the fixing pins can be inserted.

These two steps are shown in figures 9A÷9B.

During the previous phases of the mast assembling step, sections (234, 235) of the mast are arranged in such a way that the connectors comprised in intermediate section 234 of the mast are spaced apart from the corresponding connectors of mast strong back 233 by a predetermined distance "X1".

Said predetermined distance "X1", for example equal to 0.5 m, during the step for raising the sections of mast (234, 235) from height "Z1" to height "Z2", prevents mast 23 itself from striking against mast strong back 233. Furthermore, predetermined distance "X1", which spaces apart sections (234, 235) of the mast, facilitates the assembling operations performed by the operators. The backward movement of the sections of the mast, which is equal to distance "X1", allows the connectors of intermediate section 234 to perfectly coincide with the connectors of mast strong back 233.

Preferably, the extension of top section 235, the raising step and the step of bringing sections (234, 235) closer, as mentioned above, are performed thanks to the help of said stands 6; said stands 6, indeed, are adapted to extend the top section and to raise the sections of the mast as well as to bring them closer to mast strong back 233.

Said stands 6 comprise a plurality of actuators, which are adapted to move mast 23 in a predetermined manner within the orthogonal space defined by axes "X", "Y" and "Z", which are orthogonal to one another.

Said actuators, which are comprised in each stand 6, preferably are hydraulic pistons, which are preferably arranged in such a way that at least one of them operates along "X" axis, at least one of them operates along "Y" axis and at least one of them operates along "Z" axis.

At the end of the moving step for moving mast 23, the step of pivoting mast 23 is performed.

After the backward movement of mast 23 and the connection to the mast strong back, guide 511 in which top drive 51 slides has further extended, thus allowing top drive 51 to further slide in correspondence to mast strong back 233, part of mast 23 and on drill floor 22.

After that, another step can be performed, during which structure 2 is raised and which comprises, in particular, raising the mast, bringing it to the use operating configuration, and raising drill floor 22. This step is carried out in a continuous manner, without interruptions when shifting from one operating configuration to the other, by simultaneously raising mast 23 and drill floor 22 by means of a thrust, which is actuated by actuating device 3 of the hydraulic type and is directly applied to mast 23.

The simultaneous raising of drill floor 22 and of mast 23 is allowed by the fact that:

- the first portion 22a of the drill floor is directly pivoted to the mast and the second portion 22b is fixed to the mast itself;

- only one actuating device 3 is provided, which allows entire drilling apparatus 2 to be raised.

In drilling apparatus 2 according to the present invention, draw-works 58 remains in a low position, arranged on sub-bases 210 of sub-structure 21.

This solution allows the use of one single actuating device 3, thus simplifying the step of raising apparatus 2 and quickening the passage from the assembly operating configuration to the use operating configuration and vice versa.

This solution, furthermore, allows the structure of drill floor 22 to be simplified, since it does not have to support the weight of draw-works 58. This allows the movements of the drill floor to be simplified, thus simplifying the structure that has to support the drill floor itself.

Furthermore, the position of draw-works 58 on sub-bases 210 allows an easier maintenance of the draw-back itself, thus facilitating the electric connection to the motors that move the draw-works.

During the raising step, simultaneously with the beginning of the raising movement of apparatus 2 and, in particular, of mast 23 by means of the hydraulic cylinders 31, as shown in figure 10, the beams of the first portion or set-back 22a and the lateral boards associated therewith detach from their support stands, remaining substantially horizontal and parallel to ground "S", due to the action of the pantograph mechanism, for example a parallelogram-shaped pantograph mechanism, which is built by trestle connecting rods 22c.

At the end of the step of raising apparatus 2, namely when mast 23 is in the final vertical position and

apparatus 2 is in the use operating configuration, a next step can be performed, during which apparatus 2 is fixed in the use operating configuration, as shown in figure 11. During this step, the constraining pins are inserted at the base of mast 23, in particular in fixing points 23a' and the beams of rotary table 56 are leveled off at mast starter section 231.

The assembling method according to the present invention comprises further steps to make apparatus 2 operative. In particular, a dog-house 57 is provided on the ground, close to a side of mast 23, for example the left side. Subsequently, driller cabin 24 is moved in correspondence to rotary table 56, which is arranged in correspondence to the well center. The apparatus according to the present invention comprises, furthermore, at least one jib crane 8, preferably on the left side of mast 23. Said jib crane 8 is used, with the help of an equalizer beam and of four ropes, to raise dog-house 57 from the ground to drill floor 22. Dog-house 57 is laid on and constrained to two foldable beams, not shown, which belong to drill floor 22.

In order to the allow operators to access drill floor 22, the stairs for the access to the drill floor are assembled and positioned. Finally, the electric and hydraulic connections are completed, as well as the connections of the sludge plant.

In order to start the drilling steps, the raising/drill lines or drill line reeving system are installed.

The drill line is wound around the reel of draw-works 58 with nine loops. Subsequently, the drill line is let out

by powered drill line spooler 54 and the dead line is wound on the dead line anchor and finally fixed with the clamps.

Raising cylinders 31, after the step of fixing apparatus 2, are decoupled from mast 23 and preferably closed, so as to protect the telescopic stems of cylinders 31 themselves, as shown in figure 12.

Said cylinders 31 are kept under drill floor 22 with the same inclination assumed at the end of the step of raising apparatus 2, so at to be immediately ready to be extracted again and constrained to mast 23 in order to perform the steps of the disassembling or rig-down method of apparatus 2.

The disassembling or rig-down method for a drilling apparatus 2 comprises the following steps:

- releasing apparatus 2 from the use operating configuration;
- lowering drilling apparatus 2, so as to cause it to shift from the use operating configuration, which is vertical, to the assembly operating configuration, which is substantially horizontal, by means of actuating device 3;
- releasing actuating device 3, so as to allow apparatus 2 to be removed;
- disconnecting mast 23 from said sub-structure 21 in a substantially horizontal position;
- removing sub-structure 21;

characterized in that:

- the step of lowering apparatus 2 is performed in a single phase in a continuous manner, without interruptions during the passage from one operating configuration to the other;

- during the step of lowering apparatus 2, mast 23 and drill floor 23 are simultaneously lowered with the support of said actuating device 3 of the hydraulic type.

The disassembling method substantially comprises the steps of the assembling method in a reverse order, with the aim of shifting from the use operating configuration to the assembly operating configuration, so as to allow the apparatus to be disassembled and transported towards another drilling site.

The disassembling method will not be described in detail, since it can easily be deduced from the assembling method, which simply has to be performed in a reverse order, and, therefore, can be easily understood by a skilled person.

Well drilling apparatus 2, as a whole, can be installed on moving or skidding beams that are properly arranged on the ground, so as to allow the entire plant or be translated from one well to an adjacent one. Furthermore, it can be provided with a translation system by means of "hydraulic feet" constrained to the ends of the sub-bases (Walker System).

The apparatus and the assembling and disassembling method according to the present invention allow the installation of a drilling plant to be quicker, thus significantly reducing the time and the costs needed for the installation and the subsequent disassembling operations.

The use of actuating devices 3, which push mast 3 to raise it and hold mast 23 during its downward movement, allow the apparatus raising and lowering steps to be simplified, thus increasing the safety in performing these steps.

NUMERICAL REFERENCES

Well drilling apparatus	2
Sub-structure	21
Sub base	210
Beams	211
Cradles	212
Mast base section	214
Drill floor	22
First portion/set-back of the drill floor	22a
Second portion of the drill floor	22b
Trestle connecting rods	22c
Mast	23
Pivoting points	23a
Fixing points	23a'
Mast starter section	231
Mast bottom section	232
Mast strong back	233
Attachment housings	233a
Intermediate section	234
First shoulder	234a
Second shoulder	234b
Back	234c
Top section	235
Shoulders	235a
Back	235b
Driller Cabin	24
Actuating device	3
Raising cylinder	31
Pins	32
Travelling block	50
Crown block	50'
Top Drive	51

Guide	511
Drilling/fast line	52
Powered drill line spooler	54
Rotary table___	56
Dog-house	57
Draw-works	58
Actuating stands	6
Front	61
Rear	62
Intermediate	6'
Racking board	71
Belly board	70
Jib crane	8
Longitudinal axis	A
Vertical axis	Z
First height	Z1
Second height	Z2
Ground	S
Distance	D1

1. Well drilling apparatus (2), which is able to shift from a first assembly operating configuration to a second use operating configuration and vice versa;
said apparatus (2) comprises:

- a sub-structure (21), which lies on the ground (S) and supports said apparatus (2),
- a mast (23), which comprises pivoting points (23a) and fixing points (23a') pivoted to said sub-structure (21) by means of said pivoting points (23a), around which it rotates so as to shift from said assembly operating configuration, which is substantially horizontal, to said use operating configuration, which is substantially vertical, and vice versa;
- a drill floor (22), which is able to be lifted and is connected to the mast (23);
- an actuating device (3), for allowing the drilling apparatus (2) to shift from said assembly operating configuration to said use operating configuration and vice versa;

said apparatus (2) is characterized in that:

- the actuating device (3) is a hydraulic device, which is directly connected to the mast (23);
- the drill floor (22) comprises a first portion (22a), which is pivoted to said mast (23) and projects with respect to said mast (23), and a second portion (22b), which is constrained to said mast (23) and rotates with it;
- a draw-works (58) is installed, in a permanent manner, on the sub-structure (21).

2. Apparatus according to claim 1, wherein said mast (23) is modular and comprises:

- a mast starter section (231), adapted to be constrained to the sub-structure (21);
- a mast bottom section (232), which is constrained to said mast starter section (231) and to which the first portion (22a) of said drill floor (22) is pivoted and the second portion (22b) thereof is constrained;
- a mast strong back (233), to which the actuating device (3) is connected, and
- at least one further section (234, 235), on which a top drive (51), which is constrained to said mast strong back (233), is fixed in a sliding manner.

3. Apparatus according to claim 1, wherein said sub-structure (21) comprises:

- at least two sub-bases (210), which are arranged parallel to one another and for supporting the whole apparatus (2);
- at least two mast base sections (214), each of which is constrained to a sub-base (201) and on which the mast (23) is pivoted.

4. Apparatus according to claim 3, wherein said draw-works (58) is installed on said two sub-bases (210).

5. Apparatus according to claim 1, wherein said first portion (22a) of the drill floor (22) is kept parallel to the ground (S) during the shift from one operating configuration to the other and comprises a rotary table (56) and a driller cabin (24).

6. Apparatus according to claim 2, wherein the mast (23) comprises an intermediate section (234), which is constrained to said mast strong back (233), and an upper section (235), which is constrained to said intermediate section (234) and on which there are already positioned:

the top drive (51), a travelling block (50), a crown block and a powered drill line spooler (54).

7. Apparatus according to claim 6, wherein the intermediate section (234) comprises a first shoulder (234a) and a second shoulder (234b), on which a back (234c) is hinged;

said back (234c), after having been arranged perpendicular to said second shoulder (234b), is fixed to the first shoulder (234a) assuming the shape of a truncated cone with a "U"-shaped section.

8. Apparatus according to claim 5, wherein the upper section (235) has the shape of a truncated cone with a "U"-shaped section and comprises:

- two shoulders (235a), which are hinged at one end to the top of the upper section (235), and
- a back (235b), which is interposed between said two shoulders (235a);

said back (235b) is adapted to reduce its transverse extension in a telescopic manner.

9. Apparatus according to claim 1, wherein said actuating device (3) comprises a pair of telescopic hydraulic raising cylinders (31), each of which is connected to the mast (23).

10. Apparatus according to claims 9 and 6, wherein each cylinder (31) is connected to an attachment housing (233a) comprised in the mast strong back (233).

11. Assembling method for a drilling apparatus (2),

said drilling apparatus (2) comprises: a sub-structure (21), a mast (23), a drill floor (22), which is fixed to said mast (23), a draw-works (58), and an actuating device (3), for causing said apparatus (2) to move from an

assembly operating configuration to a use operating configuration and vice versa;
the method comprises the following steps:

- positioning the sub-structure (21) in the desired site;
- assembling the drill floor (22);
- pivoting the mast (23) to said sub-structure (21) in a substantially horizontal position;
- fixing the actuating device (3), so as to allow the apparatus (2) to be lifted;
- lifting the apparatus (2), so as to cause it to shift from the assembly operating configuration to the use operating configuration;
- fixing the apparatus (2) in the use operating configuration

characterized in that:

- the step of lifting the apparatus (2) is performed in a continuous manner, without interruptions during the shift from one operating configuration to the other;
- during the step of lifting the apparatus (2), the mast (23) and the drill floor (22) are simultaneously lifted by means of a thrust, which is actuated by the actuating device (3), is of the hydraulic type, and is directly applied to the mast (23);
- the draw-works (58) remains arranged on the sub-structure (21) during the shift from one operating configuration of the apparatus (2) to the other.

12. Method according to claim 11, wherein an assembling step for assembling the mast (23) is provided, during which the different sections (234, 235) of the mast (23) are prepared and assembled.

13. Method according to claim 12, wherein the assembling step comprises a moving sub-step_for causing at least one portion of the mast to move by means of actuating stands (6), so as to allow the actuation of the following steps of the method according to the present invention.

14. Method according to claim 13, wherein, during the moving sub-step, at least one section (234, 235) of the mast (23) is lifted in a leveled manner at a predetermined height (Z2) from the ground (S), at which said at least one section is kept parallel to the ground (S) and, subsequently, translated along a longitudinal axis (A) of the mast (23) itself.

15. Disassembling method for a drilling apparatus (2);
said drilling apparatus (2) comprises: a sub-structure (21), a mast (23), which is fixed to said sub-structure (21), a drill floor (22), which is fixed to said mast (23), and an actuating device (3), for causing said apparatus (2) to move from a use operating configuration to an assembly operating configuration and vice versa;
comprising the following steps:

- releasing the apparatus (2) from the use operating configuration;
- lowering the drilling apparatus (2), so as to cause it to shift from the use operating configuration to the assembly operating configuration;
- releasing the actuating device (3), so as to allow the apparatus (2) to be removed;
- releasing the mast (23) from said sub-structure (21);
- removing the sub-structure (21);

characterized in that:

the step of lowering the apparatus (2) is performed in a continuous manner, without interruptions during the shift from one operating configuration to the other;
during the step of lowering the mast (23), the mast (23) and the drill floor (22) are simultaneously lowered by means of said actuating device (3), which is of the hydraulic type and is directly pivoted to the mast (23).

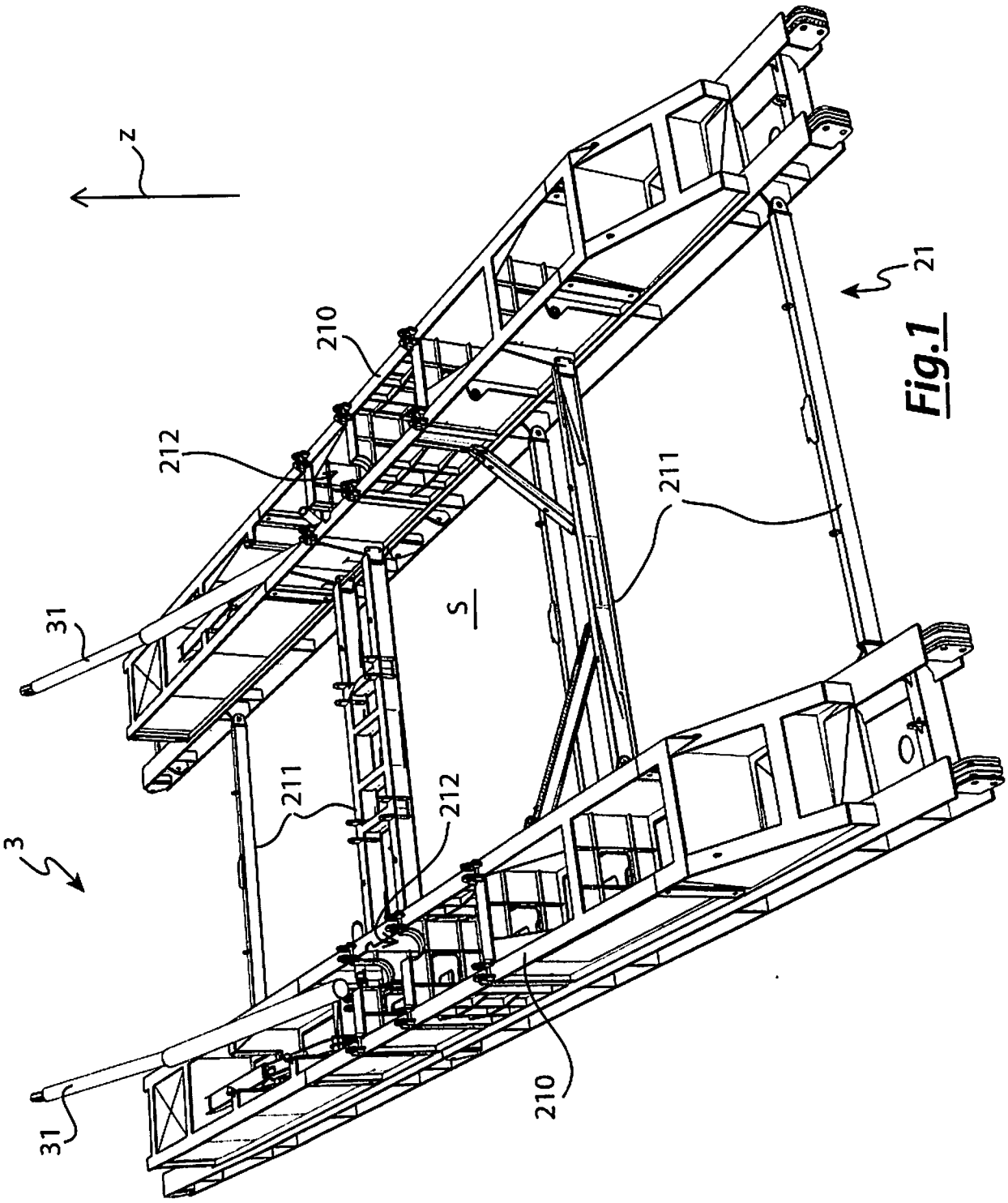

Fig.1

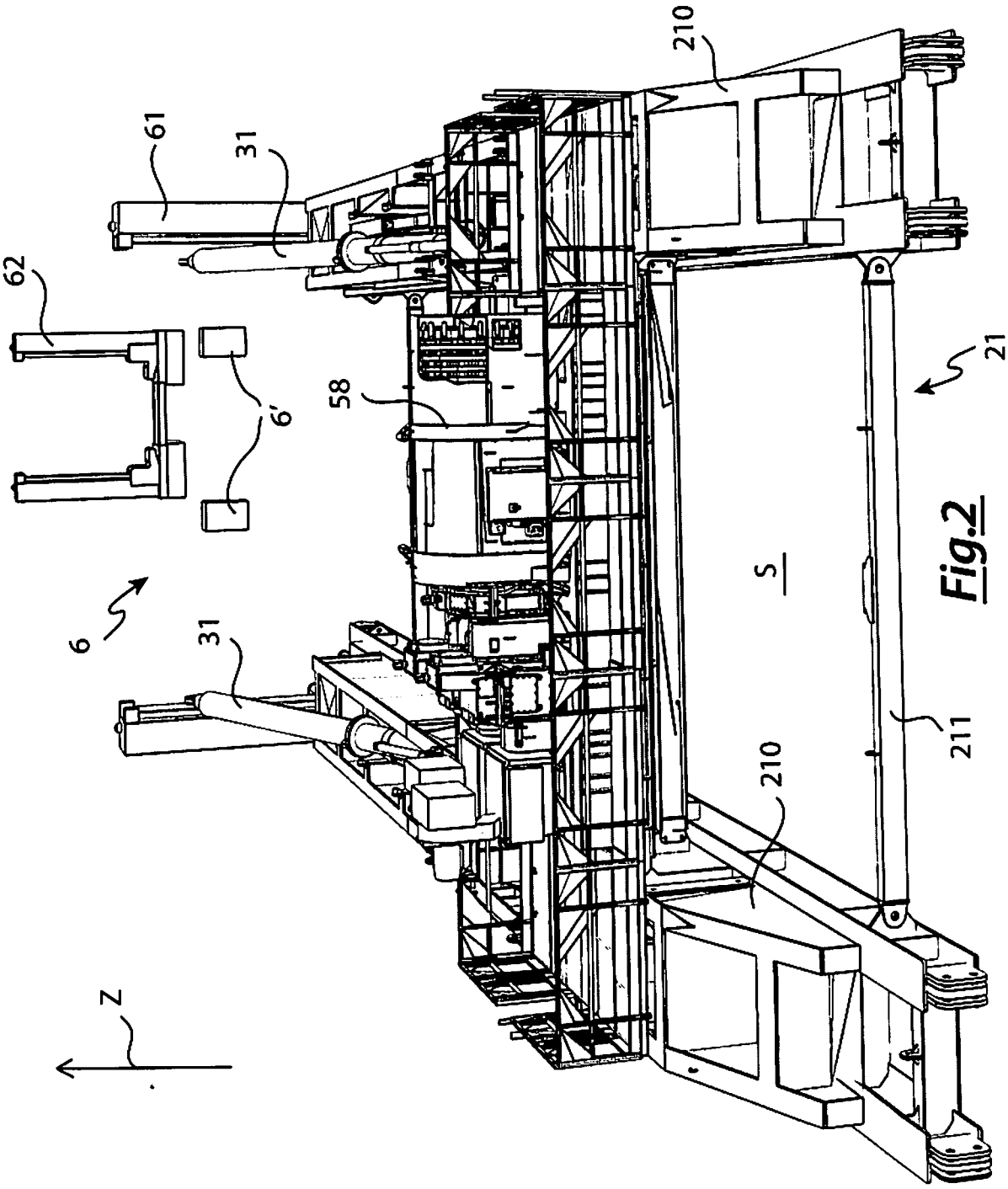

Fig.2

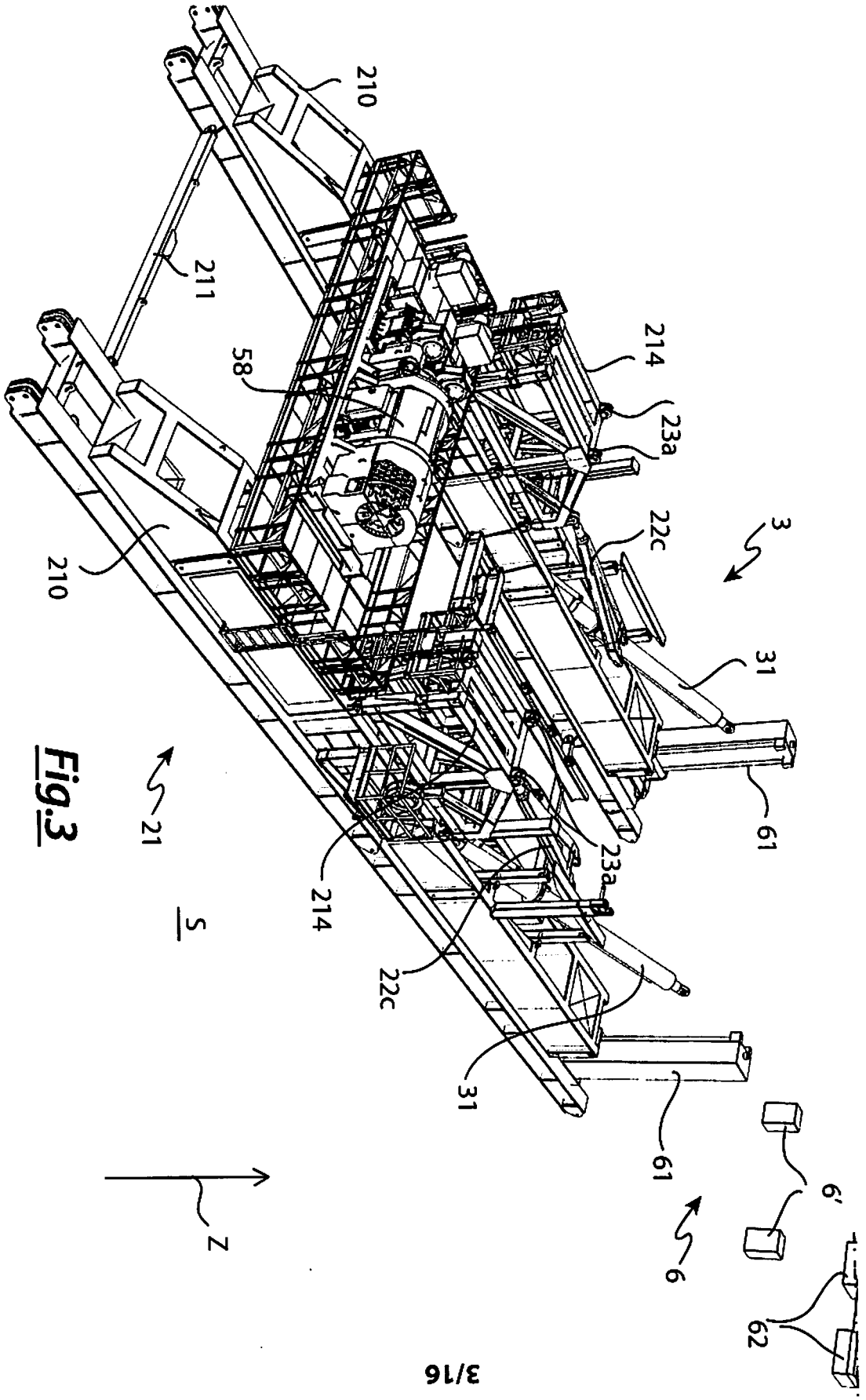

Fig.3

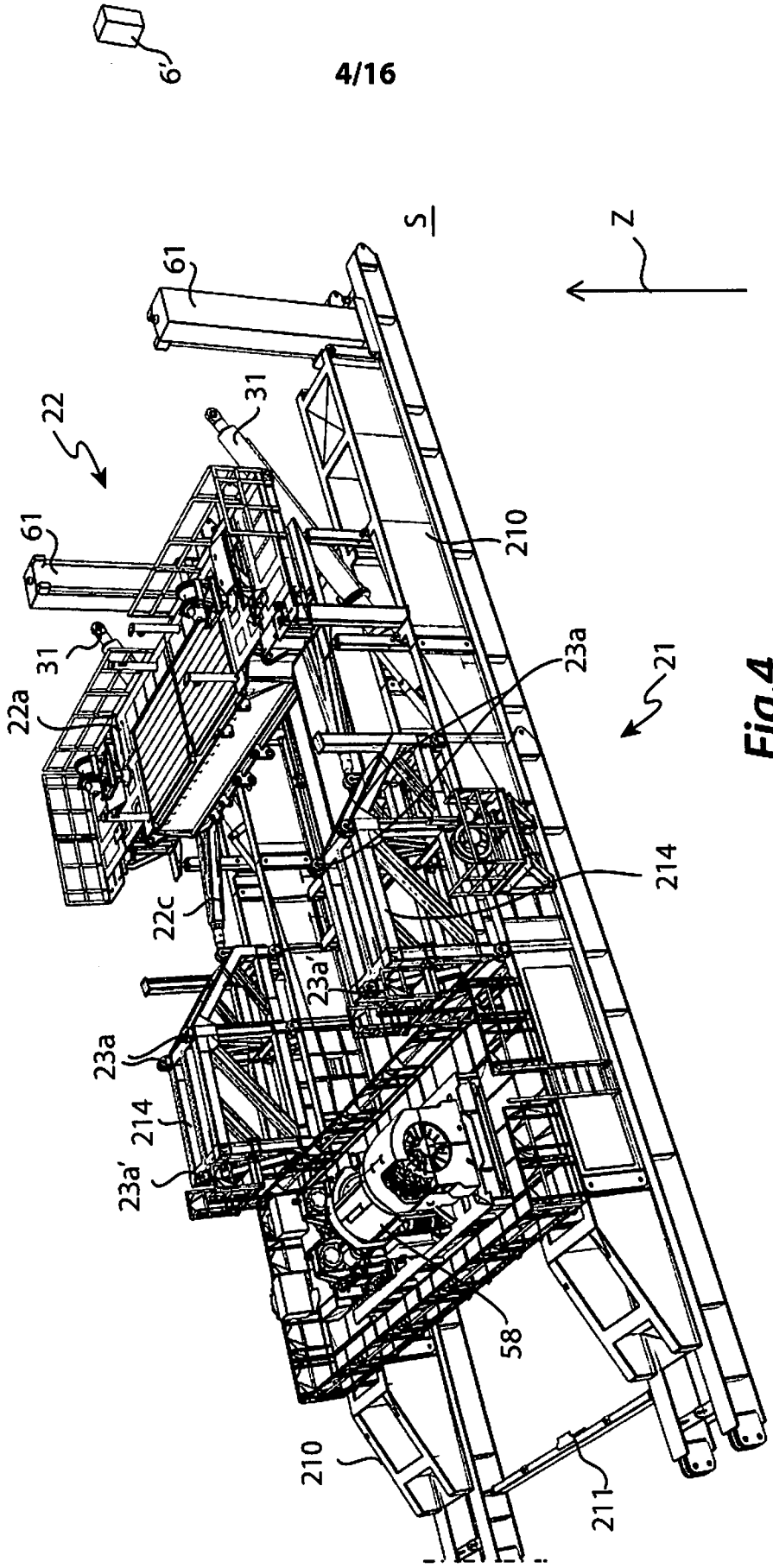
6'
S
Z
61
31
22
61
210
31
22a
23a
21
214
22c
23a'
23a
214
23a'
58
210
211

Fig.4

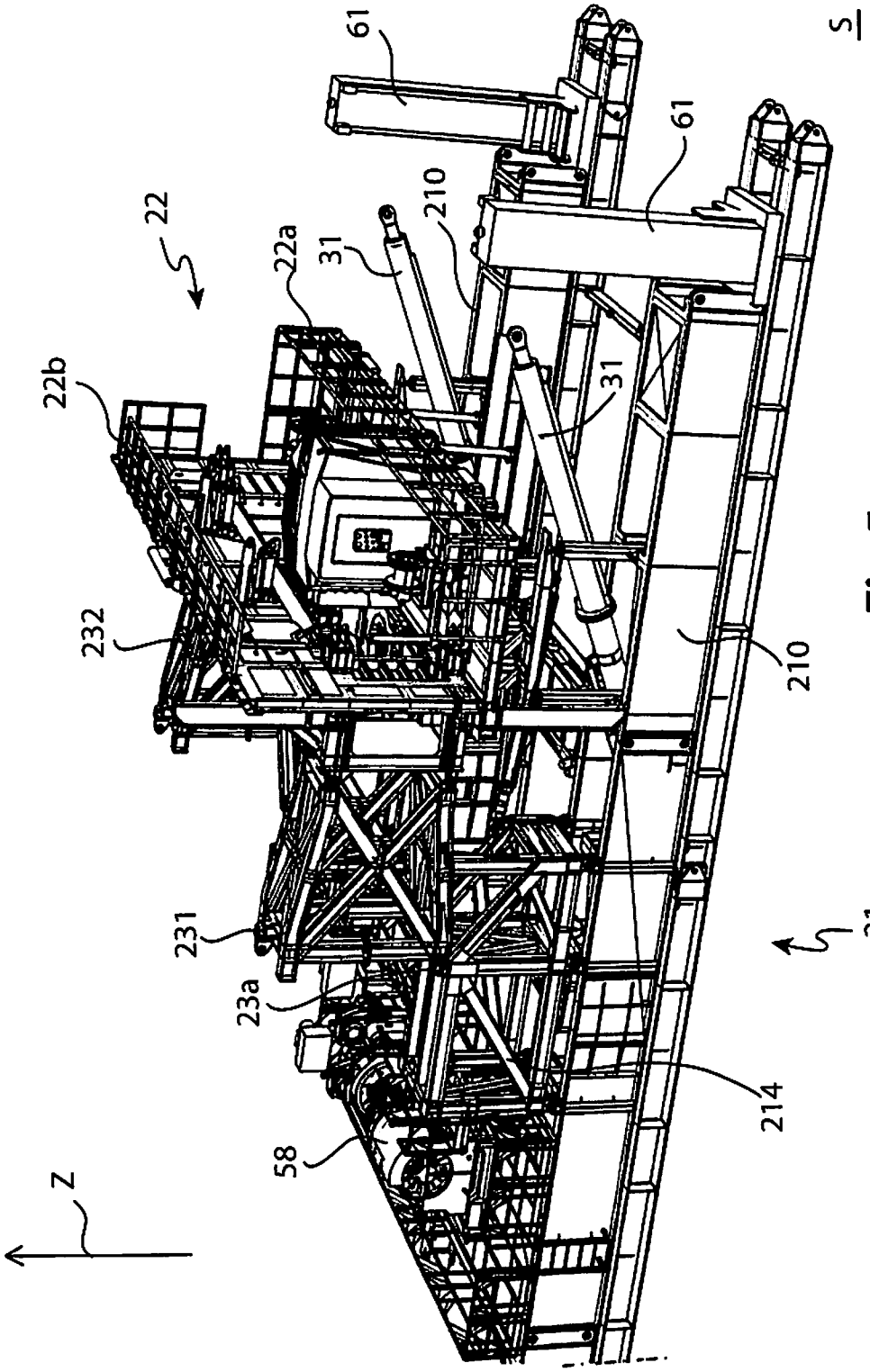

Fig.5

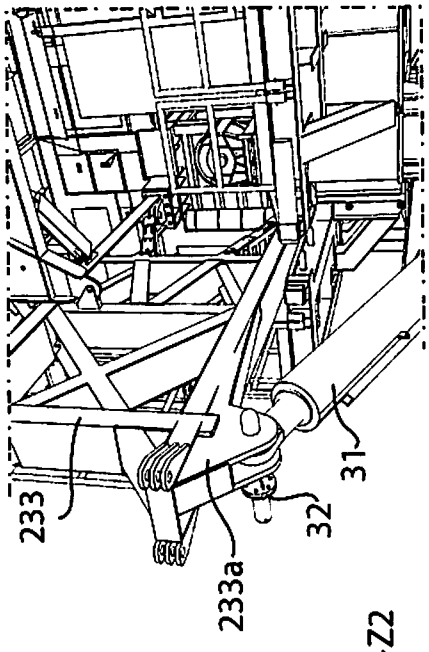
233
233a
32
31

Fig.6B

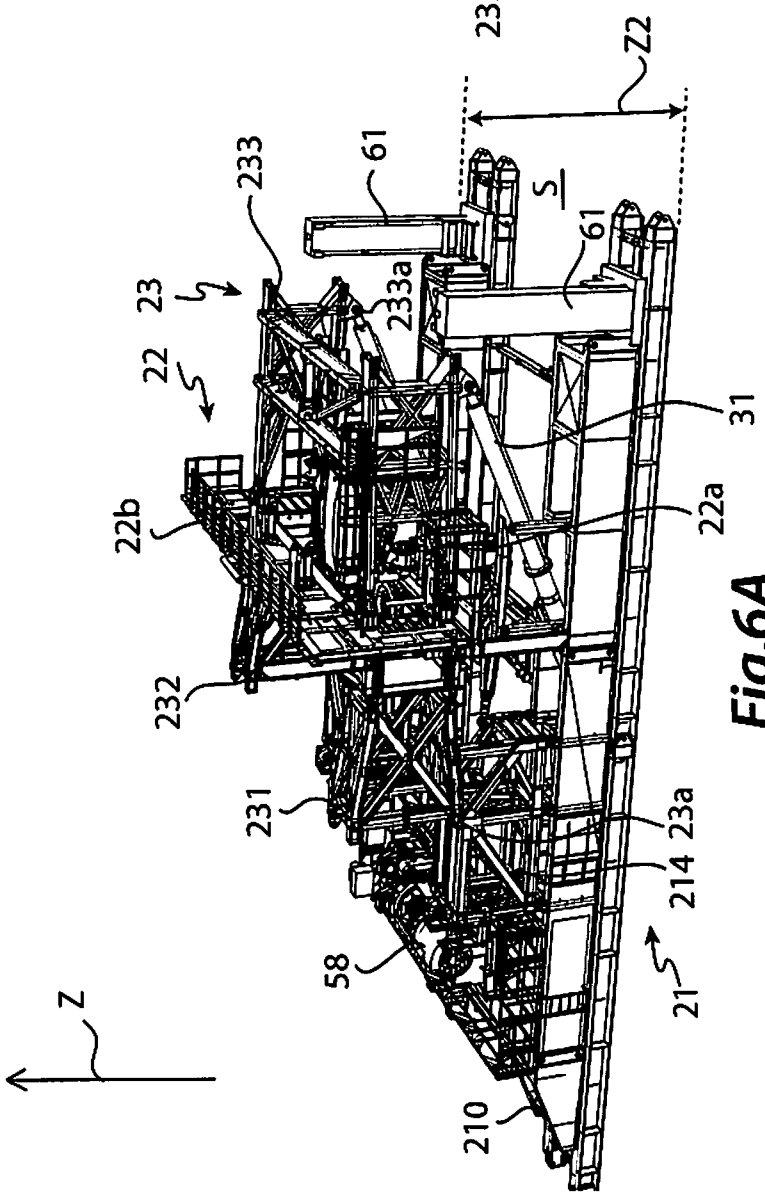
Z2
S
61
233
61
23
233a
22
S
31
22b
22a
232
231
23a
214
58
21
Z
210

Fig.6A

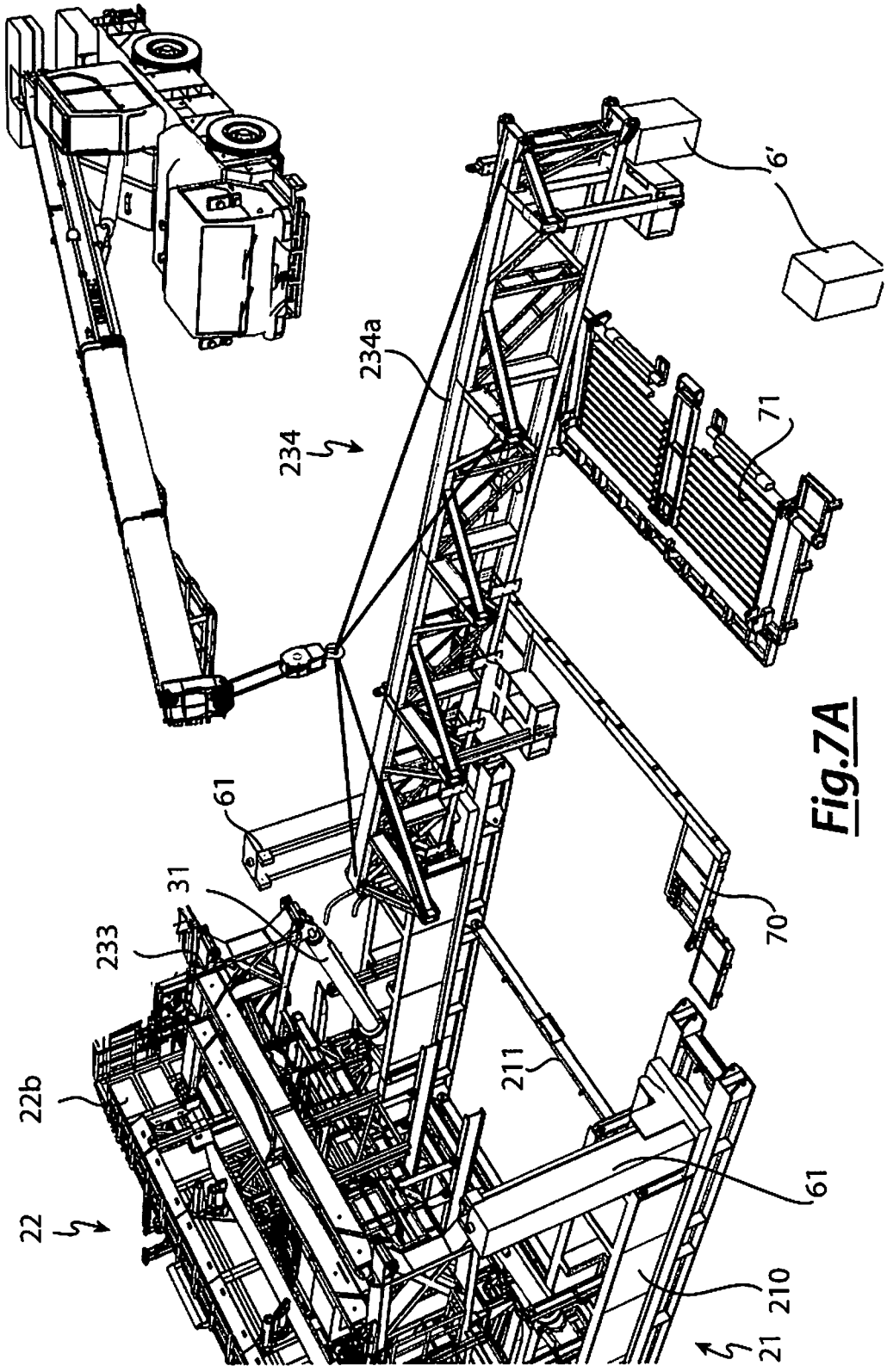

Fig.7A

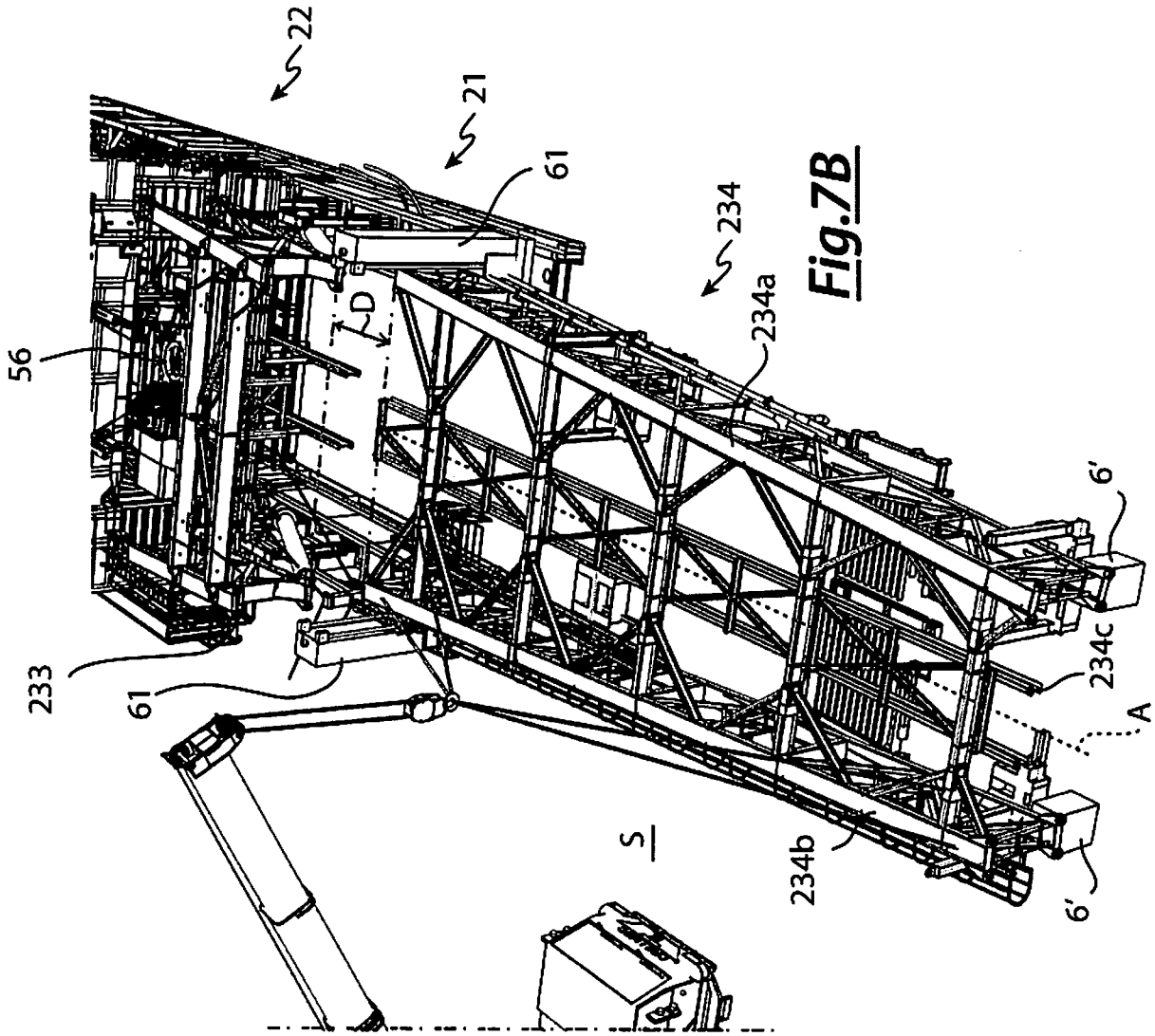

Fig.7B

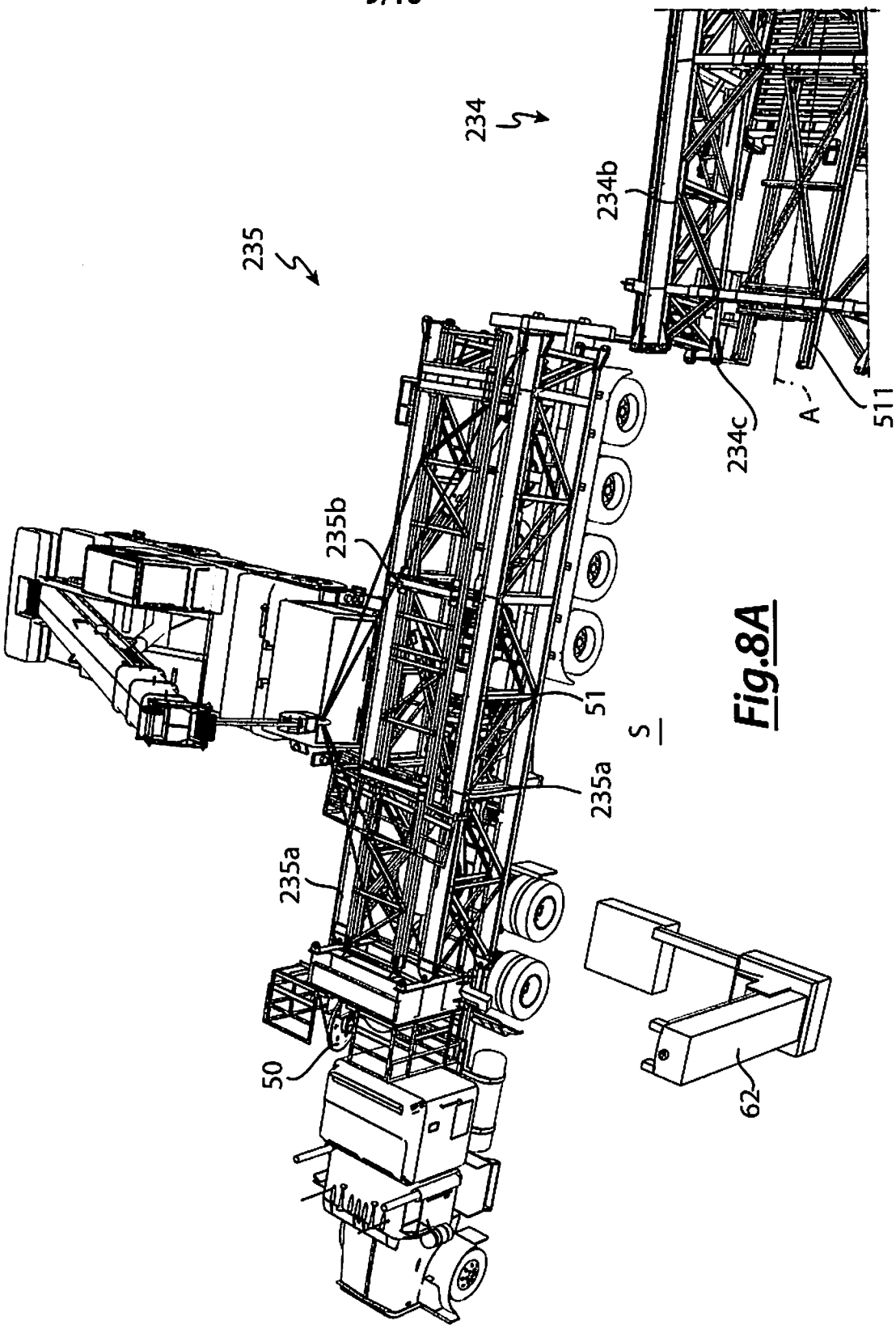

Fig.8A

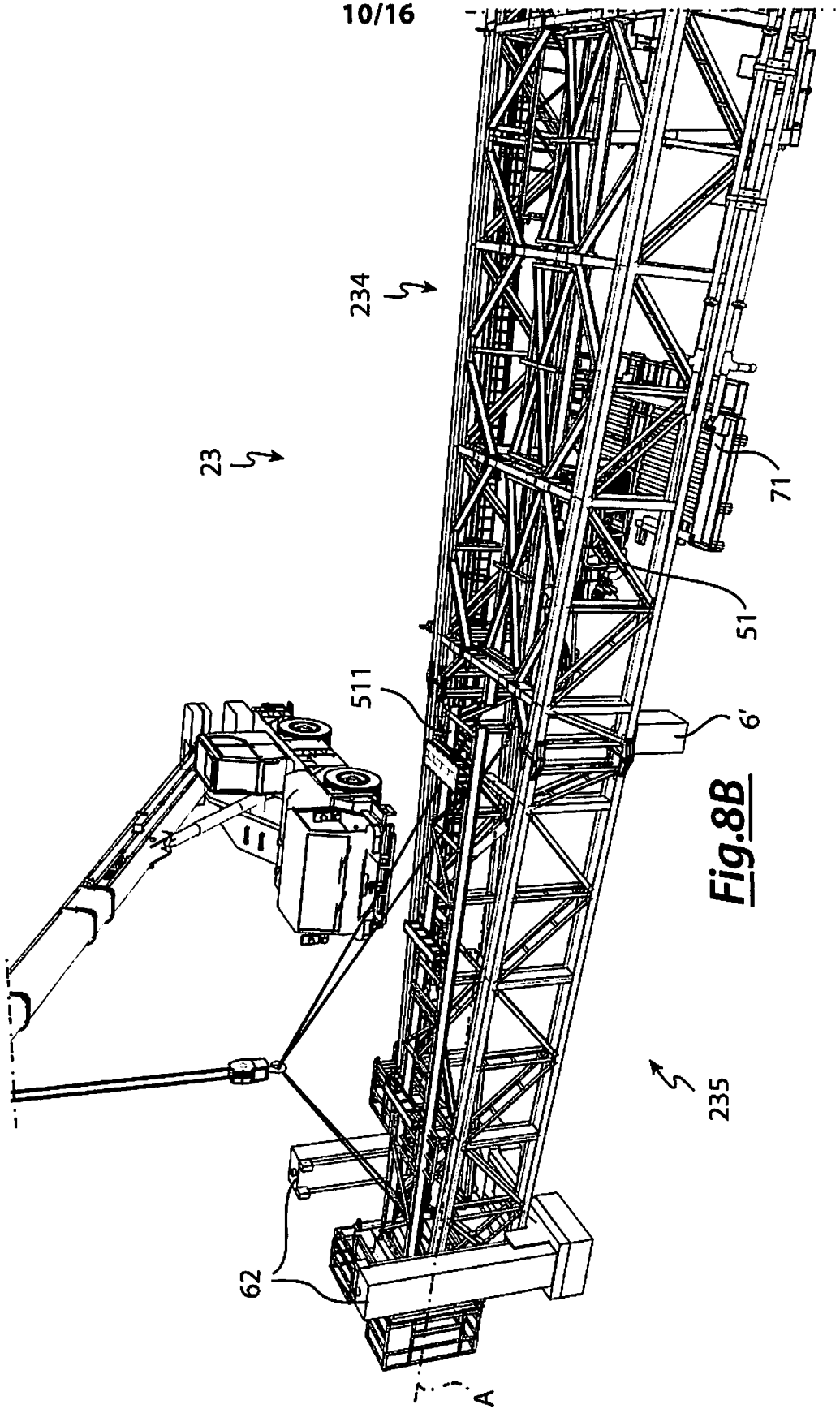

Fig.8B

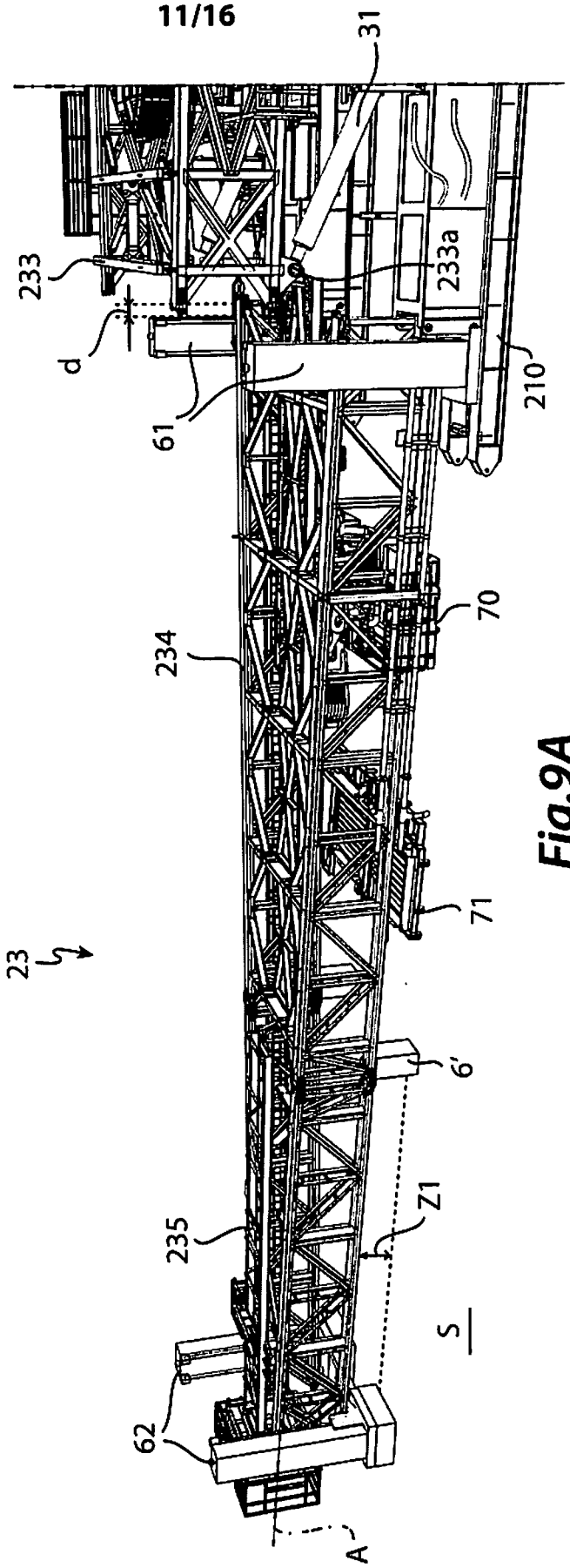

Fig.9A

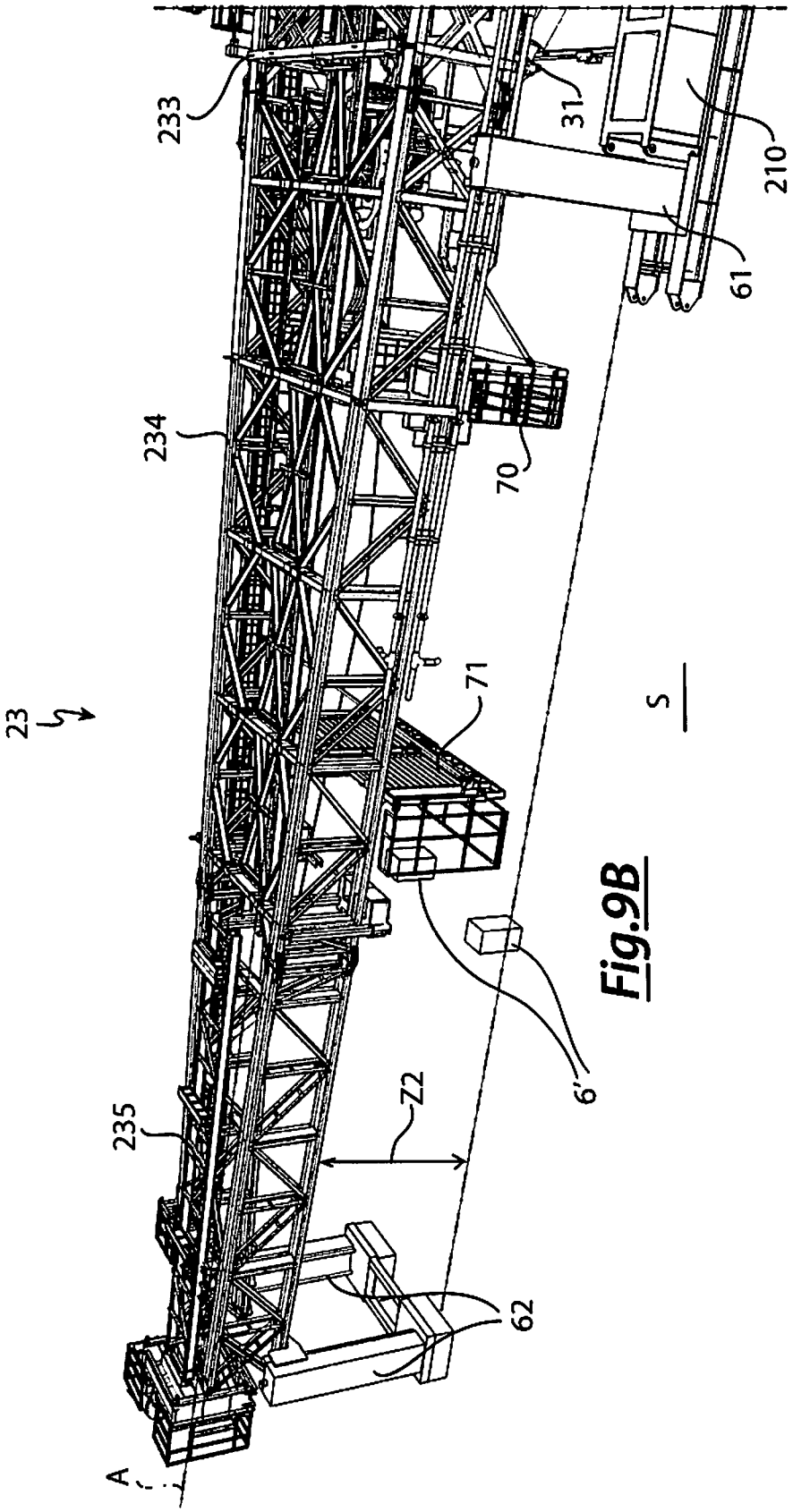

Fig.9B

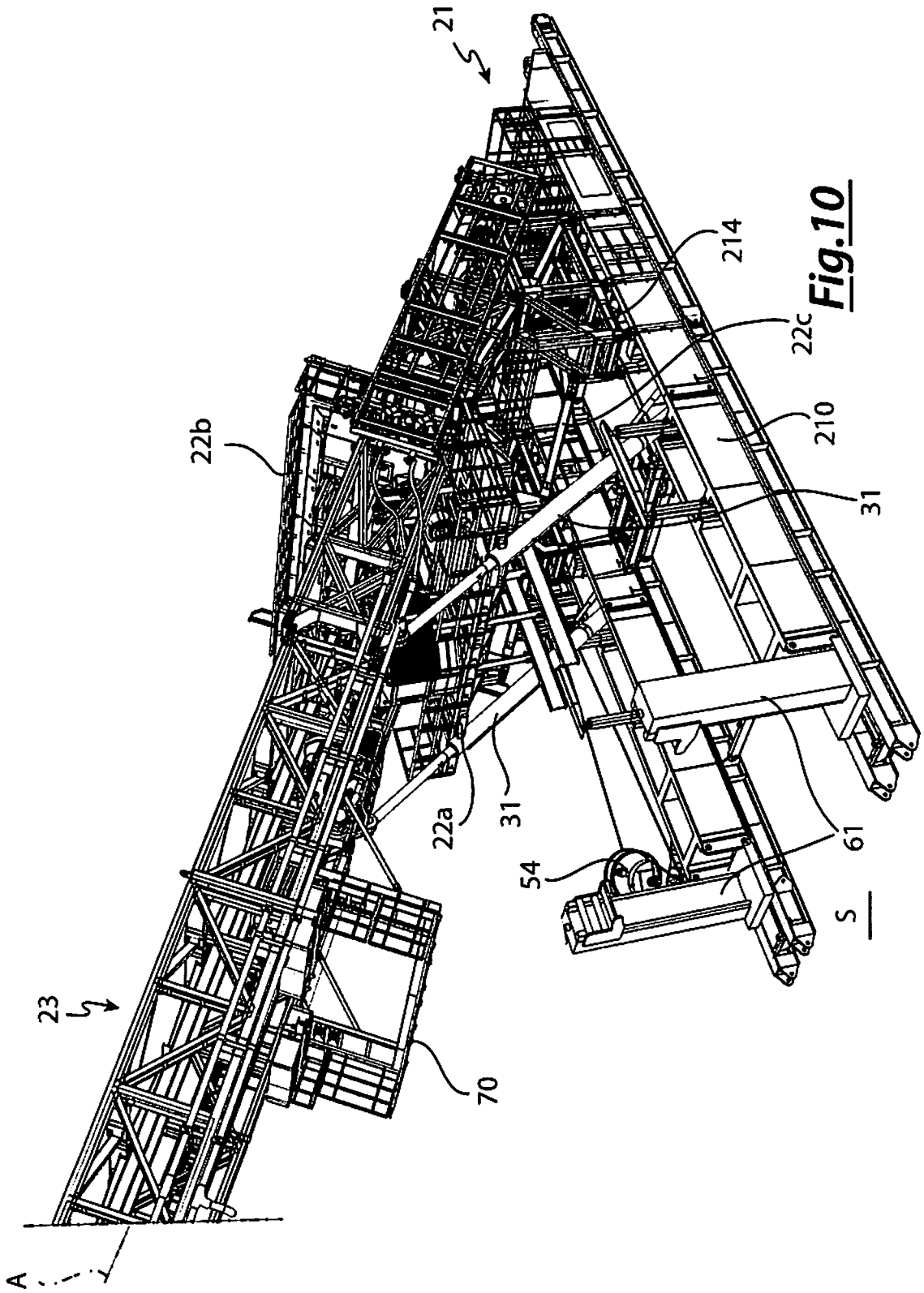

Fig.10

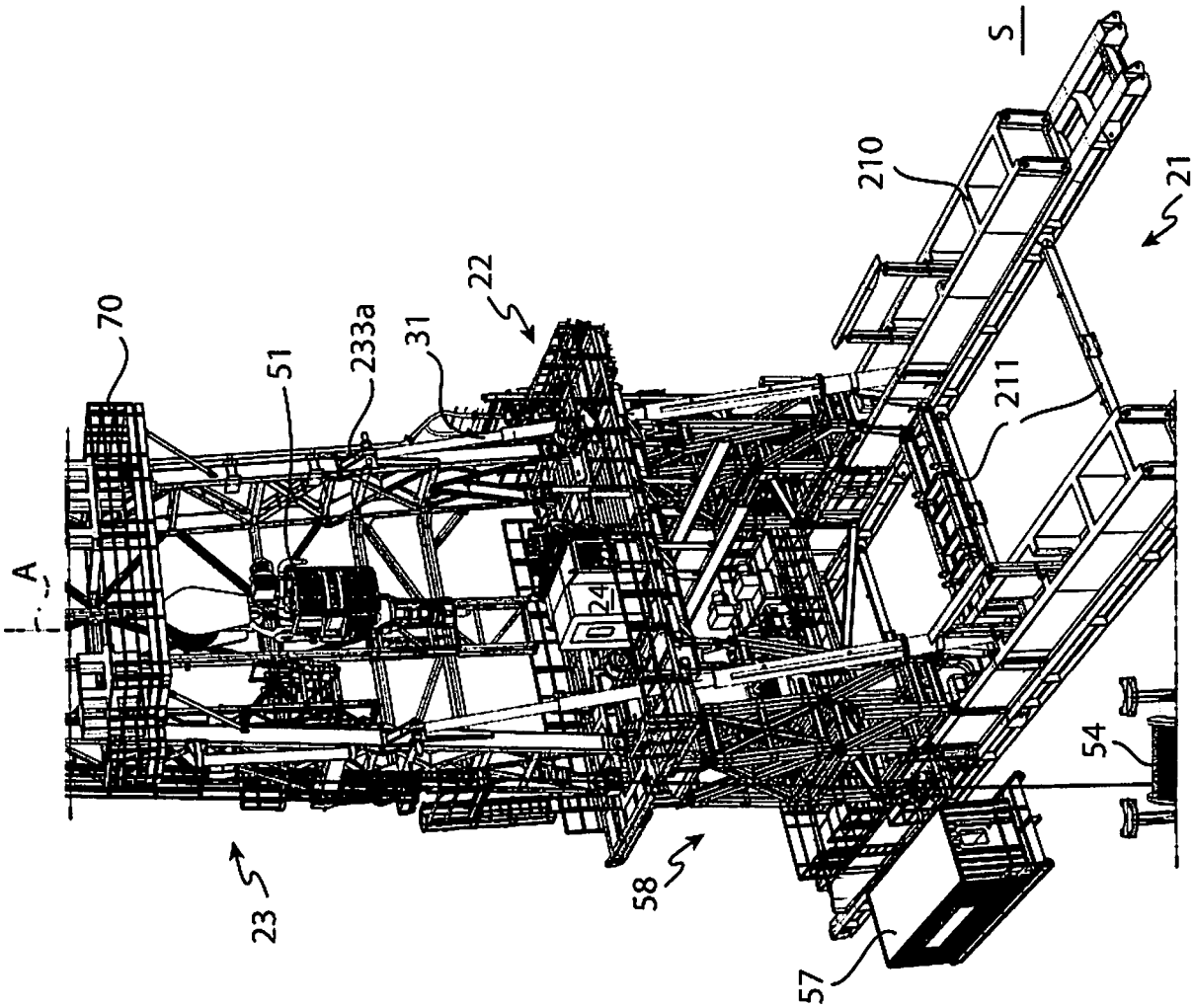

Fig.11

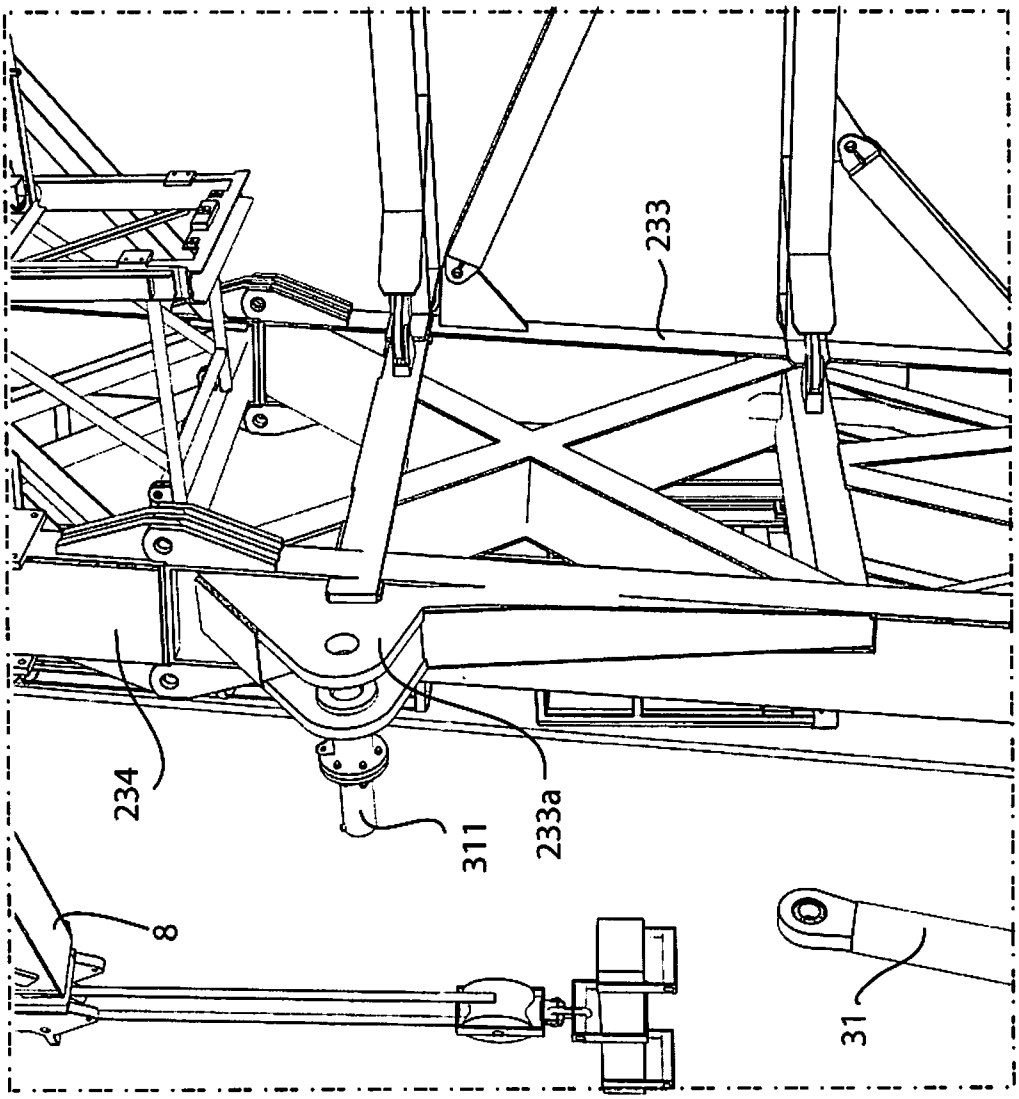

Fig.12

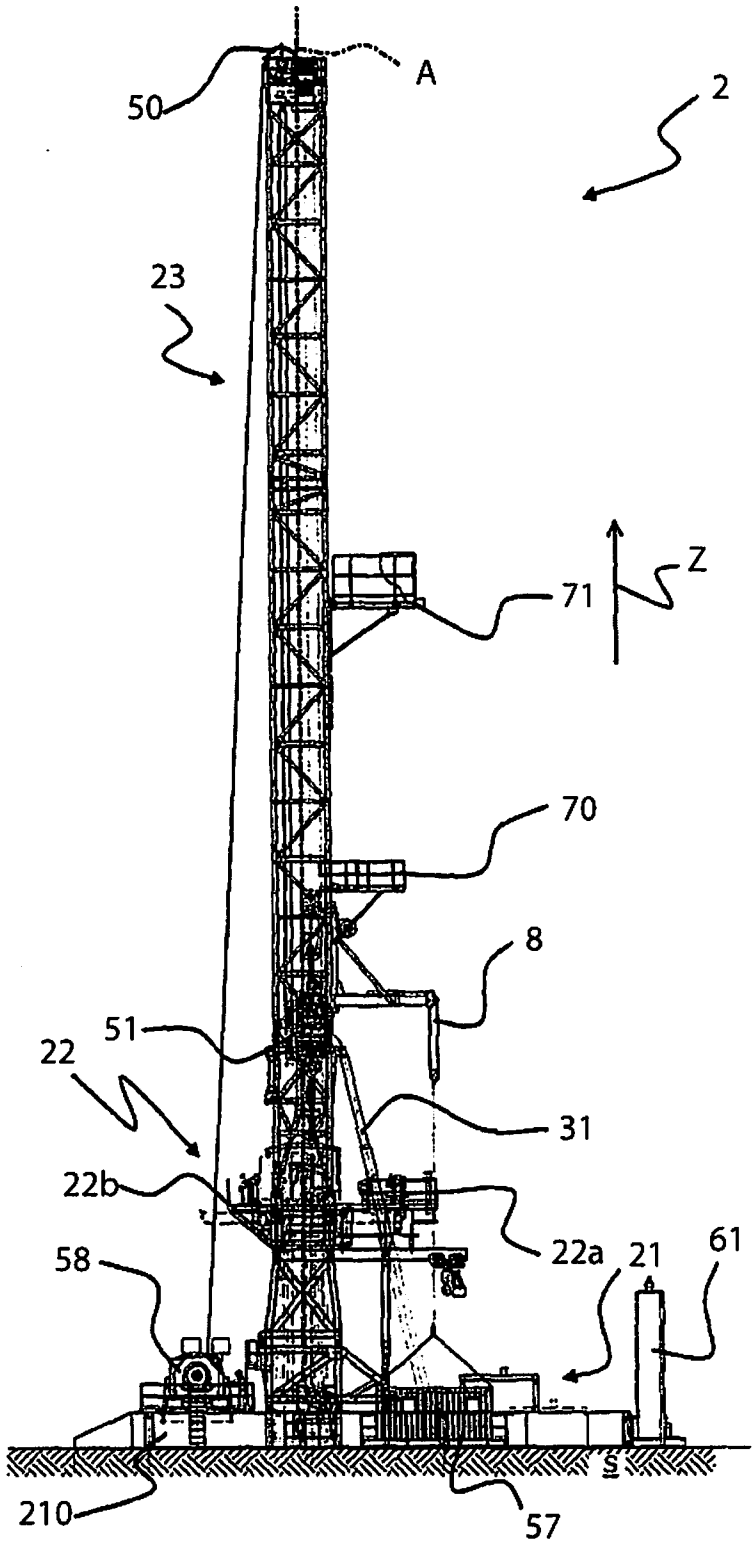

Fig.13