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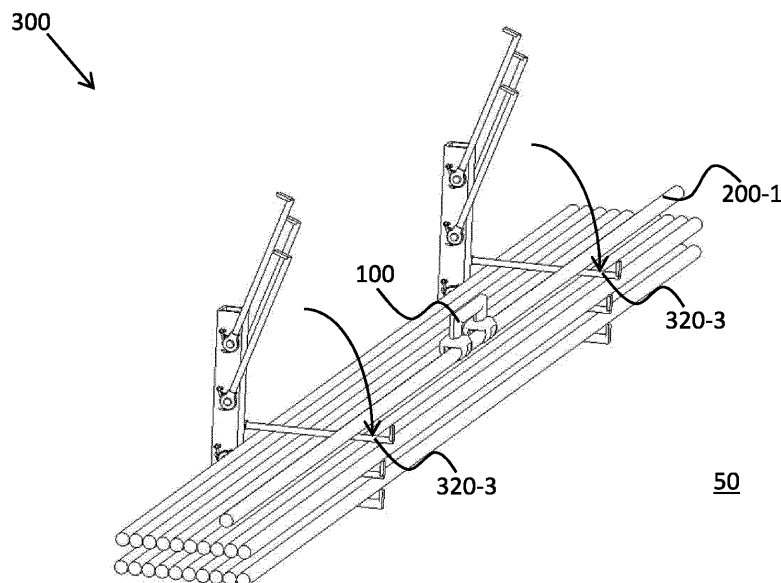
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(54) STORAGE SYSTEM FOR TUBULAR STRUCTURES

(57) The invention relates to a storage system (300) for tubular structures (200) stacked in layers (201..206). The storage system (300) comprises: i) a mechanical support (310, 310-1, 310-2) configured to be placed on a deck or surface (50) in an orientation extending away from the deck or surface (50), and ii) at least two spacer bars (320, 321) mounted to the mechanical support (310, 310-1, 310-2). Each spacer bar (320, 321) has at least a horizontal position in operational use for receiving the tubular structures (200) on top of it. At least an upper one (320-2..320-6) of the at least two spacer bars (320, 321) is pivotably mounted to the mechanical

support (310, 310-1, 310-2) for allowing rotation away from the deck or surface (50) in operational use to enable delivery and pickup of tubular structures (200) from a respective layer (205) directly underneath the respective spacer bar (320-6) by means of a tubular handling tool (100). The at least two spacer bars (320, 321) are mounted to the at least one mechanical support (310, 310-1, 310-2) at different height from the deck or surface (50) to allow the formation of layers (201..206) of tubular structures (200) spaced apart by the spacer bars (320, 321). The invention enables an unmanned pipe storage area to reduce safety hazards for the personnel on a rig.

**FIG. 10****EP 3 260 651 A1**

Description

FIELD OF THE INVENTION

[0001] The invention relates to a storage system for tubular structures stacked in layers.

BACKGROUND OF THE INVENTION

[0002] Oil drilling can be done onshore, using so-called Land Rigs, or offshore, using so-called Mobile Offshore Drilling Units (MODU). The drilling tubulars (tubular structures) are stored on the side of the drilling tower, in a specific pipe storage area. Nowadays, various systems are available in order to pick up the tubulars from their storage position and deliver them to the drilling tower. The most common solution, especially for offshore drilling, is the use of a Crane with a tubular handling tool. The use of these kind of systems requires storing the drilling tubulars in "layers" with spacers between the layers. In this way, it will be possible for the tubular handling tool's fingers to slide under the pipes and have a secure grip. If the tubulars were not stored in layers, the tubular handling tool's fingers will not be able to slide under the tubulars, which would be too bulky and compact. The spacers used for creating layers of tubulars are made of wood and they are installed and removed manually by personnel. When a layer of tubulars is emptied, the process is temporarily interrupted and a person needs to go in the pipe storage area and remove the spacers to allow the tubular handling tool to pick up tubulars from the next layer.

[0003] A first disadvantage of the above-presented storage of tubular structures (pipes) is that the operations are slowed down by the various interruptions. Moreover, the need for personnel near the tubular structures being transported leads to serious safety hazards for said personnel.

SUMMARY OF THE INVENTION

[0004] The invention has for its object to remedy or to reduce at least one of the drawbacks of the prior art, or at least provide a useful alternative to prior art.

[0005] The object is achieved through features, which are specified in the description below and in the claims that follow.

[0006] The invention is defined by the independent patent claims. The dependent claims define advantageous embodiments of the invention.

[0007] In a first aspect the invention relates to a storage system for tubular structures stacked in layers. The storage system comprises:

- a mechanical support configured to be placed on a deck or surface in an orientation extending away from the deck or surface, and
- at least two spacer bars mounted to the mechanical

support. Each spacer bar has at least a horizontal position in operational use for receiving the tubular structures on top of it. At least an upper one of the at least two spacer bars is pivotably mounted to the mechanical support for allowing rotation away from the deck or surface in operational use to enable delivery and pick up of tubular structures from a respective layer directly underneath the respective spacer bar by means of a tubular handling tool. The at least two spacer bars are mounted to the at least one mechanical support at different height from the deck or surface to allow the formation of layers of tubular structures spaced apart by the spacer bars.

[0008] The effects of the storage system in accordance with the invention are as follows. First of all, the inventor identified the need to make the drill floor unmanned in order to reduce safety hazards of personnel. The inventor also realized that forces from the tubular handling tool, such as the tubular handling tool, may be used in solving this problem. The invention provides for a mechanical support (for instance made of steel), which in operational use is placed on and extends away from the deck or surface. To this mechanical support spacer bars, for instance made of steel, have been mounted. These spacer bars replace the wooden spacer bars of the prior art. At least the upper ones of these spacer bars are mounted in a pivotable manner in such a way that the spacer bars facilitate a horizontal position for receiving tubular structures thereon as well as the possibility to rotate or pivot upwards in operational use. The spacer bar that is lowest to the deck or surface does not need to be pivotably mounted, but this could be done. The pivotability of the spacer bars makes it literally possible that tubular structures underneath the pivotable spacer bar can be picked up by the tubular handling tool. This is preferably done after that the tubular structures that were lying on top of the pivotable spacer bar all have been removed, but this is not essential, because even if a few tubular structure are lying on the upper one, still one or more from the layer underneath may be picked up. The same pivotability of the spacer bars makes it possible to access the underlying layers with the tubular handling tool for storing said tubular structures. In other words, all manipulation and handling may be carried out by the tubular handling tool. Consequently, the invention has rendered it possible to have an unmanned pipe storage area at the drill rig.

[0009] In order to facilitate understanding of the invention one or more expressions are further defined herein after.

[0010] At places in this specification where the wording "tubular structure" is used, this refers to any tubular structure or pipe that may be used in the petrochemical industry, such as casing segments, tubing segments, drill string segments, and so on.

[0011] At places in this specification where the wording "spacer bar" is used, this refers to a spacer having any kind of shape, as long as it allows for enough distance

between different layers in the stack of tubular structures.

[0012] In an embodiment of the storage system of the invention the at least upper one of the at least two spacer bars is mounted to the mechanical support via a hinge mechanism. A hinge mechanism constitutes a convenient way of providing that the spacer bars are pivotably mounted.

[0013] In an embodiment of the storage system of the invention the hinge mechanism comprises a rotation point and a hinge frame pivotably mounted to said rotation point, wherein the respective spacer bar is mounted to said hinge frame. This embodiment forms a robust solution for making a hinge. The hinge frame may be conveniently constructed to rotate around the rotation point (being formed by a round axle for example).

[0014] In an embodiment of the storage system of the invention the hinge mechanism is configured for locking the respective spacer bar in a raised position when the respective spacer bar is lifted up to prevent that the respective spacer bar falls back to a horizontal position. It is convenient to be able to lock the position of the spacer bar in an upright or substantially upright position, such that the tubular handling tool may more easily access the tubular structures in the upper one of the filled layers. Different embodiments will be discussed in the detailed description of the figures.

[0015] In an embodiment of the storage system of the invention the hinge mechanism is configured for unlocking the respective spacer bar after that its position has been locked to allow the respective spacer bar to go back to its horizontal position. Once locked, this embodiment conveniently facilitates that the respective spacer bar may be unlocked again. Different embodiments will be discussed in the detailed description of the figures.

[0016] In an embodiment of the storage system of the invention the hinge mechanism further comprises a linear expandable lockable member pivotably mounted between the respective spacer bar and the mechanical support, wherein the lockable member is configured to effect said locking and unlocking of the respective spacer bar. This embodiment forms a first main variant of a hinge mechanism for providing a lockable and unlockable spacer bar.

[0017] In an embodiment of the storage system of the invention the hinge mechanism further comprises a pin-ratchet system, wherein the pin-ratchet system is configured to effect said locking and unlocking of the respective spacer bar. This embodiment forms a second main variant of a hinge mechanism for providing a lockable and unlockable spacer bar.

[0018] In an embodiment of the storage system of the invention the hinge mechanism further comprises a magnetic system, wherein the magnetic system is configured to effect said locking and unlocking of the respective spacer bar. This embodiment forms a third main variant of a hinge mechanism for providing a lockable and unlockable spacer bar.

[0019] In an embodiment of the storage system of the

invention each spacer bar is provided with a protruding part at a distal end, wherein the protruding part is configured for preventing tubular structures to fall off said spacer bars. The protruding part may be provided as a separate part that is mounted on the spacer bar or it may be provided as an integrated part. Alternatively, it could be formed by simply making a bend in the distal end of the spacer bar.

[0020] In an embodiment of the storage system of the invention the distal end is formed with a tilted surface and configured such that, when a tubular structure is pressed against the tilted surface in the axial direction of the spacer bar, the respective spacer bar is lifted up. This embodiment is particularly advantageous when combined with embodiments that do not have locking and unlocking of the spacer bars. In the detailed description of the figures this will be further explained with an example.

[0021] In an embodiment of the storage system of the invention said at least two spacer bars extend only from one side of the mechanical support. This forms a first main variant of the invention, i.e. wherein all spacer bars are mounted at one side and may pivot or rotate in the same direction.

[0022] In an embodiment of the storage system of the invention at least two spacer bars extend from two opposite sides of the mechanical support. This forms a second main variant of the invention, i.e. wherein spacer bars are mounted on both sides of the mechanical support. Starting from their horizontal position the spacer bars on one side pivot or rotate in a direction opposite to the movement direction of the spacer bars on the other, opposite side.

[0023] An embodiment of the storage system of the invention further comprises a further mechanical support similar to and spaced apart from the mechanical support. It is possible to carry out the invention with a single mechanical support having either wide or U-shaped spacer bars. However, the invention also facilitates that the mechanical construction is just repeated such that each tubular structure is suspended on at least two points spaced apart from each other. In practice it may be between two and four mechanical supports, but any other number is also possible.

50 BRIEF INTRODUCTION OF THE DRAWINGS

[0024] In the following is described examples of embodiments illustrated in the accompanying drawings, wherein:

Figs. 1a-1c show a prior art solution for storing tubular structures;

Fig. 2 shows a first embodiment of a pipe storage system in accordance with the invention;

Fig. 3 shows a front view of the storage system

- of Fig. 2;
- Figs. 4-10 show different stages of a method of using the storage system of Fig. 2;
- Fig. 11 shows a first embodiment of a hinge mechanism to be used in the invention;
- Fig. 12 shows a second embodiment of a hinge mechanism to be used in the invention;
- Figs. 13-14 illustrates a third embodiment of a hinge mechanism to be used in the invention;
- Figs. 15-16 illustrate a fourth embodiment of a hinge mechanism to be used in the invention, and
- Figs. 17-18 illustrate a method of using the embodiment of Figs. 15 and 16.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0025] Various illustrative embodiments of the present subject matter are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

[0026] The present subject matter will now be described with reference to the attached figures. Various systems, structures and devices are schematically depicted in the drawings for purposes of explanation only and so as to not obscure the present disclosure with details that are well known to those skilled in the art. Nevertheless, the attached drawings are included to describe and explain illustrative examples of the present disclosure. The words and phrases used herein should be understood and interpreted to have a meaning consistent with the understanding of those words and phrases by those skilled in the relevant art. No special definition of a term or phrase, i.e., a definition that is different from the ordinary and customary meaning as understood by those skilled in the art, is intended to be implied by consistent usage of the term or phrase herein. To the extent that a term or phrase is intended to have a special meaning, i.e., a meaning other than that understood by skilled artisans, such a special definition will be expressly set forth in the specification in a definitional manner that directly and unequivocally provides the special definition

for the term or phrase.

[0027] Figs. 1a-1c show a prior art solution for storing tubular structures. In Fig. 1a tubular structures (pipes) 200 have been stacked to form layers 201, 202. In between each layer wooden spacers 250 are present. A tubular handling system 100, in this example a the "Gripper Yoke" as developed by National Oilwell Varco, is lowered towards the upper layer 202 of tubular structures 200. The tubular handling tool 100 comprises a manipulator with fingers 110 as shown and may be connected, for example, to a boom of a crane. These fingers are manipulated around the pipes 200 to be picked up. A conventional tubular handling tool 100 could easily pick up three pipes at the same time, as illustrated in Figs 1 b and 1 c. A tubular handling tool 100, as shown in this figure, is considered to be well known to the person skilled in the art and is therefore not discussed in more detail.

[0028] Fig. 2 shows a first embodiment of a pipe storage system 300 (referred to as a storage system for tubular structures in the claim) in accordance with the invention. The storage system 300 is placed on a deck or surface 50, for example of a rig (not shown). Next to a first layer 201 and a second layer 202 of tubular structures, there is visible a third layer 203 of tubular structures 200. The storage system 300 in this example facilitates up to 6 layers of tubular structures 200. However, the invention is not limited to any specific number of layers. The invention is useful for two or more layers to be stored. The storage system 300 comprises a first mechanical support 310-1 and a second mechanical support 310-2, here in the form of vertical poles, which may be made of steel for example. Each mechanical support 310-1, 310-2 is provided with a plurality of spacer bars 320 (for example made of steel).

[0029] Fig. 3 shows a front view of the storage system of Fig. 2. As shown in Fig. 3, the upper spacer bars 320 are pivotably mounted to the respective mechanical support 310 via respective hinge mechanisms 330. The bottom spacer bar 321 is fixedly mounted to the mechanical support 310. It must be noted that the bottom spacer bar 321 could also be made pivotable, which could then be used to make the storage system 300 more compact for storage, when it is not used for storage tubular structures. In Fig. 3, however, the bottom spacer bar 321 may be used to form a stiff frame together with the mechanical support 310 such that the storage system can stand on the deck or surface 50 without tipping over. Fig. 3 further illustrates respective protruding parts 325 at respective distal ends 320e of said spacer bars 320, 321, which serve to prevent the tubular structures to fall off said spacer bars 320, 321.

[0030] A further aspect of the embodiment shown in Fig. 3 is that the hinge mechanisms 330 are designed such that the respective spacer bars 320 can be lifted up and that their position is locked in the highest position/upright position (close to vertical orientation, i.e. 80 degrees). Furthermore, the hinge mechanisms 330 are designed such that from this (substantially) upright position,

the spacer bars 320 can be unlocked and return to their horizontal position. For the hinge mechanisms 330 many implementations are possible. Some of possible embodiments providing locking and unlocking will be discussed with reference to Figs. 11 to 14. It must be noted that the locking and unlocking of the hinge mechanisms 330 is not essential to the invention as will be explained with reference to Figs. 15 to 18.

[0031] The invention is not limited to using two mechanical supports, because the storage system 300 could be built with either one or with more than two mechanical supports. What is essential is that each tubular structure is support in a stable manner, either by two or more separate spacer bars 320, or by a U-shaped single spacer bar (not shown). The latter could theoretically be mounted to a single mechanical support. Nevertheless, it is advantageous to support the tubular structures 200 at two locations at a specific distance from each other, for instance at 25% and 75% of the length of the tubular structures 200. Another advantage of using two support points is that the tubular handling tool 100 (i.e. tubular handling tool) may grip the tubular structures 200 right in the middle and right in between said mechanical supports. This provides for a stable handling of the tubular structures, in particular where the storage system 300 is passive, i.e. where it uses the forces from the tubular handling tool 100 to lift, lock and unlock the spacer bars 320. It must be noted that there exist also other types of tubular handling tools, which grip the respective tubular structures at, for example, 25% and 75% of their length, for example. The invention provides for the possibility to choose different distances between said mechanical supports 310-1, 310-2 in order to comply with the size of the respective tubular handling tool that is used.

[0032] Figs. 4-10 show different stages of a method of using the storage system 300 of Fig. 2, which offers locking and unlocking of the position of the spacer bars 320. In all figures there is used, by way of example, the tubular handling tool as tubular handling tool 100, but this is not essential to the invention. Furthermore, in all these figures the tubular handling tool handles only one tubular structure 100 at the time. This is not essential, the tubular handling tool might also handle two, three or more tubular structures at the time, depending on the diameter.

[0033] In the stage of Fig. 4, the tubular handling tool 100 has picked a target tubular structure 200-1 in its middle point. In order to facilitate reading of the drawings, only the bottom two layers of the storage system 300 are filled, while the third layer 203 and fourth layer 204 are left empty. The target tubular structure 200-1 is take from the fifth layer 205, while the sixth layer 206 is again empty. The figure further illustrates the six spacer bars 320-1..320-6 for each respective layer 201..206.

[0034] In the stage of Fig. 5, the tubular handling tool 100 has pulled the target tubular structure 200-1 up against the upper spacer bars 320-6 (the 6th spacer bar counted from the bottom) lifting it up as illustrated.

[0035] In the stage of Fig. 6, the tubular handling tool

100 has pushed the upper spacer bars 320 so far that they went in their locking position with the target tubular structure 200-1, which has subsequently been put away for use, i.e. in a derrick (not shown).

5 **[0036]** In the stage of Fig. 7, the earlier mentioned sequence of steps has been repeated so many times that the third row until the fifth row are completely empty and the upper four spacer bars 320-3..320-6 are all in their locking position.

10 **[0037]** In the stage of Fig. 8, the tubular handling tool 100 has picked a target tubular structure 200-1 from another location in order to store it in the storage system 300. As the intention is to store the target tubular structure in the third layer 203, the tubular handling tool hits the target tubular structure 200-1 against the third spacer bars 320-3 as illustrated.

15 **[0038]** In the stage of Fig. 9, the third spacer bars 320-3 are pushed backwards as illustrated by the arrows d. This will unlock the respective hinge mechanisms, allowing the respective spacer bars 320-3 to move back to their horizontal position. This process may be guided by the tubular handling tool 100 and the target tubular structure 200-1.

20 **[0039]** In the stage of Fig. 10, the third spacer bars 320-3 have been brought back to their horizontal position and the target tubular structure 200-1 has been laid on top of them, as illustrated.

25 **[0040]** Fig. 11 shows a first embodiment of a hinge mechanism 330-1 to be used in the invention. This embodiment provides for locking and unlocking of the position of the spacer bar 320. The core of the hinge mechanism 330-1 is a rotation point 331, which is here in the form of an axle, around which a circular hinge frame 332 is pivotably mounted, i.e. the circular hinge frame 332 can freely rotate around the rotation point 331. The spacer bar 320 is mounted to the hinge frame 332 as illustrated. The locking and unlocking functionality in this embodiment is arranged through a lockable member 340, which is on one end pivotably connected to the hinge frame 332 via a first pivotable connection 341 as illustrated. On the other end the lockable member 340 is pivotably connected to the mechanical support 310 as illustrated. In Fig. 11 the lockable member 340 comprises a cylindrical frame 343 in which a plunger 344 may move up and down. When the spacer bar 320 is lifted up, the hinge frame 332 rotates clockwise and the lockable member 340 is compressed. At a certain level of compression, complying with a predefined angle of the spacer bar 320, the lockable member 340 must lock its position. One way of achieving this effect is to use the same mechanism as used in ball pens. Ball pens use a cylindrical mechanism, which consists of a plunger that rotates a cam body, which alternately engages and is disengaged from spaced apart teeth on the inner wall of a cylindrical frame, for instance as known from US Patent No. 3,120,837.

55 **[0041]** Fig. 12 shows a second embodiment of a hinge mechanism 330-2 to be used in the invention. This embodiment provides for locking and unlocking of the posi-

tion of the spacer bar 320. The core of the hinge mechanism 330-1 is also a rotation point 331, which is here in the form of an axle, around which a circular hinge frame 332 is pivotably mounted, i.e. the circular hinge frame 332 can freely rotate around the rotation point 331. The spacer bar 320 is mounted to the hinge frame 332 as illustrated. The locking and unlocking functionality in this embodiment is arranged through a pin-ratchet system as illustrated. Ratchets 350 have been provided on the hinge frame 332 and a pivotable locking pin 351 is mounted on the mechanical support 310. A first magnet 352-1 is mounted on the mechanical support 310 as illustrated for keeping the position of the locking pin 351 in its position as shown in the figure. While the hinge frame 332 is rotate clockwise, the ratchets 350 will push the locking pin outward until they passed the locking pin 351 and then the first magnet 352-1 will pull the locking pin 351 back into its original position. It is clear from Fig. 12 that the hinge mechanism 330-2 locks, holds its position at various intermediate positions as well. This effect may be advantageous, but not essential to the invention. This means that one ratchet may be enough to provide for a locking effect.

[0042] Fig. 12 further illustrates a first actuator 353 in the form of an arm that is mounted on the hinge frame 332. Fig. 12 further illustrates a second actuator 354 in the form of a protrusion on the hinge frame 332. The first actuator 353 functions as an end stop actuator and the second actuator 354 as a release actuator. This may be understood as follows. When the hinge frame 331 rotates clockwise (when the spacer arm 320 is moved up), the locking pin 351 will in effect move towards a position just behind the last ratchet 354 on the left. This complies with the upright locking position of the spacer arm 320. Unlocking of the hinge mechanism 330-2 is achieved by moving the spacer arm 320 a little bit further up such that the second (release) actuator 354 pushes the locking pin 351 away from the hinge frame 331. Consequently the second magnet 352-2 will eventually lock the locking pin 351 in its second position, wherein the hinge mechanism 330-2 is released, i.e. can freely rotate. The spacer bar 320 may now rotate back to its horizontal position such that the first (end stop) actuator 353 hits the locking 351 and pushes it back to its original position against the ratchets, which position will be locked by the first magnet 352-1.

[0043] With reference to the embodiment of Fig. 12 it is submitted that, as an alternative to using magnets 352-1, 352-2 to keep the locking pin 351 into respective positions, also other elements may be used, such as springs, pins, electrical actuators and hydraulic actuators. All such variants fall within the scope of the invention. The person skilled in the art will be able to come with such alternatives without due burden, when reading the current specification.

[0044] Figs. 13-14 illustrates a third embodiment of a hinge mechanism 330-3 to be used in the invention. This embodiment provides for locking and unlocking of the

position of the spacer bar 320. The core of the hinge mechanism 330-1 is also a rotation point 331, which is here in the form of an axle, around which a circular hinge frame 332 is pivotably mounted, i.e. the circular hinge frame 332 can freely rotate around the rotation point 331. The spacer bar 320 is mounted to the hinge frame 332 as illustrated. The locking and unlocking functionality in this embodiment is arranged through the implementation of an electromagnetic device 360 mounted on the mechanical support 310. The electromagnetic device 360 cooperates with a metal plate 361 (or any other type of material, which can be magnetized) mounted on the spacer bar 320. In Fig. 13 the spacer bar 200 is oriented in its upright position, wherein the metal plate 361 touches the electromagnetic device 360 for locking said hinge mechanism 330-3. The advantage of taking an electromagnetic device 360 is that it can be switched off to unlock the hinge mechanism 330-3.

[0045] Figs. 15-16 illustrate a fourth embodiment of a hinge mechanism 340-4 to be used in the invention. This embodiment does not provide for locking and unlocking of the position of the spacer bar 320, which makes this embodiment less complex and costly to build. The core of the hinge mechanism 330-1 is also a rotation point 331, which is here in the form of an axle, around which a circular hinge frame 332 is pivotably mounted, i.e. the circular hinge frame 332 can freely rotate around the rotation point 331. The spacer bar 320 is mounted to the hinge frame 332 as illustrated. The hinge mechanism 340-4 is configured such that the horizontal position of freely pivotable spacer bars 320 is ensured by so-called end stops 370 as illustrated in Fig. 16. Fig. 15 further illustrates that the protruding elements 325 are formed different than in Fig. 3, namely they are formed such that they define a tilted surface 326 at the respective distal ends 320e of the spacer bars 320. The purpose of these tilted surfaces 326 is explained with reference to Figs. 17 and 18.

[0046] Figs. 17-18 illustrate a method of using the embodiment of Figs. 15 and 16. In this embodiment the tubular handling tool 100 has gripped three target tubular structures 200-1 with its fingers as illustrated, but it may also be a different number of tubular structures 200. The first two layers 201, 202 of the storage system 300 have been filled with tubular structures 200 and the target tubular structures 200-1 are to be placed in the third layer 203. The main idea of this embodiment is that all tubulars 200 are moved in and out from their respective layers 201, 202, 203 in a horizontal movement. Fig. 17 illustrates that the gripper joke moves horizontally in the direction of the horizontal arrow. At a certain point the target tubular structures 200-1 will hit the tilted surface 326 of the fourth spacer bar 320-4 right above the third row 203. This is also illustrated in Fig. 18. At that point the fourth spacer bar 320-4 will move a bit up (in accordance with the small vertical arrows) creating more space for the tubular handling tool 100 to move the target tubular structures deeper in to the storage system 300. In this system the tubulars

are placed in the respective rows from the left to the right as shown in the figure, and they are taken out of the respective rows from the right to the left.

[0047] Many variations on the embodiments shown in the figures are possible. For instance, it must be noted that in all figures the tubular structures 200 have the same diameter. One of the great advantages of the invention is that this is no longer essential. It is possible to place tubular structures having different diameters on the same storage system 300. Furthermore, in all figures there are shown two mechanical supports, while this may be any other number in practise.

[0048] The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. For example, the method steps set forth above may be performed in a different order. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

[0049] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware.

Claims

1. Storage system (300) for tubular structures (200) stacked in layers (201..206), characterized in that the storage system (300) comprising:

- a mechanical support (310, 310-1, 310-2) configured to be placed on a deck or surface (50) in an orientation extending away from the deck or surface (50), and
- at least two spacer bars (320, 321) mounted to the mechanical support (310, 310-1, 310-2), wherein each spacer bar (320, 321) has at least a horizontal position in operational use for re-

ceiving the tubular structures (200) on top of it, wherein at least an upper ones (320-2..320-6) of the at least two spacer bars (320, 321) is pivotably mounted to the mechanical support (310, 310-1, 310-2) for allowing rotation away from the deck or surface (50) in operational use to enable delivery and pickup of tubular structures (200) from a respective layer (205) directly underneath the respective spacer bar (320-6) by means of a tubular handling tool (100), and wherein the at least two spacer bars (320, 321) are mounted to the at least one mechanical support (310, 310-1, 310-2) at different height from the deck or surface (50) to allow the formation of layers (201..206) of tubular structures (200) spaced apart by the spacer bars (320, 321).

2. The storage system (300) according to claim 1, wherein the at least upper one (320-2..320-6) of the at least two spacer bars (320, 321) is mounted to the mechanical support (310, 310-1, 310-2) via a hinge mechanism (330, 330-1..330-4).
3. The storage system (300) according to claim 2, wherein the hinge mechanism (330, 330-1..330-4) comprises a rotation point (331) and a hinge frame (332) pivotably mounted to said rotation point (331), wherein the respective spacer bar (320) is mounted to said hinge frame (332).
4. The storage system (300) according to claims 2 or 3, wherein the hinge mechanism (330, 330-1..330-3) is configured for locking the respective spacer bar (320) in a raised position when the respective spacer bar (320) is lifted up to prevent that the respective spacer bar (320) falls back to a horizontal position.
5. The storage system (300) according to claim 4, wherein the hinge mechanism (330, 330-1..330-3) is configured for unlocking the respective spacer bar (320) after that its position has been locked to allow the respective spacer bar (320) to go back to its horizontal position.
6. The storage system (300) according to claim 5, wherein the hinge mechanism (330-1) further comprising a linear expandable lockable member (340..344) pivotably mounted between the respective spacer bar (320) and the mechanical support (310, 310-1, 310-2), wherein the lockable member (340..344) is configured to effect said locking and unlocking of the respective spacer bar (320).
7. The storage system (300) according to claim 5, wherein the hinge mechanism (330-2) further comprising a pin-ratchet system (350..354), wherein the pin-ratchet system (350..354) is configured to effect said locking and unlocking of the respective spacer

bar (320).

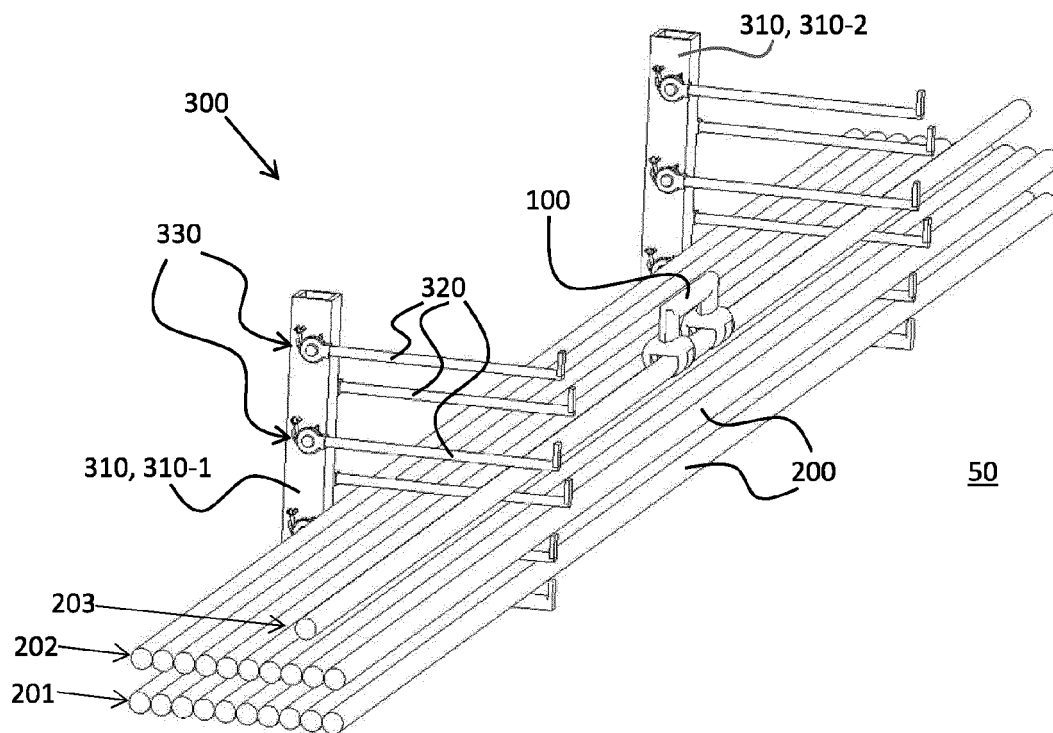
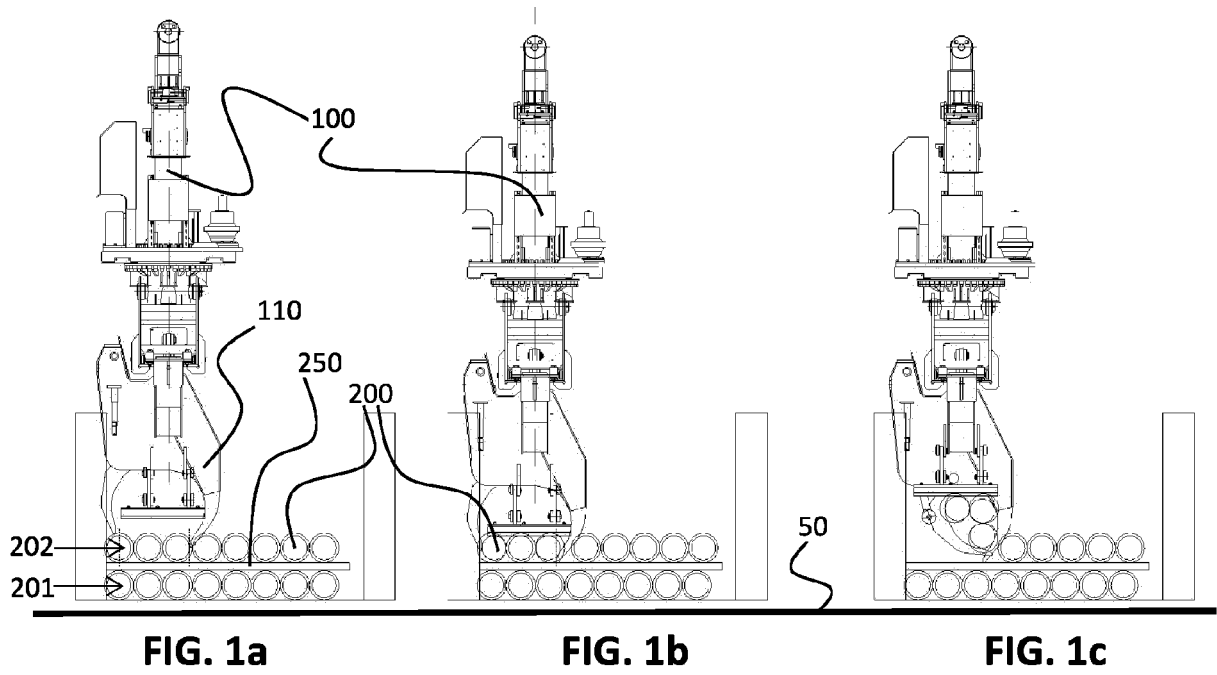
8. The storage system (300) according to claim 5, wherein the hinge mechanism (330-3) further comprising a magnetic system (360, 361), wherein the magnetic system (360, 361) is configured to effect said locking and unlocking of the respective spacer bar (320). 5
9. The storage system (300) according to any one of the preceding claims, wherein each spacer bar (320, 321) is provided with a protruding part (325) at a distal end (320e), wherein the protruding part (325) is configured for preventing tubular structures (200) to fall off said spacer bars (320, 321). 10 15
10. The storage system (300) according to claim 9, wherein the distal end (320e) is formed with a tilted surface (326) and configured such that, when a tubular structure is pressed against the tilted surface (326) in the axial direction of the spacer bar (320), the respective spacer bar (320) is lifted up. 20
11. The storage system (300) according to any one of claims 1 to 10, wherein said at least two spacer bars (320) extend only from one side of the mechanical support (310). 25
12. The storage system (300) according to any one of claims 1 to 10, wherein said at least two spacer bars (320) extend from two opposite sides of the mechanical support (310). 30
13. The storage system (300) according to any one of the preceding claims, further comprising a further mechanical support (310-2) similar to and spaced apart from the mechanical support (310-1). 35

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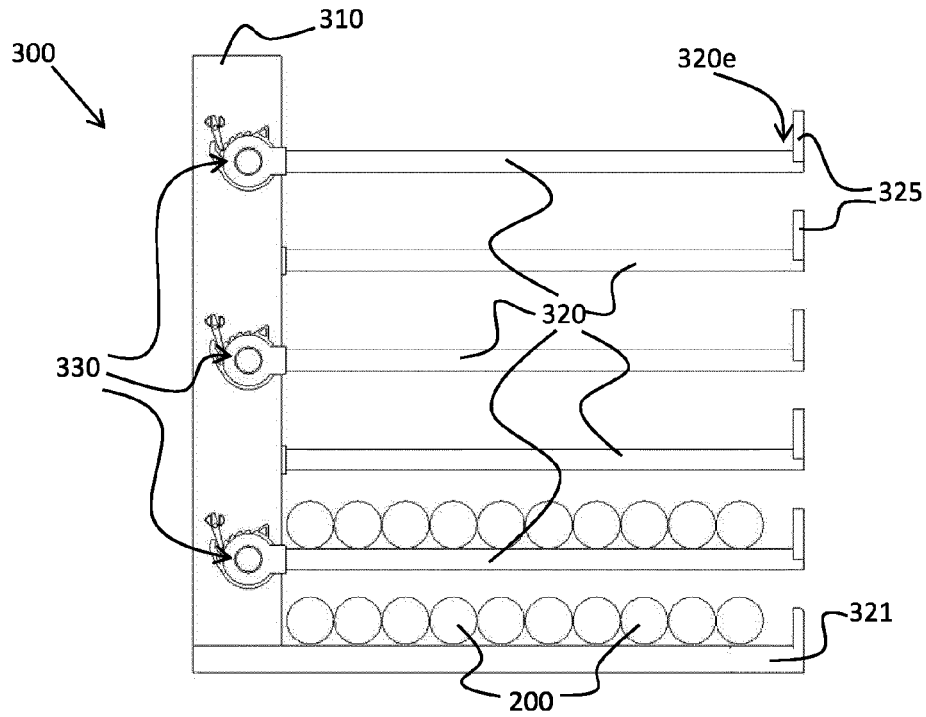


FIG. 3

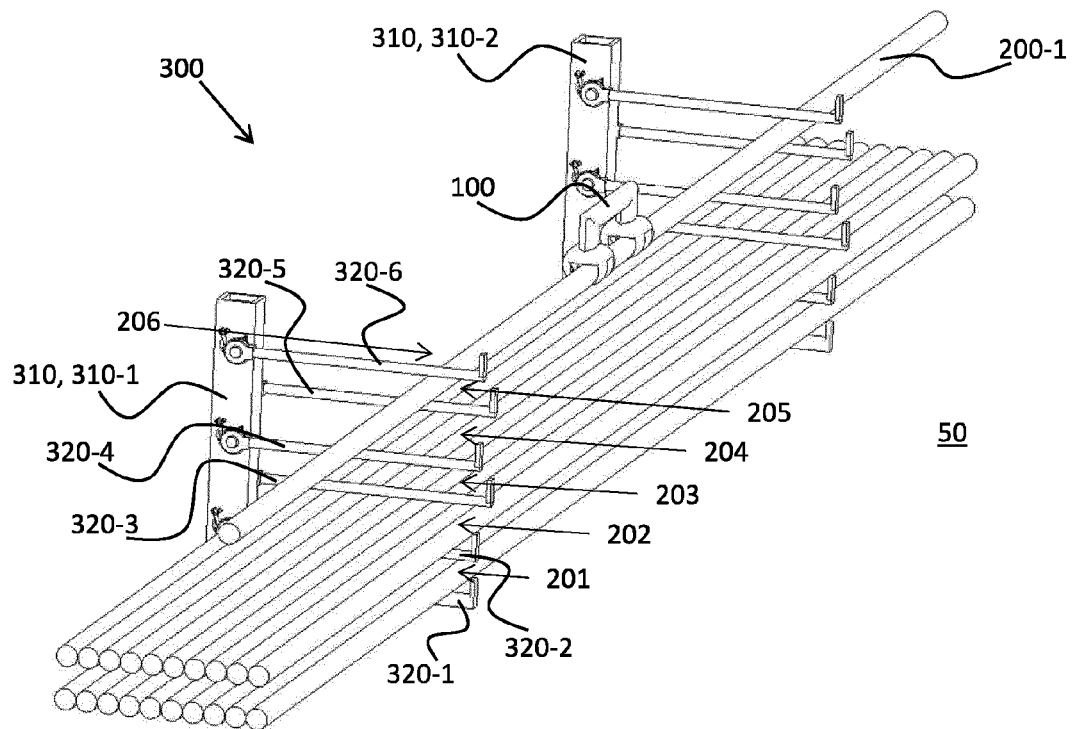


FIG. 4

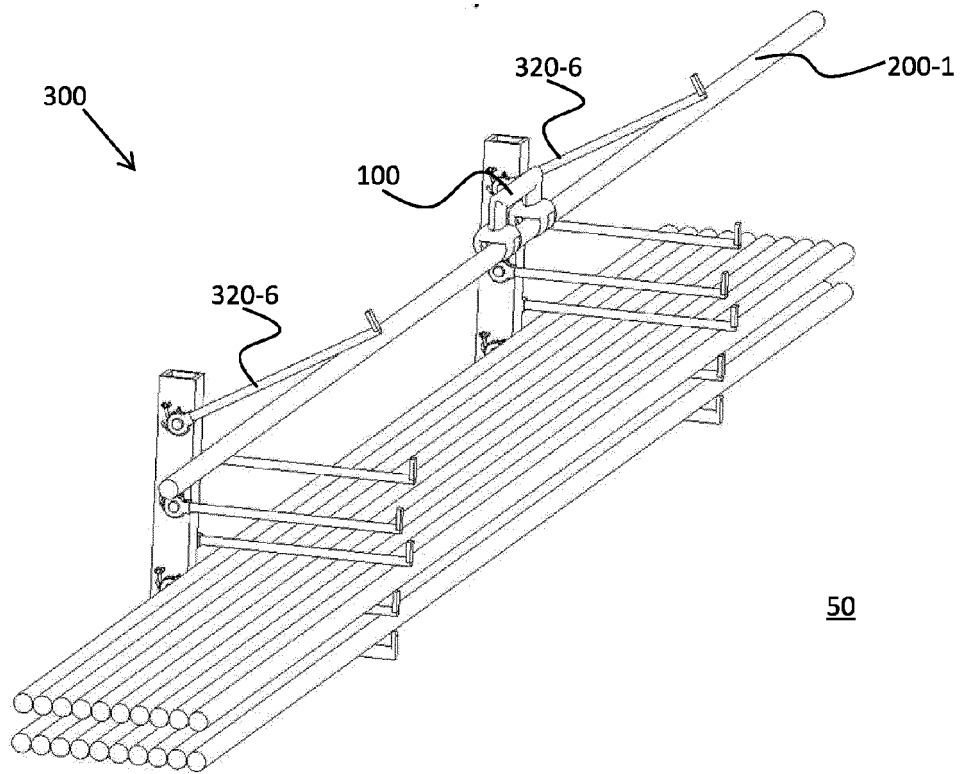


FIG. 5

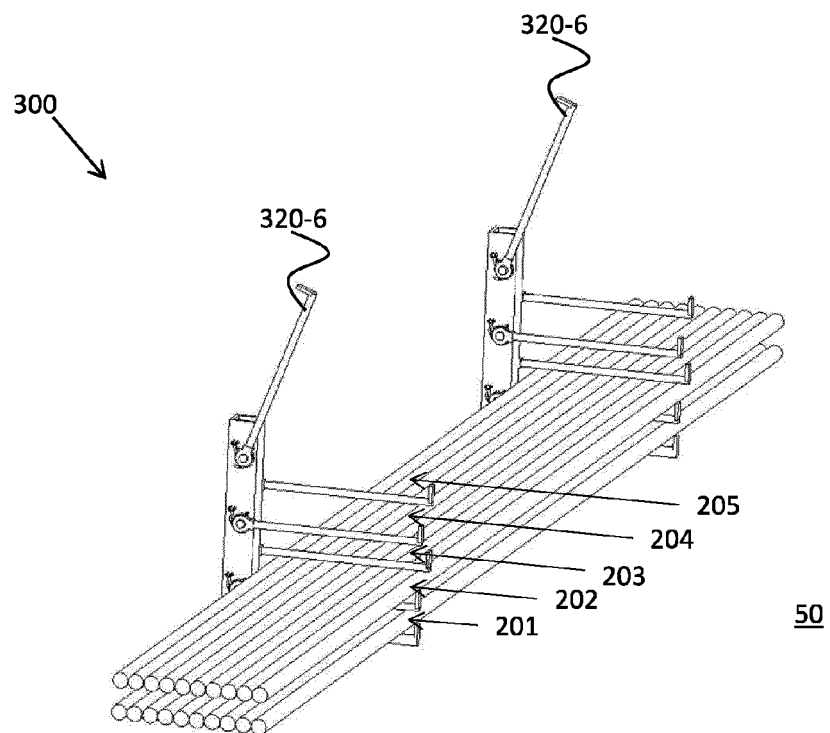


FIG. 6

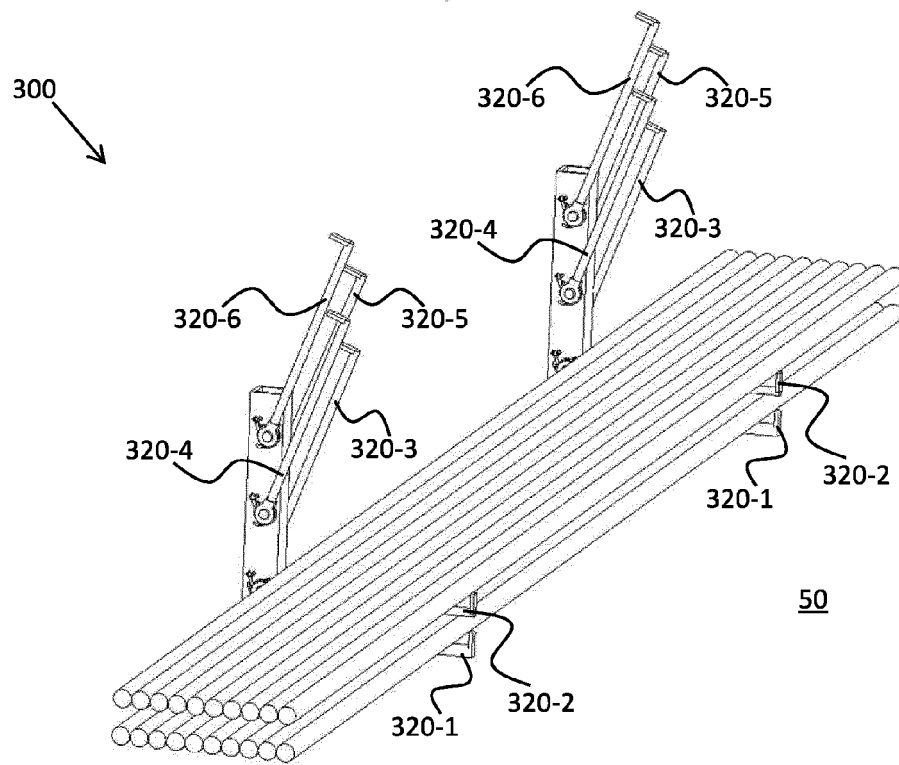


FIG. 7

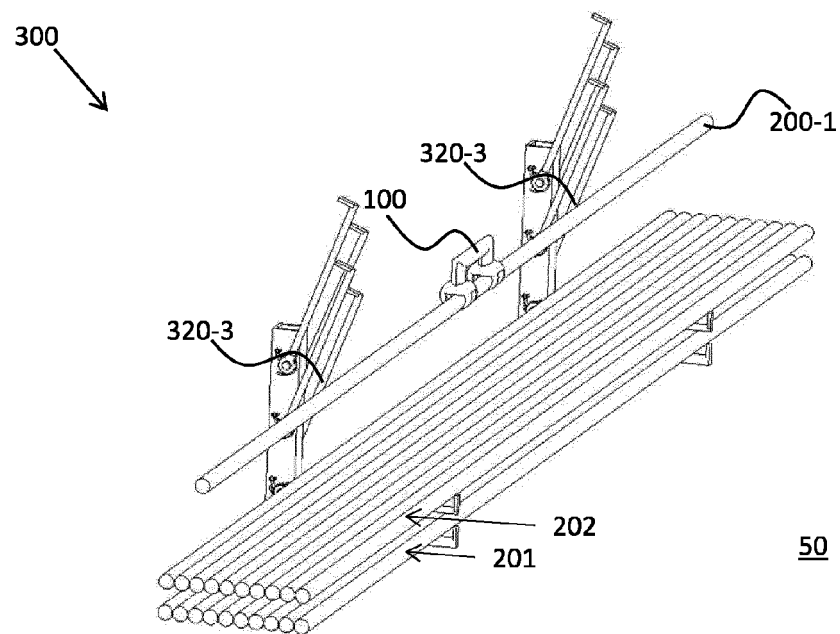


FIG. 8

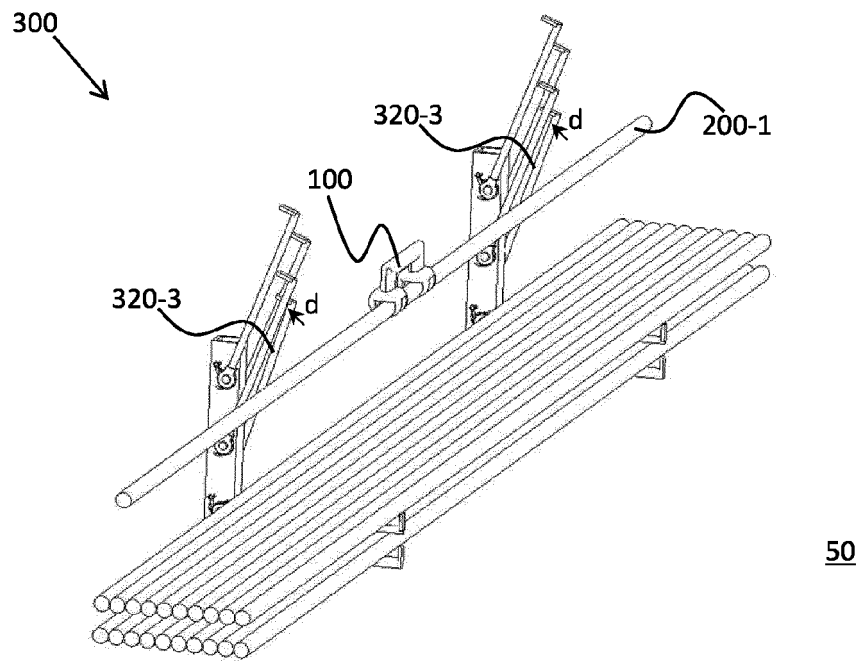


FIG. 9

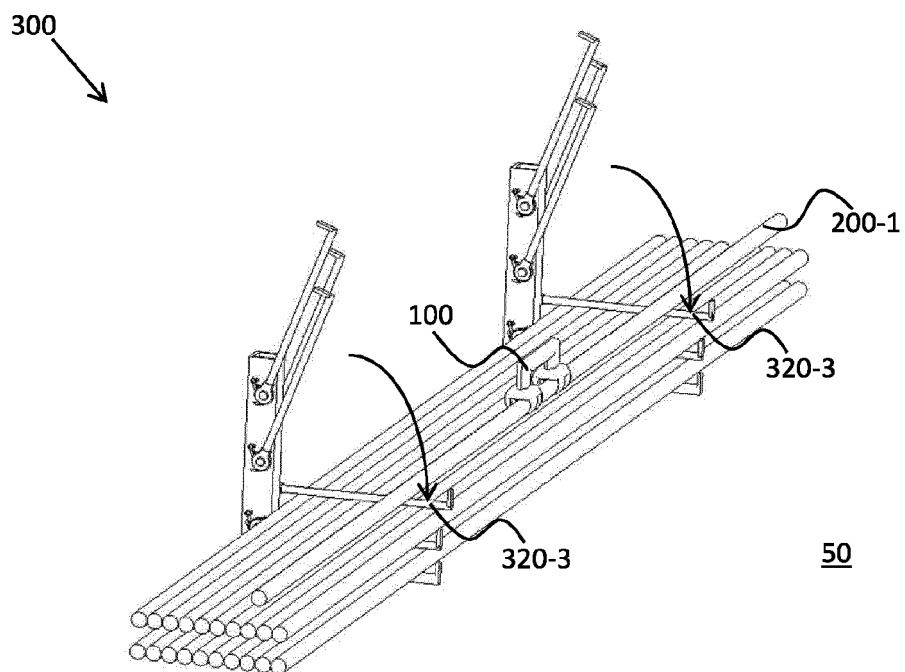


FIG. 10

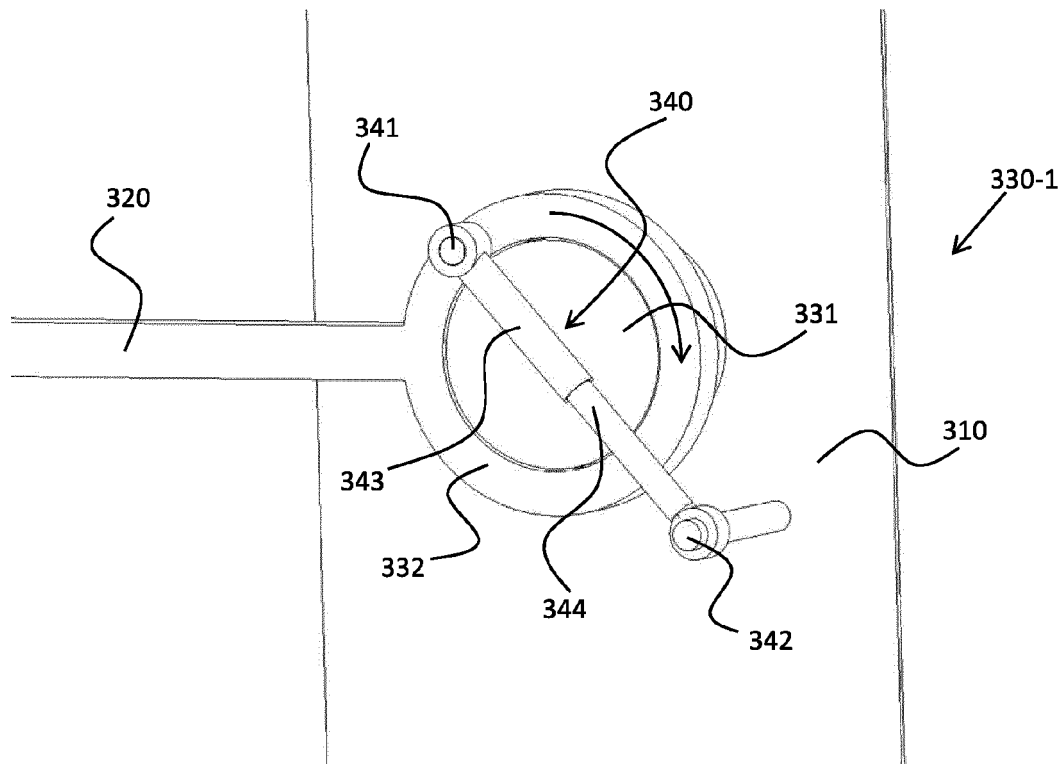


FIG. 11

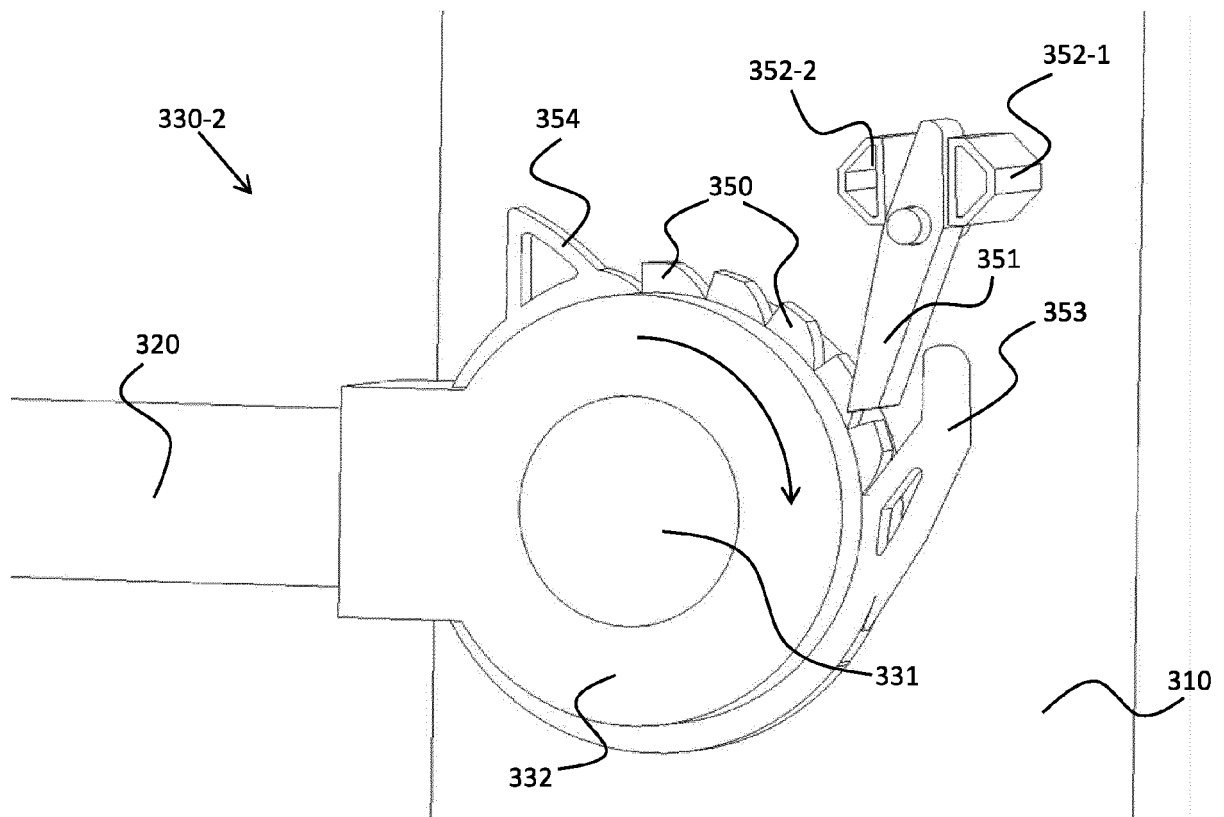


FIG. 12

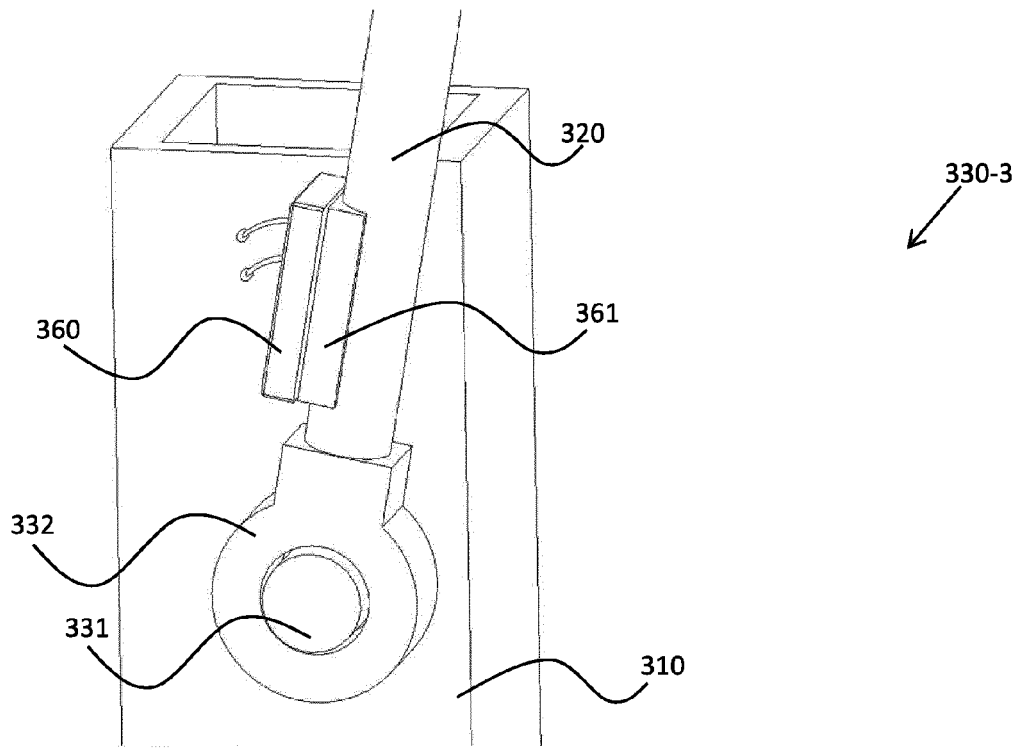


FIG. 13

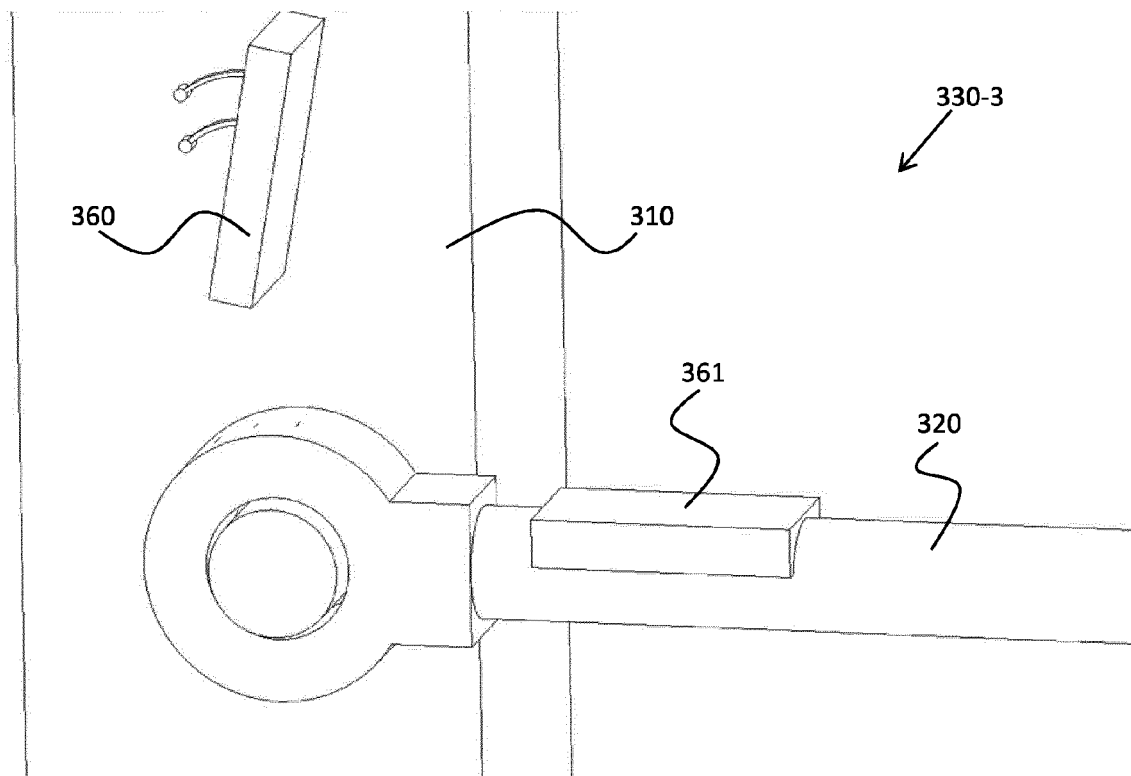


FIG. 14

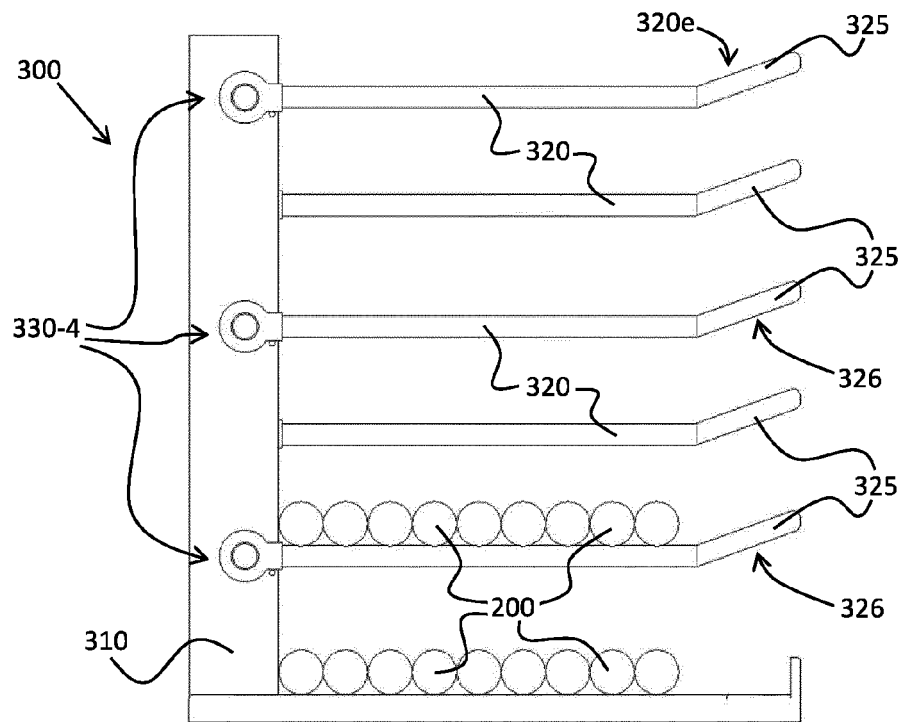


FIG. 15

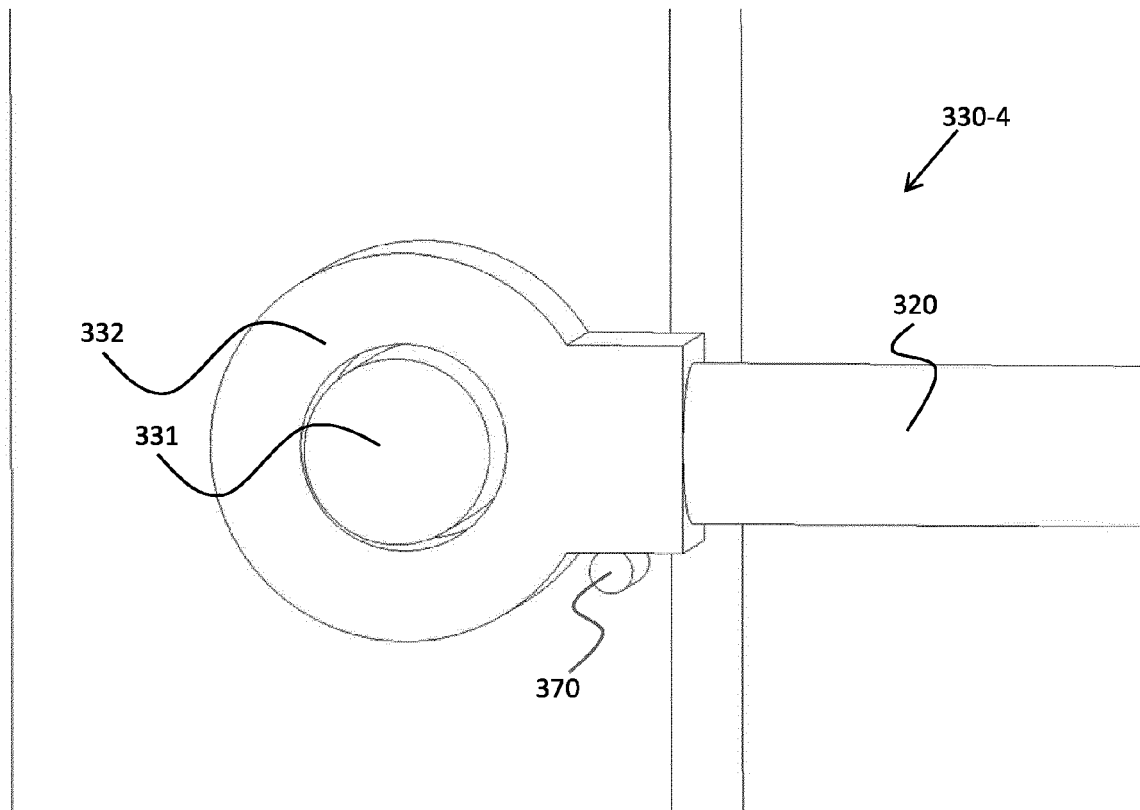


FIG. 16

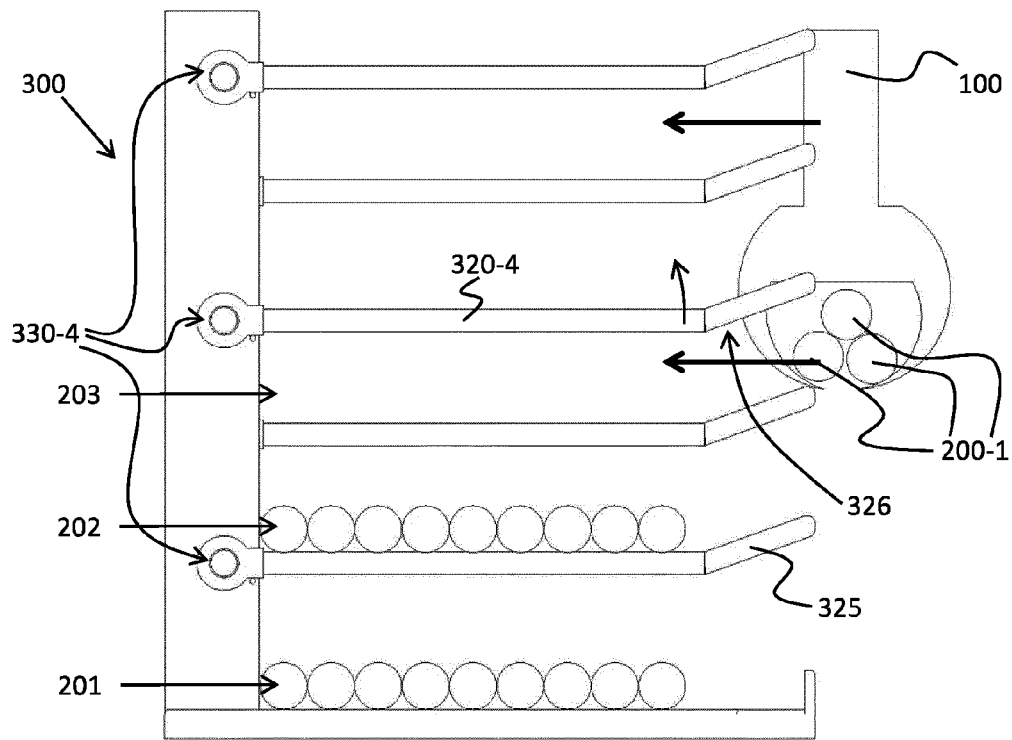


FIG. 17

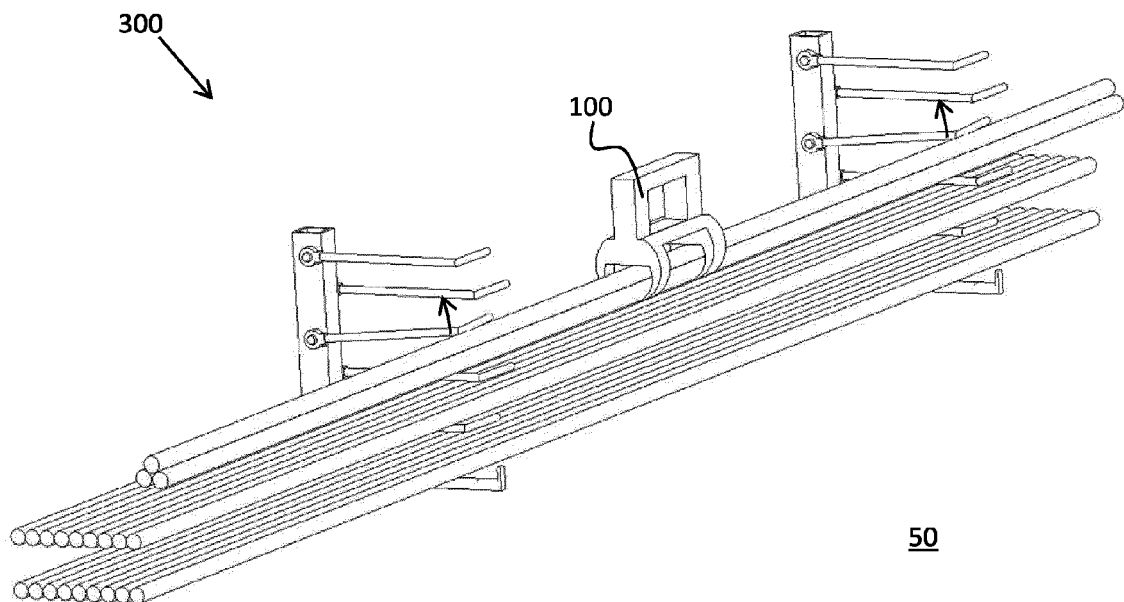


FIG. 18



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Y	* figures 1, 2, 4, 7-9 * * paragraphs [0001], [0036] - [0053] *	9,10	
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Place of search Munich		Date of completion of the search 5 December 2016	Examiner Posavec, Daniel
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 December 2016	Examiner Posavec, Daniel
CATEGORY OF CITED DOCUMENTS			
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