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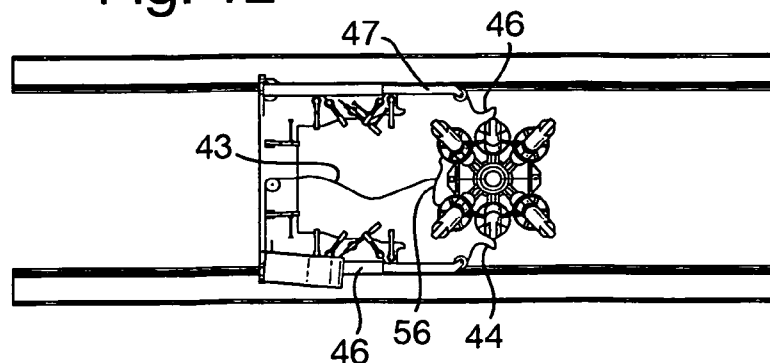
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(54) Title: A SEAFASTENING APPARATUS FOR A TENSIONER ASSEMBLY

Fig. 12



(57) Abstract: A seafastening apparatus (20; 40) comprises a movable frame (23; 49) having an opening (A) configured for receiving and at least partially supporting an equipment unit (70). Locking means (25a,b; 43, 44, 45, 48) are configured for selective locking and releasing of the equipment unit and hence controlling lateral movements of the equipment unit relative to the apparatus. The locking means comprise wires (43, 44, 45) configured for connection to the equipment unit and tensioners (53, 54, 55) configured for controlling the tension in each wire, and a pair of extendible and retractable arms (46, 47) are configured for conveying and guiding at least one of the wires.



A seafastening apparatus for a tensioner assembly

Field of the invention

5 The invention concerns devices for retraining and supporting equipment on a movable platform, such as a vessel floating in water. More specifically, the invention concerns a seafastening apparatus specified in the introduction to claim 1.

Background of the invention

10 In the offshore petroleum industry it is well known to use tensioner systems on floating drilling rigs and other vessels, in order to maintain a pre-selected vertical tension in a marine riser extending from the rig and down to a subsea wellhead. When the vessel is heaving and rolling due to waves, currents and winds, the tensioner system will try to keep constant tension in the riser.

15 One type of tensioner system which is known in the art, is termed a “direct acting tensioner” (DAT) system. In a typical arrangement on a drilling vessel, a DAT system basically comprises a number of hydraulic-pneumatic cylinders suspended underneath the drill floor in a circle-symmetrical configuration above the lower deck. The cylinders’ free (lower) ends are connected to a so-called tensioner ring, which may be connected to the riser.

20 When the DAT system is not in use, i.e. not being connected to the riser, the assembly is “parked” in a location away from the well centre, where it does not interfere with other operation taking place above or through the moonpool. However, as the drilling rig may be moving considerably in waves and swell, the cylinders (and thus the tensioner ring) of a parked DAT system is susceptible of swinging uncontrolled back and forth, with the risk of damaging adjacent equipment – as well as the cylinders themselves – and causing harm to personnel.

25 Methods and means of DAT system seafastening exist, commonly employing an arrangement of wires and winches. The known systems are, however, cumbersome and time consuming to connect and activate. In addition, the prior art seafastening systems induce large, undesired, forces on the cylinders and/or packing boxes. The uncontrolled movement of the DAT system also makes connecting the tensioner ring to the riser difficult and potentially dangerous.

30 Another problem with DAT systems arises when the tensioner ring is connected to the riser and the DAT system is in operation: Due to the rig motions, the hydraulic and/or pneumatic hoses extending from the pressure source and to each of the tensioner cylinders are swinging about in the moonpool in an uncontrolled manner, and are often damaged.

The state of the art includes US 2010/0047024 A1 (Curtiss), which describes an apparatus to restrain a riser tensioner of an offshore drilling rig when the tensioner

is not connected to a riser. The apparatus includes a restraint cone configured to fit within hydraulic cylinders of the riser tensioner, a hoist configured to extend and retract the restraint cone, and a tension member extending from a lower end of the restraint cone, the tension member configured to engage a lower end of the riser tensioner and maintain a wedging action between the restraint cone and the hydraulic cylinders.

The present inventor has devised and embodied this invention to overcome these shortcomings and to obtain further advantages.

Summary of the invention

The invention is set forth and characterized in the main claims, while the dependent claims describe other characteristics of the invention.

The purpose of the invention is to achieve a seafastening device for a DAT system or similar equipment which is safe and reliable, easy to assemble and disassemble, and does not subject the system to unwanted loads.

Another purpose of the invention is to provide a guiding device for aiding in the connection of the tensioner ring to the riser, and contribute to closing the hinged tension ring.

Another purpose of the invention is to provide a support element for DAT hoses, when the DAT system is in use in the moonpool.

It is thus provided a seafastening apparatus, characterized by a movable frame having an opening configured for receiving and at least partially supporting an equipment unit, and by locking means configured for selective locking and releasing of the equipment unit and hence controlling lateral movements of the equipment unit relative to the apparatus.

In one embodiment, the locking means comprise a pair of locking arms which by means of actuators are rotatable about respective joints on the frame and configured for extending at least partially around a circumference of the equipment unit in a region between the upper end and a lower end.

In one embodiment, the locking means comprise abutment portions for contact with corresponding abutment elements on the equipment unit. The abutment portions advantageously comprise an elastic, shock absorbing and abrasion reducing material.

In one embodiment, the locking means are arranged to rotate in a plane which is substantially perpendicular with respect to the equipment unit longitudinal axis.

The apparatus comprises in one embodiment one or more support devices for supporting hoses, cables and similar components extending from the equipment unit. The support device is advantageously rotatably connected to the frame at a

first end and is height adjustable with respect to the frame via actuation means. In one embodiment, the support device comprises an arc-shaped support tray.

In one embodiment, the apparatus comprises locking elements for fixing the locking means in position when they are in engagement with the equipment unit.

5 In one embodiment, the locking means comprise wires configured for connection to the equipment unit and tensioners configured for controlling the tension in each wire. A pair of extendible and retractable arms is arranged on the frame, each arm configured for conveying and guiding at least one of the wires.

10 In one embodiment, the opening is defined by support regions in the frame, said regions being shaped complementary with a corresponding portion of the equipment unit. The apparatus comprising in one embodiment fastening lugs for connection between the frame and selected portions of the equipment unit.

15 The apparatus advantageously comprises frame motion means and fixing means, whereby the apparatus is movable on a supporting surface and is releasably lockable with respect to the supporting surface. The motion means advantageously comprises wheels for interaction with rails and drive units. The apparatus and the equipment unit are in one embodiment arranged on a movable platform, such as a vessel floating in a body of water.

20 In one embodiment, the equipment unit comprises a Direct Acting Tensioner (DAT) unit, having a plurality of cylinders, each one suspended via a respective upper end to the structure above the apparatus, and each one connected at a respective lower end to a ring element for connection to a riser or similar.

Brief description of the drawings

25 These and other characteristics of the invention will be clear from the following description of a preferential form of embodiment, given as a non-restrictive example, with reference to the attached drawings wherein:

Figure 1 is an elevation view of the device according to the invention next to a DAT system on a drilling rig, the DAT system being connected to a riser;

30 Figures 2 and 3 are perspective views of a first embodiment of the device according to the invention;

Figure 4 is an elevation view of the device illustrated in figures 2 and 3;

Figure 5 is a perspective view of the device illustrated in figures 2 and 3, with the locking arms in an open position;

35 Figure 6 is a plan view of the device illustrated in figures 2 and 3, with the locking arms in a closed position, enclosing the DAT tensioner cylinders;

Figures 7, 8 and 9 are a perspective view, front view, and top view, respectively, of a second embodiment of the device according to the invention;

Figures 10, 11 and 12 are a perspective view, side view, and top view, respectively, of the second embodiment of the device according to the invention connected to DAT cylinders via stabilizing wires, and the wires are not tightened;

Figures 13 and 14 are a top view and a side view, respectively, of the second embodiment of the device according to the invention connected to DAT cylinders via stabilizing wires, and the wires have been tightened;

Figures 15, 16 and 17 are a side view, top view, and perspective view, respectively, of the second embodiment of the device according to the invention connected to DAT cylinders, showing a state where the telescopic arms have been retracted and the DAT cylinders are locked to the device;

Figure 18 is an elevation view of the device according to the invention, in a closed position, enclosing the tensioner cylinders, and in parked (seafastened) position to one side of the moonpool, and

Figure 19 is an elevation view similar to figure 18, illustrating a parked (seafastened) position to the other side of the moonpool.

Detailed description of preferential embodiments

Figure 1 shows part of a drilling vessel, which per se is known in the art (only parts which are relevant for the elucidation of this invention are illustrated). A DAT system 70, comprising a plurality of tensioner cylinders 73, is suspended underneath a drill floor 8, above a moonpool 7 in a lower deck 6. The cylinders 73 are suspended by a trip-saver 10, by means of which the DAT system (package of cylinders) may be moved back and forth above the lower deck and moonpool. The cylinders 73 are connected to a riser 1 via a tensioner ring 72, in a manner which is known in the art. In this configuration, the DAT system is operating to provide the required tension in the riser while drilling is taking place (rotary table 9 schematically illustrated on drill floor 8). Reference number 4 indicates a BOP crane.

Arranged on the lower deck 6 and resting on rails 5, adjacent to the moonpool 7, is a so-called DAT seafastening trolley 20; 40, i.e. the motion control and restraining device according to the invention. Hydraulic hoses 71, extending from on-board supply and control systems (not shown) to each of the tensioner cylinders 73, are supported by a support element on the DAT seafastening trolley, in a manner which is explained below.

Description of a first embodiment

Referring now to figures 2 - 6, illustrating a second embodiment, the support device 20 according to the invention comprises a u-shaped frame (or undercarriage) 23 supported via wheels 21 on tracks 5 (indicated in figure 3). The tracks are advantageously the BOP/x-mas tree tracks. The DAT seafastening trolley 20 is self-

propelled, via motors 22 and cogwheels 22' which interact with corresponding pinions (not shown) in the lower deck. Movable dowels 31 are provided for locking the trolley in a desired position against a corresponding interface (receptacle, etc., not shown) on the deck.

5 Locking arms 25a, 25b are arranged on respective sides of the opening "A" defined by the u-shaped frame, defining a gripping, or locking, jaw. Each locking arm is pivotally connected to the frame 23 via respective pivotal joints 27 and is operative to move (rotate) about its respective joint between an open position of the jaw (figure 5) and a closed position of the jaw (figures 2, 3, 5). Movements of the
10 locking arms 24a, 25b are effected by actuators 28 (e.g. hydraulic actuators). Hydraulic lines, cables, control systems, etc., which are required in order to operate the DAT seafastening trolley are not disclosed, as such items are well known in the art.

15 Each locking arm is provided with a protective fender 26 of an elastic and shock absorbing material, in order not to damage the tensioner cylinders.

Each locking arm is preferably provided with a mechanical locking device (not shown), whereby the arm may be fixed with respect to the frame when in the seafastening position.

20 Support trays 29 for cables, hoses, etc., are arranged on both sides of the jaw. Each support tray 29 is connected to the frame via respective hinges 32 and is height adjustable by means of actuators 28. Arrow denoted "R" on figure 4 indicates direction of tray movement.

Figure 6 illustrates the DAT seafastening trolley in position around the tensioner cylinders 73. Both locking arms 25a, 25b are in a closed position, abutting against
25 the cylinders 73. Each cylinder is preferably furnished with one or more fenders 74, extending along a portion of the cylinder. In this position, the locking arms provide lateral support for the tensioner cylinders, and thus an effective seafastening for the DAT system.

Description of a second embodiment

30 Referring now to figures 7 – 17, illustrating a second embodiment, the support device 40 according to the invention comprises a u-shaped frame (or undercarriage) 49 supported via wheels on tracks as described above. The DAT seafastening trolley 40 is self-propelled, via motors 22 and cogwheels 22' which interact with corresponding pinions (not shown) in the lower deck. Movable dowels (not shown)
35 may advantageously be provided for locking the trolley in a desired position, similar to the first embodiment. Support trays 29 for cables, hoses, etc., are arranged on both sides of the jaw. Each support tray 29 is connected to the frame in a manner similar to that of the first embodiment, described above.

The u-shaped frame 49 has a rear support region 50a and two side support regions 50b,c, together defining an opening "A" Each support region may be provided with protective fenders (not shown).

5 Arranged on each side of the u-shaped opening A are two arms 46, 47, each of which is telescopically movable between an extended position (see e.g. figure 12) and a retracted position (see e.g. figure 16). Each arm comprises a sheave 51 in the tip region and a rearward sheave 52. A first wire 44 runs from a first linear tensioner 54, via a rearward sheave 52, through the right-hand arm 46 and over the forward sheave 51. Similarly, a second wire 45 runs from a second linear tensioner 10 55, via a rearward sheave 52, through the left-hand arm 47 and over the forward sheave 51. A third wire 43 runs from a third linear tensioner 53, via a rearward sheave 52' and into the opening A near the rear support region 50a.

A number of seafastening lugs 48 are arranged on the frame 49, around the opening, each of which is configured for connection the DAT cylinders.

15 Figures 10 – 12 show the DAT seafastening trolley 40 arranged on a pair of rails 5 and being connected to DAT cylinders 73. The DAT cylinders are typically suspended by a trip saver 10, having pinions 11 which ride on a rack 12 which is connected to the underside of the drill floor 8. This trip-saver arrangement is illustrated schematically on figures 1, 11, 14, 15, 18 and 19, but has been omitted from the other figures. The rails 5 for the trolley are arranged on the lower deck 6, 20 as shown in figure 1. However, the deck structures have been omitted from figures 7 – 17. In the state illustrated in figures 10 – 12, the first wire 44 and the second wire 45 are connected to respective DAT cylinders, and the third, central, wire 43 is connect to the two rearmost DAT cylinders via a crow foot or yoke 56. Each DAT 25 cylinder is furnished with a protective collar 77, to which the wires also may be connected. The wires are slack, allowing DAT movement. In this state, the DAT system is typically connected to the riser (not shown) via the tensioner ring 72, and the DAT cylinders move with the riser (in fact, the rig is moving, and the riser and cylinders are connected to the seabed and are not moving). This configuration of the 30 DAT seafastening trolley is typically used when preparing to open the tensioner ring and disconnect the DAT cylinders from the riser.

Figures 13 and 14 show a state where the wires 43, 44, 45 have been tightened (by the linear tensioners) in order to hold the DAT cylinders still. The tensioner ring 72 is open, allowing the trolley and DAT system to move away from the riser 1. The 35 linear tensioner (compensators) are active in this state. The tensioner ring is subsequently closed and the DAT cylinders are pulled into the opening A by retraction of the arms 46, 47 and a further tightening of the wires.

Figure 15, 16 and 17 show the DAT cylinders fully retracted into the DAT seafastening trolley, bearing against the complementary shaped support regions 50a- 40 c and locked to the frame by the lugs 48. Turnbuckles 42 on the frame, connectable

to the seafastening lugs, prevent rotation of the lugs. The arms 46, 47 are fully retracted. . In this position, the locking DAT seafastening trolley 40 provides lateral support for the tensioner cylinders, and thus an effective seafastening for the DAT system.

- 5 Hydraulic lines, cables, control systems, etc., which are required in order to operate the DAT seafastening trolley are not disclosed, as such items are well known in the art.

10 Alternative seafastening positions are illustrated by figures 18 and 19, i.e. showing the DAT system and DAT seafastening trolley 20; 40 in “parked” positions on respective sides of the moonpool. The tensioner cylinders are retracted. In the position illustrated by figure 18, the DAT hoses 71 are supported by the support trays 29. This hose support feature is also shown in figure 1, where the trays 29 provide support for the hoses 71 even when the DAT is connected to and providing tension on the riser 1.

- 15 The DAT seafastening trolley may also be used when the DAT system is to be moved (by means of the trip-saver) from a “parked” position (figures 18 or 19) to an operative position over the moonpool 7 (figure 1). Having the DAT seafastening trolley thus connected to the DAT system during this procedure ensures that the relocation of the DAT system and connecting the tensioner ring to the riser may be
20 performed in a controlled and safe manner.

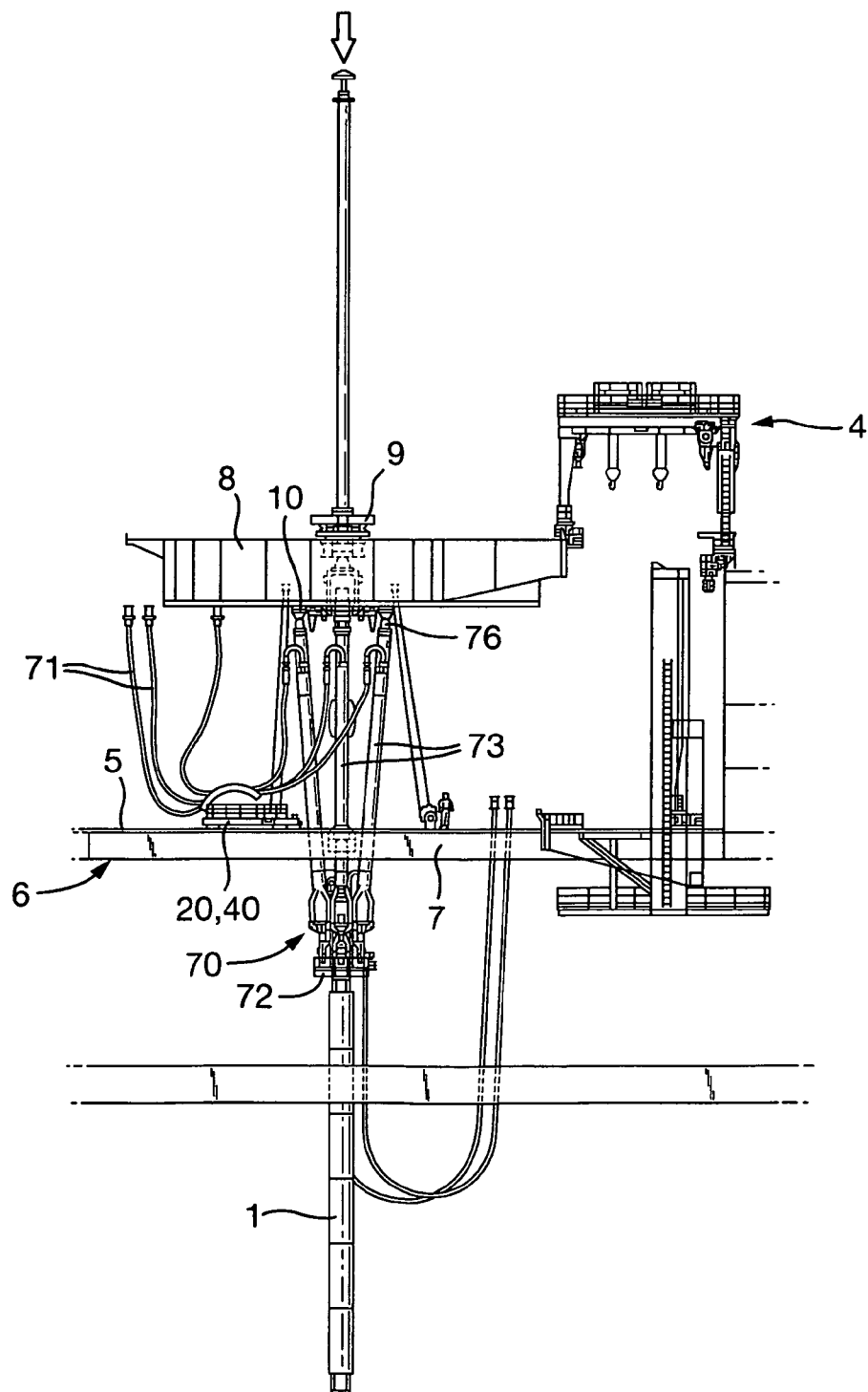
Claims

1. A seafastening apparatus (20; 40), **characterized by**
a movable frame (23; 49) having an opening (A) configured for receiving and at
least partially supporting an equipment unit (70), and by locking means (25a,b; 43,
5 44, 45, 48) configured for selective locking and releasing of the equipment unit and
hence controlling lateral movements of the equipment unit relative to the apparatus.
2. The apparatus of claim 1, wherein the locking means comprise a pair of
locking arms (25a, 25b) which by means of actuators (28) are rotatable about
respective joints (27) on the frame and configured for extending at least partially
10 around a circumference of the equipment unit in a region between the upper end and
a lower end (72).
3. The apparatus of any one of the preceding claims, wherein the locking arms
(25a,b) are arranged to rotate in a plane which is substantially perpendicular with
respect to the equipment unit longitudinal axis.
- 15 4. The apparatus of any one of the preceding claims, further comprising locks
for fixing the locking arms (25a,b) in position when they are in engagement with the
equipment unit.
5. The apparatus of claim 1, wherein the locking means comprise wires (43, 44,
45) configured for connection to the equipment unit and tensioners (53, 54, 55)
20 configured for controlling the tension in each wire.
6. The apparatus of claim 5, further comprising a pair of extendible and
retractable arms (46, 47), each arm configured for conveying and guiding at least
one of the wires.
7. The apparatus of claim 5 or claim 6, wherein the opening (A) is defined by
25 support regions (50a-c) in the frame, said regions being shaped complementary with
a corresponding portion of the equipment unit.
8. The apparatus of any one of claims 5 – 7, further comprising fastening lugs
(48) for connection between the frame and selected portions of the equipment unit.
9. The apparatus of any one of the preceding claims, further comprising frame
30 motion means (21, 22, 22') and fixing means (31), whereby the apparatus is
movable on a supporting surface (6) and is releasably lockable with respect to the
supporting surface.
10. The apparatus of claim 9, wherein the motion means comprises wheels (21)
for interaction with rails (5) and drive units (22, 22').
- 35 11. The apparatus of any one of the preceding claims, wherein the apparatus and
the equipment unit are arranged on a movable platform, such as a vessel floating in
a body of water.

12. The apparatus of any one of the preceding claims, wherein the equipment unit comprises a Direct Acting Tensioner (DAT) unit, having a plurality of cylinders (73), each one suspended via a respective upper end (76) to a structure (8) above the apparatus, and each one connected at a respective lower end to a tensioner ring (72) for connection to a riser (1) or similar.
- 5

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Fig. 1



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Fig. 2

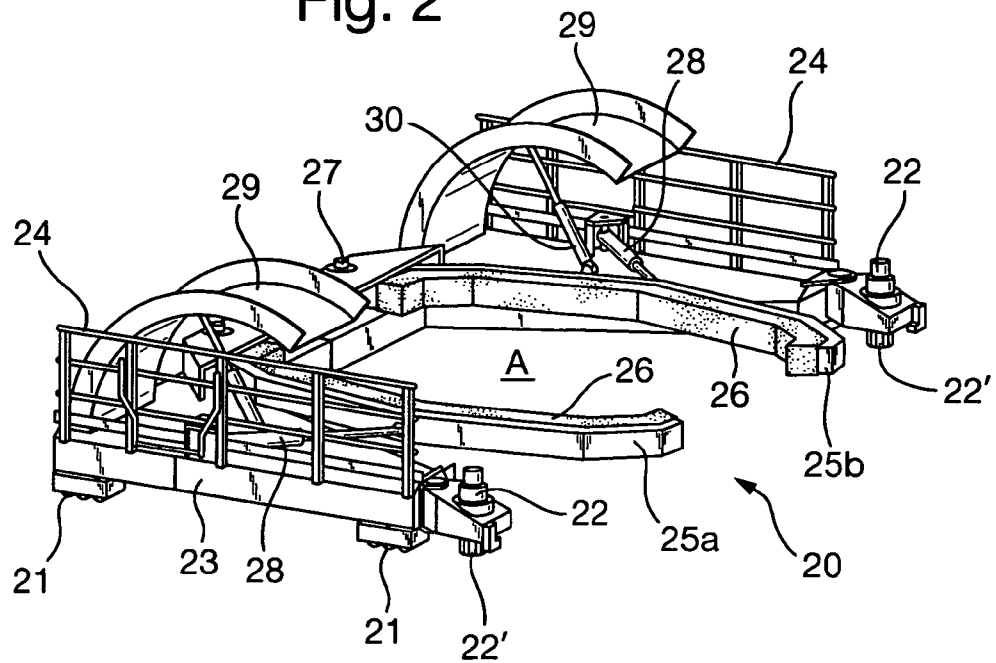
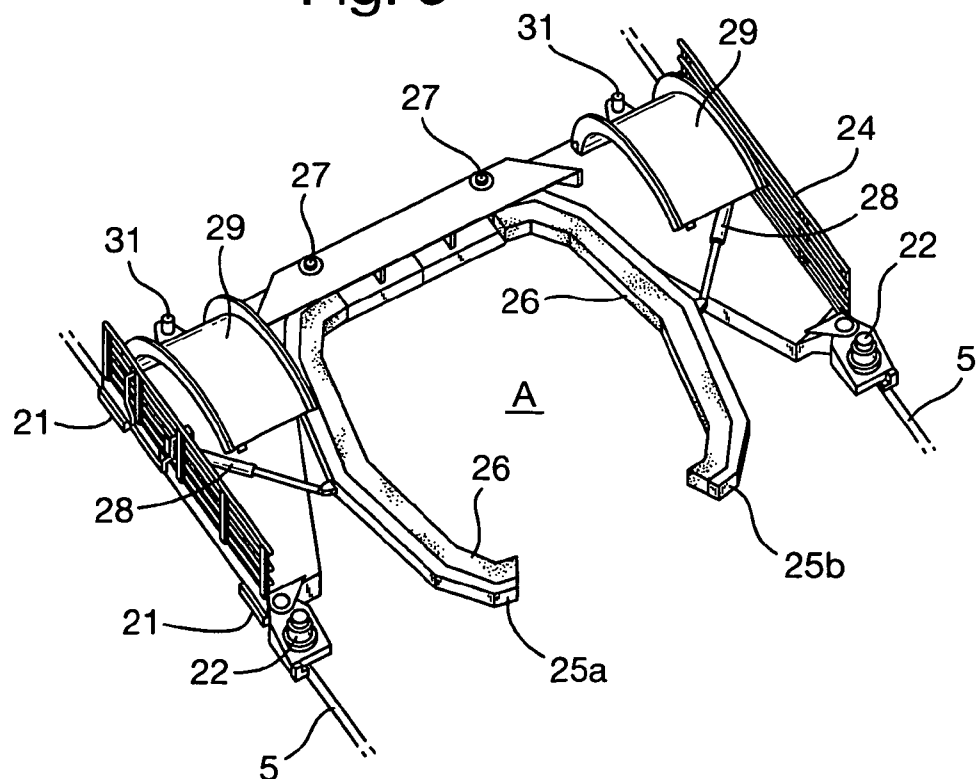


Fig. 3



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Fig. 4

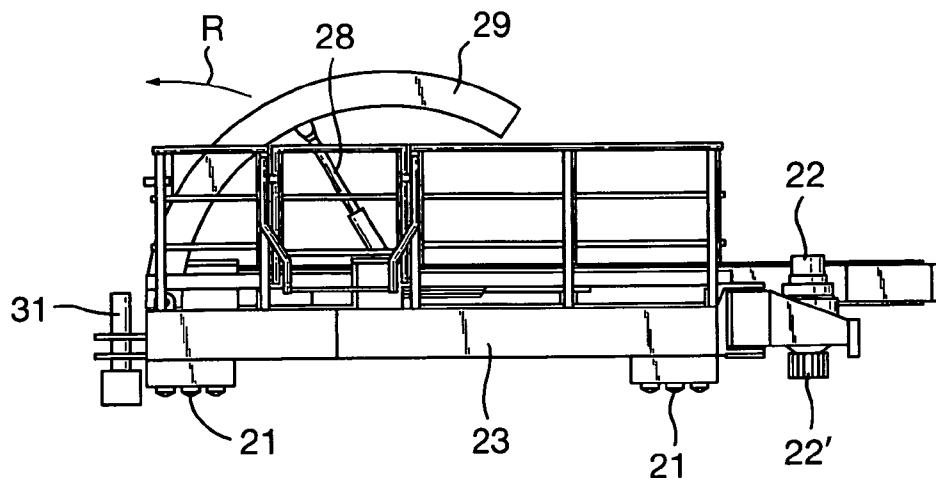
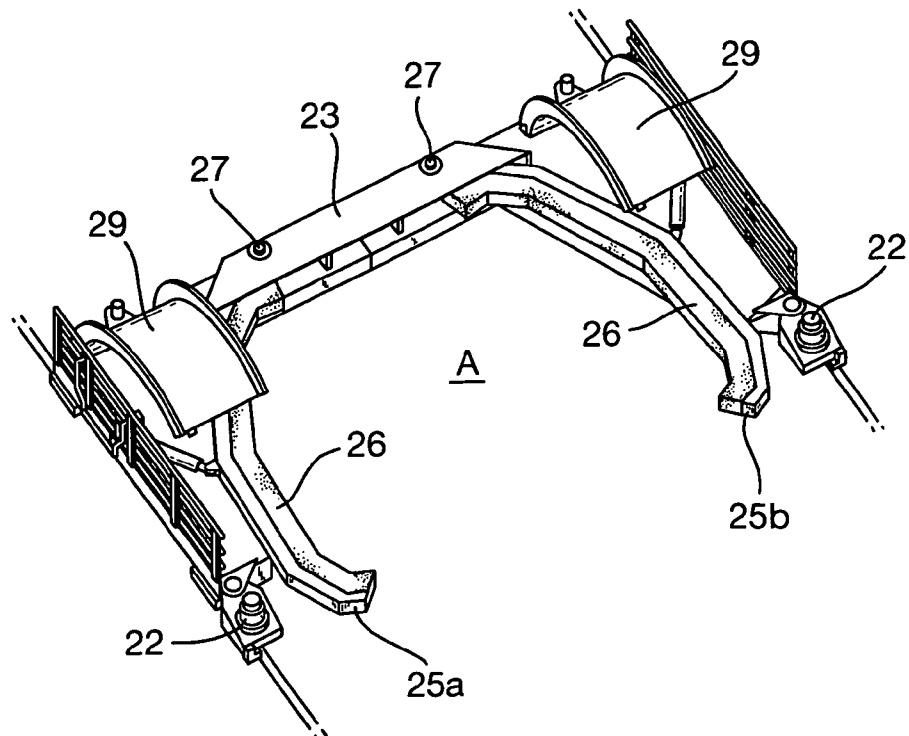
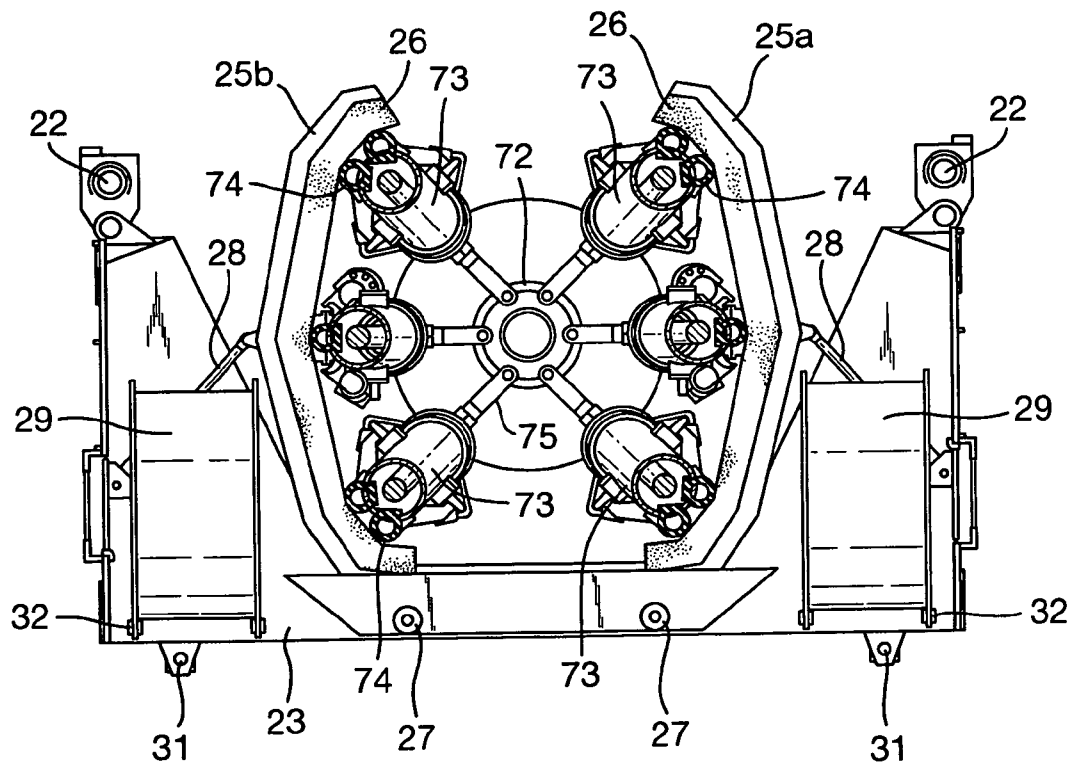


Fig. 5



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Fig. 6



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Fig. 7

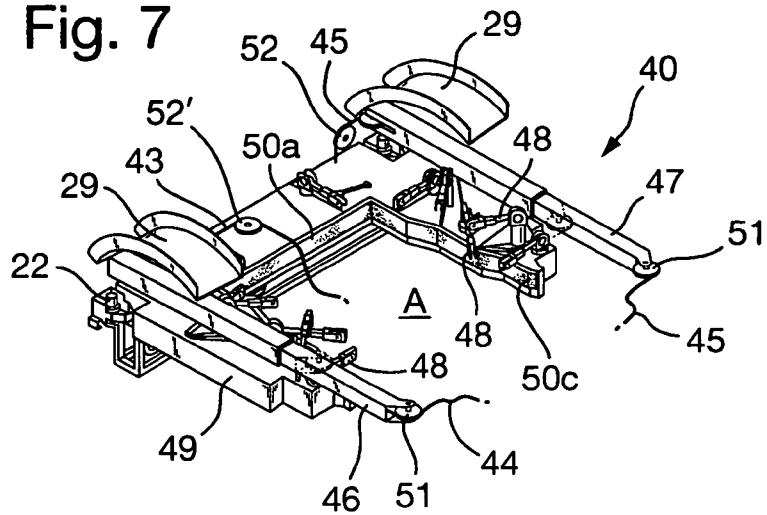


Fig. 8

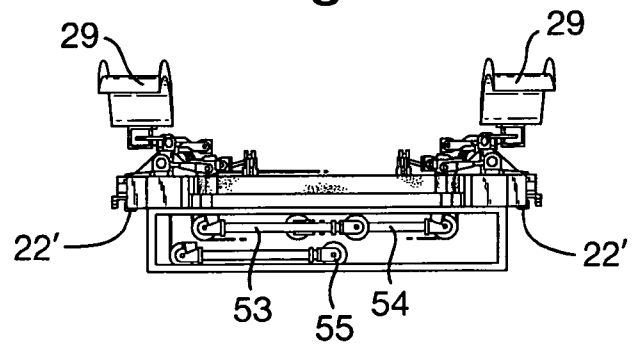
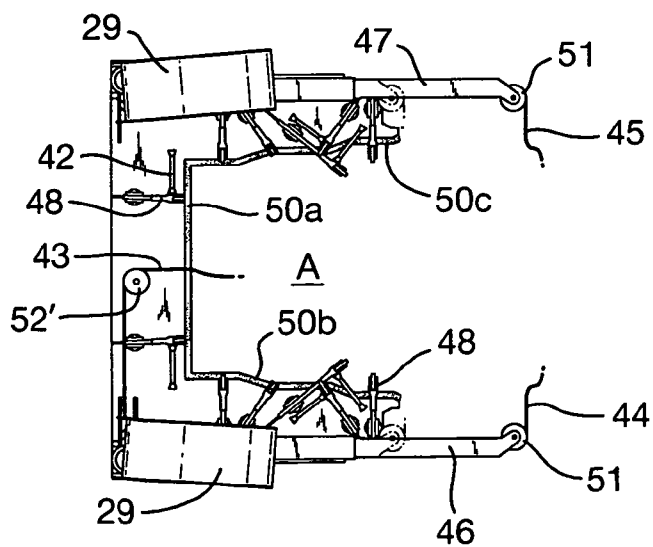


Fig. 9



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Fig. 10

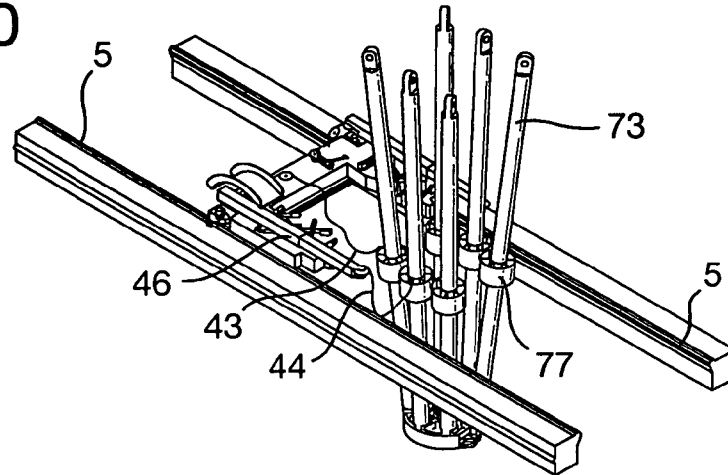


Fig. 11

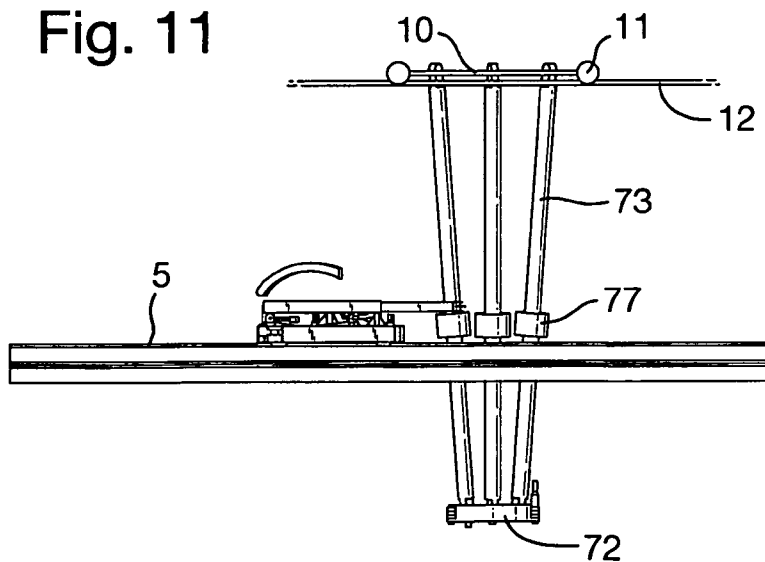
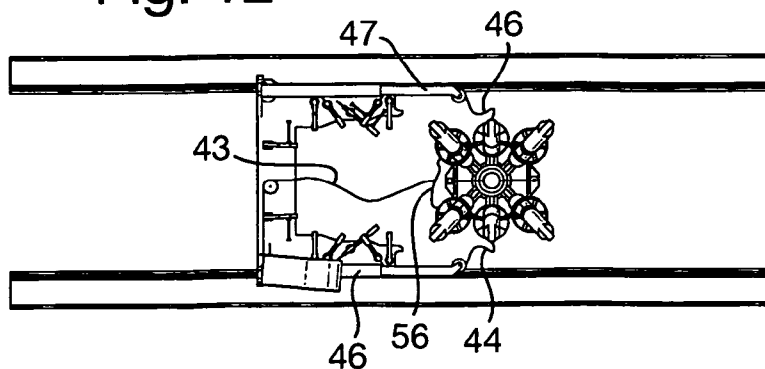


Fig. 12



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Fig. 13

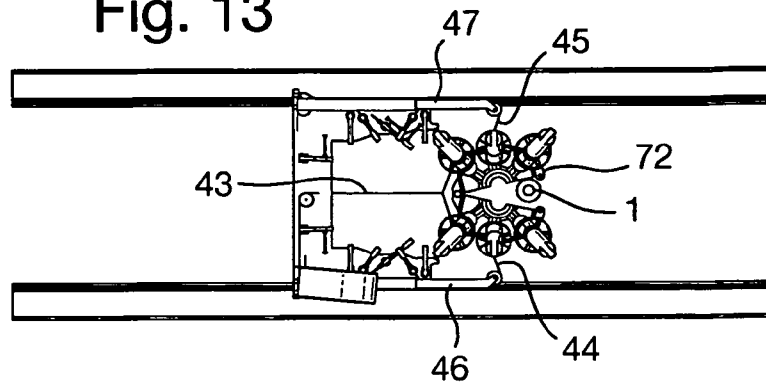


Fig. 14

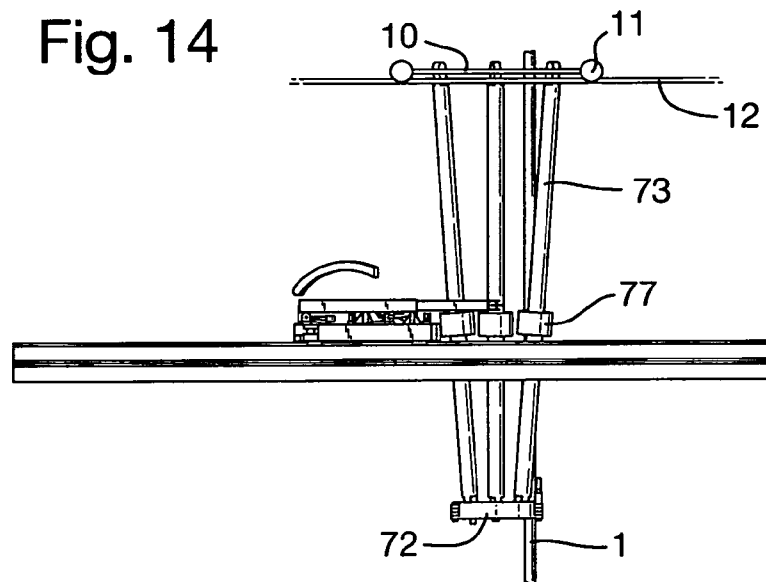
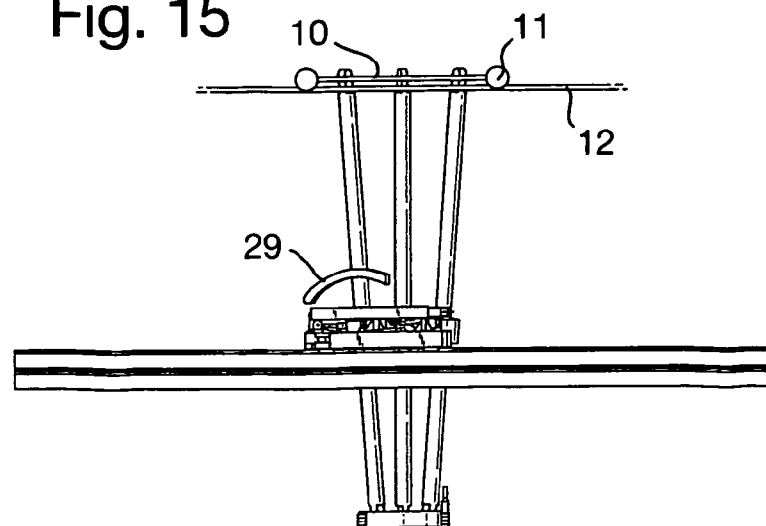


Fig. 15



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Fig. 16

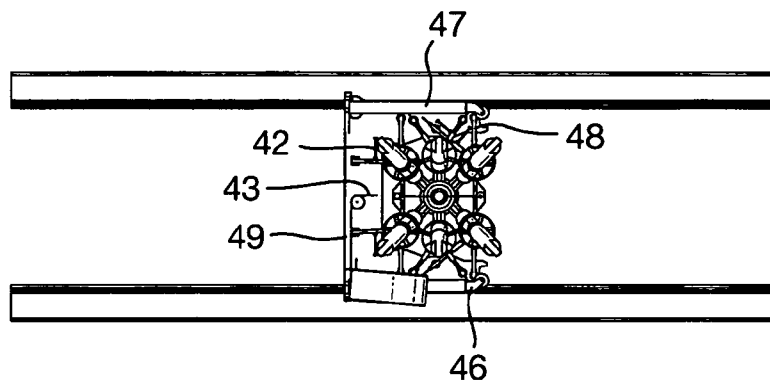
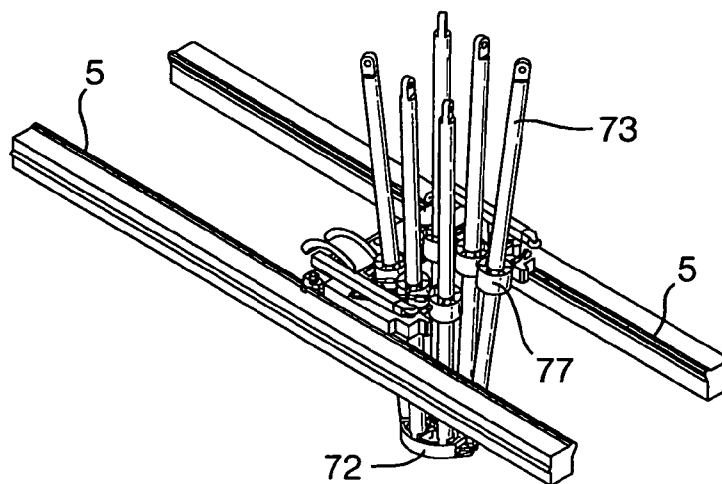


Fig. 17



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Fig. 18

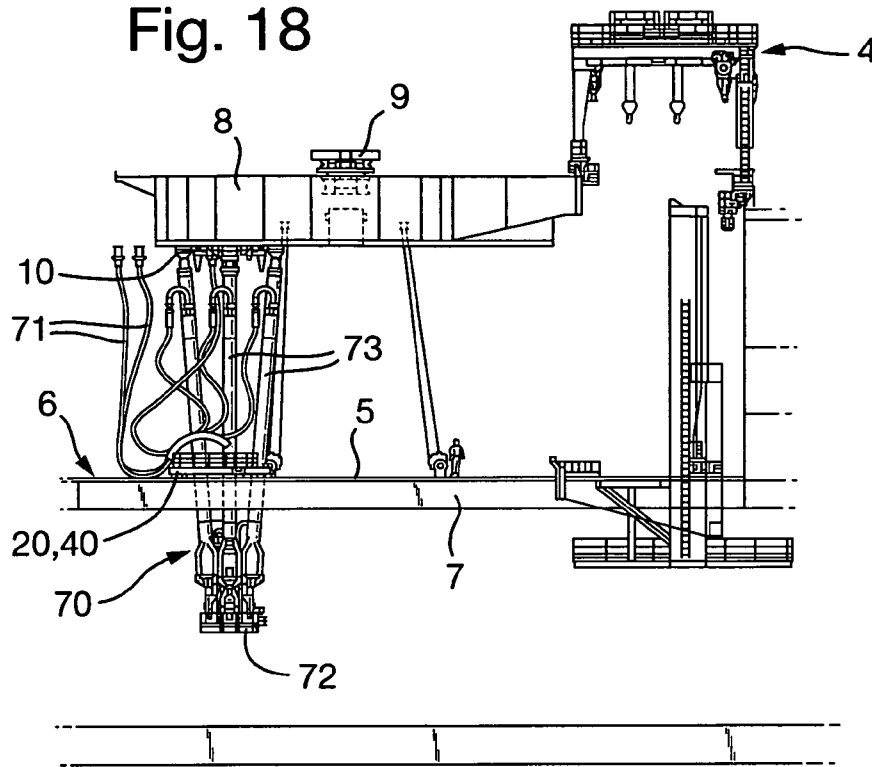


Fig. 19

