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Description

[0001] The present invention relates to offshore structures such as for example, relocatable oil production platforms.

[0002] It is known in the art to provide offshore structures for use in oil production having a base, a number of legs and a platform which are pre-assembled before the entire structure is then transported to the production site. However, the transportation and installation of such structures is extremely costly and time consuming so that they are not easily relocatable.

[0003] Therefore it has been proposed in the art to provide offshore platforms in which a jacking system is used to lower the base to the seabed and to raise the platform to the required height above the base. Thus, ideally the deck or platform may be easily lowered and the base may be easily raised so that the entire structure can then be moved to a new site. Such platforms have a plurality of legs, a base and a platform and a rack and pinion type of jacking device has been used to raise and lower the base and platform as required. The rack and pinion provides a guide for the base and platform as they are being raised and lowered and also can be locked off so as to hold the platform at the required height while the rig is in use.

[0004] However, the jacking equipment required for such decks is expensive to produce and, in addition, as it remains permanently attached to the deck, it requires regular maintenance which is also extremely costly. Thus, if it were possible to remove the jacking system from the structure after installation, substantial savings could be made.

[0005] The present invention therefore seeks to provide an improved offshore structure in which a jacking system is not used to hold up the deck.

[0006] US-A-3,974,657 discloses an offshore structure comprising a base, a deck having two substantially parallel side edges and a plurality of legs extending between the base and the deck, wherein the legs are arranged outboard of the parallel side edges and a permanent connection is provided between each said leg and the deck.

[0007] The present invention is characterised over US-A-3,974,657 in that each said leg is a lattice leg comprising a vertically extending chord at each corner thereof, and in that the permanent connection comprises a shear plate attached substantially vertically between the deck and each said leg chord and is provided between an inwardly facing face of each said leg and the deck.

[0008] By providing legs located outboard of the platform, the deck may be raised to the required height relatively easily. Also, the formation of the connection between the legs and the deck allows the jacking system easily to be removed after installation. Thus, a standard jacking system can be hired for the duration of the installation of the structure, avoiding the manufacturing and maintenance costs involved with the permanent jacking

systems of the prior art.

[0009] Preferably the deck is formed so that it does not include recesses for the legs. Preferably the deck is generally rectangular.

5 **[0010]** Most preferably the jacking system provided to raise the deck is also arranged entirely outside the line of the deck.

[0011] Preferably each chord of each lattice leg is circular in cross-section.

10 **[0012]** Further, the lattice leg may be of any shape which satisfies the design requirements for a particular structure. However, preferably the lattice leg is triangular.

[0013] In certain design situations, the chord of the leg could be of sufficient strength for the required loading. However, preferably the connection further comprises a stiffening plate extending through a diameter of the tubular member, wherein a first end of the shear plate is welded to the stiffening plate and the shear plate and the stiffening plate are substantially aligned.

20 **[0014]** This provides a relatively simple means of connecting the shear plate to the tubular member and also provides extra strength in the structure.

[0015] In the event that the base of the structure was lying level on the seabed, the deck could be raised to the same height on each of the legs of the structure. However, in order to provide tolerances in the level of the deck relative to the legs, thus allowing for different seabed conditions, the stiffening plate preferably extends over a greater length of the chord than the length of shear plate.

30 **[0016]** Thus, the shear plate need not be accurately aligned in the vertical direction before being welded to the stiffening plate.

[0017] Preferably, tolerance in the distance between the inboard end of the shear plate and the deck edge is also accommodated. Thus, preferably the inboard end of the shear plate is welded between two plates extending outwardly from the deck edge.

40 **[0018]** Preferably, the shear plate as described above carries only the shear forces between the platform and the legs. Therefore, the connection preferably further comprises at least one further coupling plate attached horizontally between the deck and the leg chords. This plate may carry tensile and compressive forces and bending moment loading applied between the deck and the legs.

[0019] The coupling plate could be attached to the tubular chord and the deck in any suitable manner. Preferably however, the coupling plate has a cut-out in its end facing the leg chord, such that a part of the periphery of the leg chord is received within the cut-out. More preferably still, the cut-out is elliptical in shape. Therefore, a degree of tolerance in angular misalignment of the platform relative to the tubular leg is provided.

50 **[0020]** Although the coupling plate may be attached to the deck in any suitable manner, it is desirable that the plate be relatively simple to connect to the deck onsite. Preferably therefore, a horizontal web is attached to the

deck and the coupling plate is butt welded thereto.

[0021] The coupling plate could be designed so as to be of sufficient strength itself to carry the necessary loading. However, preferably plate stiffeners extending from the inboard end to the outboard end and most preferably across the deck web are provided in the coupling plate. Still more preferably, a coupling plate is provided both at the top and the bottom of the shear plate.

[0022] Although it may be possible to attach the plates together in various ways, each coupling plate is preferably welded to the shear plate at the join between the plates.

[0023] Although a single connection could be provided between each of the legs and the deck, in a preferred embodiment of the invention, the connection is formed between the deck and two leg chords located at either end of the inwardly facing face of the lattice legs. Such an arrangement allows a stable connection to be formed between each leg and the deck.

[0024] In addition to the structure described above, a method of installing an offshore platform having some of the above described features is believed to be novel and inventive in its own right. Therefore, from a second aspect, the present invention provides a method of installing an offshore structure comprising a base, a deck having two substantially parallel side edges, and a plurality of lattice legs located outboard of the parallel side edges, each said lattice leg comprising a vertically extending chord at each corner thereof, the method comprising the steps of: installing the base on the seabed; jacking the deck to the required height; forming a permanent connection between the deck and an inwardly facing face of each of the legs by attaching a substantially vertically extending shear plate between a chord of each lattice leg and the deck edge; and removing the jacking system from the structure.

[0025] As the legs of the structure are located entirely outboard of the deck, the deck may be jacked up the leg relatively easily without a high risk of it becoming obstructed. In addition, the removal of the jacking system allows the installation of the structure to be carried out at a significantly reduced cost.

[0026] Also, the jacking mechanism is also preferably entirely located outside the line of the deck.

[0027] Although as stated above, the deck would be unlikely to become obstructed when being jacked up the legs, guides are preferably provided on the deck so as to guide the deck as it is jacked up the leg. Thus, in severe wave and wind conditions as are often found on site, the deck is hindered from moving excessively relative to the legs. However, guides may not be necessary depending on the size of the platform, water depth and other factors.

[0028] There will be many possible ways of assembling the base, deck, legs and guides relative to one another prior to installation of the platform. However, preferably, the method of installing the offshore structure further comprises the steps of: attaching four legs to the base; attaching two guides to the deck; floating the deck over

the base so that it passes between the legs until the guides engage two of said legs; and attaching two guides to the deck.

[0029] Thus two guides are installed after the deck has been floated into position so that they do not interfere with the positioning of the deck.

[0030] Preferably, the guides comprise beams attached to and projecting from the deck and being shaped for engaging a chord of a said leg.

[0031] Preferably, the deck is located relative to the legs prior to formation of the permanent connection. This allows some elements of the permanent connection to be prefabricated as their approximate dimensions will be known. In addition, as the deck cannot move relative to the legs once it has been located, the permanent connection is easier to make.

[0032] Preferably, the deck is located by pulling the leg towards the deck so as to hold a leg chord against the guide. Still more preferably, a hydraulic tugger is provided between an outer edge of the leg and the deck so as to pull the leg towards the deck.

[0033] In the method described above, the legs might skew slightly when the hydraulic tugger is tightened. This is because, the leg chord adjacent the guide would be held in position so that the other leg chord adjacent the deck would continue to be pulled towards the deck, effectively pivoting the leg about the guide. Therefore, hydraulic screw jacks are preferably provided at the base of the platform so as to push the inboard leg chords away from the lower deck edge, thus locating the leg squarely adjacent the deck edge.

[0034] Each of the legs could be located relative to the deck one by one and the permanent connection formed after each leg was located. However, preferably, the deck is pulled towards each of the legs simultaneously. This allows the location of the deck relative to the legs to be adjusted so as to provide a relatively even gap between each of the legs and the deck.

[0035] Preferably, the permanent connection is formed by welding the substantially vertically extending shear plate between a chord of the lattice leg and the deck edge. Still more preferably, a stiffening plate is provided through a diameter of the leg chord, and a first side edge of said shear plate is welded to said stiffening plate, and said shear plate and said stiffening plate are substantially aligned.

[0036] In order to allow for tolerance in the vertical level of the deck relative to the leg, the stiffening plate preferably extends over a greater length of the leg chord than the length of the shear plate.

[0037] In order to provide tolerance in the horizontal dimensions of the gap between the deck edge and the inboard edge of the stiffening plate, two plates are preferably welded to the deck edge on respective sides of the shear plate and extending outwardly from the deck edge, and the inboard end of the said shear plate is preferably welded between the two plates.

[0038] Preferably, the shear plate carries shear forces

only such that the web plate does not have to line up precisely with the bulkhead of the deck. Therefore, the connection further preferably comprises a further coupling plate attached horizontally between the deck and the leg chord, the second plate having a cut-out in an edge facing the leg chord, such that a part of the periphery of the leg chord is received within the cut-out. Still more preferably, the cut-out is elliptical in shape.

[0039] Although sufficient strength could be provided by a single coupling plate located either above or below the shear plate, preferably, a coupling plate is provided at the top and the bottom of the shear plate. Still more preferably, the shear plate and the coupling plate are welded together.

[0040] A preferred embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a side elevation of an offshore structure; Figure 2 is a side elevation of the structure of Figure 1, showing the deck and the base in their final positions relative to the legs;

Figures 3.1 to 3.12 are a series of schematic drawings showing the construction and installation sequence of the offshore structure;

Figure 4 is a side elevation of a leg of the offshore structure, showing the arrangement of a jacking system relative to the leg;

Figure 5 is a top plan view of the offshore structure, showing the arrangement of installation guides relative to the legs of the structure;

Figure 6 is a detail as shown at A on Figure 5;

Figure 7 is a plan view of a leg of the structure showing how the leg is located relative to the deck;

Figure 8 is a section through AA of Figure 7;

Figure 9 is a perspective view showing the connection made between a chord of a leg of the structure and the platform;

Figure 10 is a top plan view of the connection between a leg of the structure and the platform;

Figure 11 is a section along line 1-1 as shown in Figure 10;

Figure 12 is a detail at point A as shown in Figure 11;

Figure 13 is a detail at point B as shown in Figure 10; and

Figure 14 is a section along line 2-2 of Figure 12.

[0041] As shown in Figures 1 and 2, an offshore production platform 2 is provided having a concrete gravity base 4 of conventional construction, four triangular section lattice legs 6, and a deck 8. When installed, the gravity base 4 lies on the seabed and a permanent connection is provided between the deck 8 and the legs 6 which are arranged outboard of the deck 8, which carries conventional topsides equipment.

[0042] As is further shown in Figure 2, lifting beams 10 are provided at the top of each of the lattice legs 6. During installation a jacking system, which will be discussed later

will be attached between the lifting beams 10, the deck 8 and the base 4 so that the base and deck may be raised and lowered relative to one another.

[0043] The basic steps involved in the construction and installation of the various components of the offshore structure will now be described with reference to Figures 3.1 to 3.12.

[0044] As shown in Figure 3.1, the deck 8 of the structure is constructed at an onshore site. The deck 8 is of a generally standard rectangular construction and is designed to float, which avoids the need to use separate barges when transporting the structure to the installation site as will be shown below. In particular, the deck will provide buoyancy to transport the platform from its place of fabrication to the offshore site, will assist in installing the platform at that site, refloat the platform at the end of its useful life at that site, transport it to another site, and eventually remove the platform to shore to be scrapped.

[0045] The deck 8 is then launched onto a semi-submersible barge 12 which is submerged so that the deck 8 floats off onto the water (Figures 3.2 and 3.3). The deck 8 is then towed to a fitting out quay where the topsides are installed on the deck (see Figure 3.4).

[0046] Figures 3.5 to 3.8 show the construction and installation of the gravity base 4 and legs 6 of the structure. As shown in Figure 3.5, the legs 6 and the base 4 are constructed on shore, one of the legs 6 then being attached to each of the four corners of the base 4 in a conventional manner. A jacking system (not shown) is then assembled between the base 4 and the legs 6. In particular a plurality of strand jacks are connected between the lifting beams 10 at the tops of the legs 4 and the gravity base. The jacking system is arranged outboard of the line of the deck 8.

[0047] Next, the base 4 is launched onto a semi-submersible barge 12, the barge is submerged and the base and legs are floated off the barge. The base 4 is then sunk in the shallow water close to the shore in preparation for mating with the deck 8.

[0048] As shown in Figure 3.9, to mate the base 4 and deck 8, the deck 8 is towed between the legs 6 so that it is positioned over the base 4. As shown in Figures 5 and 6, four guide members 14 are provided on the deck 8 so as to aid in installation of the structure. Each guide member 14 is made up of a steel beam having an L-shaped recess 16 in one end thereof. The recess 16 has a hardwood facing 17 to minimise contact damage. Two of the guide members 14 at one end of the deck 8 are attached to the upper surface of the deck 8, one on either side thereof, prior to engagement of the base 4 and deck 8, so that as the deck is towed between the legs 6, it will come to rest against two legs 6 of the structure when the respective guide members 14 abut these legs 6. Thus, the guide members are used loosely to locate the deck relative to the legs 6.

[0049] Once the deck 8 is in position over the base 4, the other two guide members 14 are fixed to the deck, with the other two legs received within the recesses 16

thereof. A clearance is left between them so as to allow for tolerances later on in the installation process. The deck 8 and base 4 are then firmly secured together by jacking the base 4 up against the deck 8. The assembly is then towed offshore to the installation site as shown in Figure 3.10.

[0050] On arrival at the installation site, the base 4 is lowered to the seabed 18 as shown in Figure 3.11 and the platform is then jacked up to the required elevation as shown in Figure 3.12. Further details of those operations will now be discussed.

[0051] The arrangement of the jacking system 21 and the guide members 14 is shown in greater detail in Figures 4 to 6. As shown in Figures 4 and 5, the jacking system 21 includes eight jacks located adjacent each of the four legs 6 of the structure. A set of four jacks 20 for lowering the base 4 relative to the deck 8 on to the seabed is provided adjacent the inner inboard corner 22 of each of the triangular lattice legs 6. Two jacks 24 for raising the deck 8 are provided between each set of base lowering jacks 22 and each leg 6, and a further two deck raising jacks 26 are provided on the other side of each of the legs 6 adjacent the deck 8. Each guide member 14 extends from the deck 8 for location, to engage the outer inboard corner 28 of each leg 6, adjacent the two further deck raising jacks 26.

[0052] Figure 4 shows the eight jacks 20,24,26 adjacent one of the legs 6 in vertical perspective view. The jacks 20,24,26 are attached to the top of the legs 6 via the lifting beam 10. They extend parallel to the leg 6 to the base 4 where they are held in a jack anchorage 30. The deck 8 located between the lifting beam 10 and base 4 is attached to each of the jacks 20,24,26 via anchor plates 23 attached to the deck 8 after the deck has been floated into position on the base 4. The deck 8 and base 4 may be raised and lowered relative to one another and to the legs 6.

[0053] As can be seen from Figures 5 and 6, as the deck is jacked up to the required height during installation, it will be located relative to the legs 6, but with some play, by the corner 28 of each leg abutting against the guide member 14. Typically a gap of approximately 1m is left between the deck edge 32 and each of the legs 6 and about 15 cm between the legs 6 and the guide end and the legs 6.

[0054] Once the deck has been raised to the required height by the jacking system, it is necessary to form a permanent connection between the deck 8 and the legs 6 so that the jacking system may be removed. In order to do this, the deck 8 is first more accurately located relative to the legs 6.

[0055] The means of locating the deck relative to the legs 6 are shown in Figures 7 and 8. As shown in Figure 7, each lattice leg 6 is triangular in shape and has a vertically extending chord 34 at each of its three corners. Two of the three corners of each triangular leg are arranged adjacent the deck edge 32. Thus, the third corner of the leg (referred to as the outboard chord) is positioned

further outboard with respect to the deck 8.

[0056] To locate the deck, a strop 36 is attached around the outboard chord 34. A hydraulic tugger 38 is then attached between the strop and a padeye 40 provided at the bottom 42 of the deck edge 32. In addition, a pair of inwardly included hydraulic screw jacks 44 are positioned between fixed deck brackets 41 extending from the bottom 42 of the deck edge 32 and each of the inboard tubular members 34. The hydraulic tugger 38 is then tensioned so as to pull the respective leg 6 towards the deck 6 and, more specifically, the relevant chord 34 of the leg 6 against the guide member 14.

[0057] Next, the screw jacks 44 are activated to seat between the deck brackets 41 and the tubular members 34 and the hydraulic tugger 38 is tensioned further so as to hold the connection in position. As the guide members 14 are positioned at the top surface of the deck 8 and the screw jacks at the bottom of the deck 8, the temporary connection formed to locate the deck relative to the legs 6, provides a relatively accurate means of location in both the horizontal and vertical planes.

[0058] After the deck has been located relative to the legs 6 as described above, a permanent connection is then formed between the deck and the legs 6. A schematic perspective view of the connection between an inboard chord 34 of a leg 6 and the deck edge 32 is shown in Figure 9. The connection is made up of a vertically extending steel shear plate 46 and upper 48 and lower 50 horizontally extending metal coupling plates. The connection is shown in greater detail in Figures 10 to 13. As shown in Figure 10, respective connections are made between each of the two inboard chords 34 of the leg and the deck edge 32.

[0059] One end of the shear plate 46 is butt welded to one end of a stiffening plate 52 which extends through the diameter of each of the inboard chords 34 to which a connection is to be made (see Figure 12). When making the connection, the shear plate 46 is firstly swung into position between a chord 34 and the deck edge 32. This plate 46 is then butt welded to the stiffening plate 52 along one of its outboard vertical edges. In order to allow for a degree of tolerance in vertical alignment between the legs and deck, the stiffening plate 52 extends over a greater length L_1 of the chord 34 than the length L_2 of the shear plate 46 to which it is welded. Indeed the stiffening plate extends upwardly as far as the lifting beam 10 in each leg 6.

[0060] The shear plate 46 is then attached to the platform edge as follows.

[0061] As shown in Figure 14, a first metal plate 54 is fillet welded to the deck edge 32 so that it extends out from the deck adjacent one side of the shear plate 46. A second metal plate 56 is then fillet welded to the deck edge 32 so that it extends adjacent the other side of the shear plate 46. The shear plate 46 is then fillet welded to both of the metal plates 54 and 56. This method of attachment means that the width of the shear plate 46 need not be exactly the same as the distance between

the stiffening plate 52 and the deck edge, thereby providing a tolerance in the horizontal positioning of the deck 8 relative to the legs 6.

[0062] Once the shear plate 46 has been welded into position, the upper 48 and lower 50 coupling plates are then swung into position. The coupling plates 48,50 are formed with an elliptical cut-out 58 in their outboard edges, as shown in Figures 10 and 13, and each chord is received in a cut-out 58. As the cut-out 58 is elliptical rather than circular, in shape, some degree of angular tolerance is provided in the positioning of the coupling plate 48,50 relative to the chord 34. As can be seen from Figure 13, web 60 extends outwardly from the upper surface 62 of the deck edge 32. Location brackets 63 are pre-welded to the deck 8 and the web 60 so as to assist in alignment of the upper coupling plate 48,50 with the web 60. The coupling plate is then cut to size so as to fit between the web 60 and the chord. One end of the coupling plate 48,50 is positioned against the end of the web 60 and butt welded to the web, while the other end of the coupling 48,50 is butt welded to the chord 34 around the circumference of the cut-out 58. The coupling plates 48,50 are also fillet welded to the shear plate 46. Thus, again, tolerance is allowed in the horizontal distance between the leg and platform. Plate stiffeners 64 are also welded across the coupling plates 48 and 50 and their respective webs 60.

[0063] The connection between the deck 8 and each leg chord 34 thus comprises a shear plate 46, and two coupling plates 48,50, and this provides a strong connection capable of withstanding both shear and bending loads.

[0064] Once a connection as described above has been made between the two chords 34 of each leg 6 and the deck 8, the jacking system may then be removed.

[0065] It will be appreciated by those skilled in the art that many modifications could be made to the embodiment of the invention described above without departing from the scope of the invention as claimed. Thus, the platform may have any number of legs and those legs could be of any shape, for example, they could be square.

Claims

1. An offshore structure comprising a base (4), a deck (8) having two substantially parallel side edges, and a plurality of legs (6) extending between the base and the deck, wherein the legs are arranged outboard of the parallel side edges, and a permanent connection is provided between each said leg and the deck, **characterised in that** each said leg comprises a lattice leg having a vertically extending chord (34) at each corner thereof, and **in that** the permanent connection is provided between an inwardly facing face of each said leg and the deck and comprises a shear plate (46) attached substantially vertically between the deck and each said leg chord.

2. An offshore structure as claimed in claim 1, wherein each said leg chord (34) is circular in cross section.
3. An offshore structure as claimed in claim 1 or 2, wherein each said lattice leg (6) is triangular.
4. An offshore structure as claimed in any preceding claim, wherein the connection further comprises a stiffening plate (52) extending through a diameter of the leg chord (34), wherein a first side edge of said shear plate (46) is welded to said stiffening plate and said shear plate and said stiffening plate are substantially aligned.
5. An offshore structure as claimed in claim 4, wherein the stiffening plate (52) extends over a greater length of the leg chord (34) than the shear plate (46).
6. An offshore structure as claimed in any preceding claim, wherein the inboard end of said shear plate (46) is welded between two plates (54,56) extending outwardly from the deck edge.
7. An offshore structure as claimed in any preceding claim, wherein the connection further comprises a further metal coupling plate (48,50) attached horizontally between the deck and the leg chord.
8. An offshore structure as claimed in claim 7, wherein the coupling plate has a cut-out (58) in an edge facing the leg chord (34), such that a part of the periphery of the leg chord is held within the cut-out.
9. An offshore structure as claimed in claim 8, wherein the cut-out is elliptical in shape.
10. An offshore structure as claimed in any of claims 7 to 9, wherein a horizontal web (60) is attached to the deck (8) and the coupling plate (48,50) is butt welded thereto.
11. An offshore structure as claimed in any of claims 7 to 10, wherein plate stiffeners (64) extending from the inboard end to the outboard end are provided in the coupling plate (48,50).
12. An offshore structure as claimed in any of claims 7 to 11, wherein a coupling plate (48,50) is provided at the top and the bottom of the shear plate (46).
13. An offshore structure as claimed in claim 12, wherein each coupling plate (48,50) is welded to the shear plate (46) at the join between the plates.
14. An offshore structure as claimed in any preceding claim, wherein the connection is formed between the deck (8) and two said leg chords (34) located at either end of the inwardly facing face of the lattice legs (6).

15. A method of installing an offshore structure comprising a base (4), a deck (8) having two substantially parallel side edges, and a plurality of lattice legs (6) located outboard of the parallel side edges, each said lattice leg comprising a vertically extending chord (34) at each corner thereof, the method comprising the steps of: installing the base on the seabed; jacking the deck to the required height; forming a permanent connection between the deck and an inwardly facing face of each of the legs by attaching a substantially vertically extending shear plate (46) between a chord of each lattice leg and the deck edge; and removing the jacking system from the structure.
16. A method of installing an offshore structure as claimed in claim 15, wherein guides (14) are provided on the deck (8) so as to guide the deck as it is jacked up the legs (6).
17. A method of installing an offshore structure as claimed in claim 16, further comprising the steps of: attaching four legs (6) to the base (4); attaching two guides (14) to the deck (8); floating the deck over the base so that it passes between the legs until the guides abut against two said legs; and attaching another two guides (14) to the deck.
18. A method of installing an offshore structure as claimed in claim 16 or 17, wherein the guides (14) comprise beams attached to and projecting from the upper surface of the deck (8) and being shaped for engaging a chord (34) of a said leg (6).
19. A method of installing an offshore structure as claimed in any of claims 15 to 18, wherein the deck (8) is located relative to the legs (6) prior to formation of the permanent connection.
20. A method of installing an offshore structure as claimed in claim 19, wherein the deck (8) is located by pulling the leg (6) towards the deck so as to hold the leg chord (34) against the guide (14).
21. A method of installing an offshore structure as claimed in claim 20, wherein a hydraulic tugger (38) is provided between an outer edge of the leg (6) and the deck (8) so as to pull the leg towards the deck.
22. A method of installing an offshore structure as claimed in any of claims 19 to 21, wherein hydraulic screw jacks (44) are provided at the base of the deck (8) so as to push the inboard leg chords (34) away from the lower deck edge.
23. A method of installing an offshore structure as claimed in any of claims 20 to 22, wherein the deck (8) is pulled towards each of the legs (6).
24. A method of installing an offshore structure as claimed in any of claims 15 to 23, wherein the substantially vertically extending shear plate (46) is attached between a chord (34) of the lattice leg (6) and the deck edge by welding.
25. A method of installing an offshore structure as claimed in claim 24, wherein a stiffening plate (52) is provided through a diameter of the leg (6), and a first side edge of said shear plate (46) is welded to said stiffening plate, and said shear plate and said stiffening plate are substantially aligned.
26. A method of installing an offshore structure as claimed in claim 25, wherein the stiffening plate (52) extends over a greater length of the leg chord (34) than the shear plate (46).
27. A method of installing an offshore structure as claimed in claim 25 or 26, wherein two plates (54,56) are welded to the deck edge on respective sides of the shear plate (46) and extending outwardly from the deck edge, and the inboard end of said shear plate is welded between the two plates.
28. A method of installing an offshore structure as claimed in any of claims 24 to 27, wherein the connection further comprises a further metal coupling plate (48,50) attached horizontally between the deck (8) and the leg chord (34), the second metal plate having a cut-out (58) in an edge facing the leg chord, such that a part of the periphery of the leg chord is held within the cut-out.
29. A method of installing an offshore structure as claimed in claim 28, wherein the cut-out (58) is elliptical in shape.
30. A method of installing an offshore structure as claimed in claim 28 or 29, wherein a coupling plate (48,50) is provided at the top and the bottom of the shear plate (46).
31. A method of installing an offshore structure as claimed in any of claims 28 to 30, wherein the shear plate (46) and the coupling plate (48,50) are welded together.

Patentansprüche

1. Offshore-Struktur mit einer Basis (4), einem Deck (8) mit zwei im Wesentlichen parallelen Seitenrändern und mehreren Beinen (6), die sich zwischen der Basis und dem Deck erstrecken, wobei die Beine außerhalb der parallelen Seitenränder angeordnet sind und zwischen jedem Bein und dem Deck eine dauerhafte Verbindung vorgesehen ist, **dadurch**

- gekennzeichnet, dass** jedes Bein ein Gitterbein mit einer sich vertikal erstreckenden Strebe (34) an jeder Ecke davon umfasst und dass die dauerhafte Verbindung zwischen einer nach innen weisenden Fläche jedes Beins und dem Deck vorgesehen ist und eine im Wesentlichen vertikal zwischen dem Deck und jeder Beinstrebe befestigte Abscherplatte (46) umfasst.
2. Offshore-Struktur nach Anspruch 1, bei der jede Beinstrebe (34) einen kreisförmigen Querschnitt aufweist.
 3. Offshore-Struktur nach Anspruch 1 oder 2, bei der jedes Gitterbein (6) dreieckig ist.
 4. Offshore-Struktur nach einem der vorhergehenden Ansprüche, bei der die Verbindung weiterhin eine sich durch einen Durchmesser der Beinstrebe (34) erstreckende Versteifungsplatte (52) umfasst, wobei ein erster Seitenrand der Abscherplatte (46) mit der Versteifungsplatte verschweißt ist und die Abscherplatte und die Versteifungsplatte im Wesentlichen aufeinander ausgerichtet sind.
 5. Offshore-Struktur nach Anspruch 4, bei der sich die Versteifungsplatte (52) über eine größere Länge der Beinstrebe (34) als die Abscherplatte (46) erstreckt.
 6. Offshore-Struktur nach einem der vorhergehenden Ansprüche, bei der das innen liegende Ende der Abscherplatte (46) zwischen zwei sich von dem Deckrand nach außen erstreckenden Platten (54, 56) verschweißt ist.
 7. Offshore-Struktur nach einem der vorhergehenden Ansprüche, bei der die Verbindung weiterhin eine weitere Metallverbindungsplatte (48, 50) umfasst, die horizontal zwischen dem Deck und der Beinstrebe befestigt ist.
 8. Offshore-Struktur nach Anspruch 7, bei der die Verbindungsplatte in einem zur Beinstrebe (34) weisenden Rand einen Ausschnitt (58) aufweist, so dass ein Teil des Umfangs der Beinstrebe in dem Ausschnitt festgehalten wird.
 9. Offshore-Struktur nach Anspruch 8, bei der der Ausschnitt eine elliptische Form aufweist.
 10. Offshore-Struktur nach einem der Ansprüche 7 bis 9, bei der ein horizontaler Steg (60) am Deck (8) befestigt ist und die Verbindungsplatte (48, 50) durch Stumpfschweißen damit verbunden ist.
 11. Offshore-Struktur nach einem der Ansprüche 7 bis 10, bei der sich vom innen liegenden Ende zum außen liegenden Ende erstreckende Platten aussteifungen (64) in der Verbindungsplatte (48, 50) vorgesehen sind.
 12. Offshore-Struktur nach einem der Ansprüche 7 bis 11, bei der am oberen und unteren Ende der Abscherplatte (46) eine Verbindungsplatte (48, 50) vorgesehen ist.
 13. Offshore-Struktur nach Anspruch 12, bei der jede Verbindungsplatte (48, 50) an der Verbindungsstelle zwischen den Platten mit der Abscherplatte (46) verschweißt ist.
 14. Offshore-Struktur nach einem der vorhergehenden Ansprüche, bei der die Verbindung zwischen dem Deck (8) und den beiden an beiden Enden der nach innen weisenden Fläche der Gitterbeine (6) angeordneten Beinstreben (34) gebildet ist.
 15. Verfahren zur Installation einer Offshore-Struktur mit einer Basis (4), einem Deck (8) mit zwei im Wesentlichen parallelen Seitenrändern und mehreren Gitterbeinen (6), die außerhalb der parallelen Seitenränder angeordnet sind, wobei jedes Gitterbein an jeder seiner Ecken eine sich vertikal erstreckende Strebe (34) umfasst, wobei das Verfahren die folgenden Schritte umfasst: Installieren der Basis auf dem Meeresboden; Hochwinden des Decks auf die erforderliche Höhe; Bilden einer dauerhaften Verbindung zwischen dem Deck und einer nach innen weisenden Fläche jedes der Beine durch Befestigen einer sich im Wesentlichen vertikal erstreckenden Abscherplatte (46) zwischen einer Strebe jedes Gitterbeins und dem Deckrand; und Entfernen des Hochwindesystems von der Struktur.
 16. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 15, bei dem am Deck (8) Führungen (14) vorgesehen sind, um das Deck bei seinem Hochwinden an den Beinen (6) zu führen.
 17. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 16, das weiterhin die folgenden Schritte umfasst: Befestigen von vier Beinen (6) an der Basis (4); Befestigen von zwei Führungen (14) am Deck (8); Treiben des Decks über die Basis, so dass es zwischen den Beinen passiert, bis die Führungen gegen die beiden Beine stoßen; und Befestigen von zwei anderen Führungen (14) am Deck.
 18. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 16 oder 17, bei dem die Führungen (14) Träger umfassen, die an der Oberseite des Decks (8) befestigt sind und davon wegragen und zur Eingriffnahme einer Strebe (34) des Beins (6) geformt sind.
 19. Verfahren zur Installation einer Offshore-Struktur

nach einem der Ansprüche 15 bis 18, bei dem das Deck (8) vor Bildung der dauerhaften Verbindung bezüglich der Beine (6) positioniert wird.

20. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 19, bei dem das Deck (8) durch ziehen des Beins (6) zum Deck, um die Beinstrebe (34) gegen die Führung (14) zu halten, positioniert wird. 5
21. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 20, bei dem zwischen einem äußeren Rand des Beins (6) und dem Deck (8) eine hydraulische Ziehvorrichtung (38) vorgesehen wird, um das Bein zum Deck zu ziehen. 10
22. Verfahren zur Installation einer Offshore-Struktur nach einem der Ansprüche 19 bis 21, bei dem an der Basis des Decks (8) hydraulische Schraubwinden (44) vorgesehen werden, um die innen liegenden Beinstreben (34) von dem unteren Deckrand weg zu schieben. 15 20
23. Verfahren zur Installation einer Offshore-Struktur nach einem der Ansprüche 20 bis 22, bei dem das Deck (8) zu jedem der Beine (6) gezogen wird. 25
24. Verfahren zur Installation einer Offshore-Struktur nach einem der Ansprüche 15 bis 23, bei dem die sich im Wesentlichen vertikal erstreckende Abscherplatte (46) durch Schweißen zwischen einer Strebe (34) des Gitterbeins (6) und dem Deckrand befestigt wird. 30
25. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 24, bei dem eine Versteifungsplatte (52) durch einen Durchmesser des Beins (6) vorgesehen und ein erster Seitenrand der Abscherplatte (46) mit der Versteifungsplatte verschweißt wird und die Abscherplatte und die Versteifungsplatte im Wesentlichen aufeinander ausgerichtet werden. 35 40
26. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 25, bei dem sich die Versteifungsplatte (52) über eine größere Länge der Beinstrebe (34) erstreckt als die Abscherplatte (46). 45
27. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 25 oder 26, bei dem beide Platten (54, 56) auf jeweiligen Seiten der Abscherplatte (46) mit dem Deckrand verschweißt sind und sich von dem Deckrand nach außen erstrecken und das innen liegende Ende der Abscherplatte zwischen den beiden Platten verschweißt ist. 50
28. Verfahren zur Installation einer Offshore-Struktur nach einem der Ansprüche 24 bis 27, bei dem die Verbindung weiterhin eine weitere Metallverbindungsplatte (48, 50) umfasst, die horizontal zwi-

schen dem Deck (8) und der Beinstrebe (34) befestigt ist, wobei die zweite Metallplatte in einem zur Beinstrebe weisenden Rand einen Ausschnitt (58) aufweist, so dass ein Teil des Umfangs der Beinstrebe in dem Ausschnitt festgehalten wird.

29. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 28, bei dem der Ausschnitt (58) eine elliptische Form aufweist.
30. Verfahren zur Installation einer Offshore-Struktur nach Anspruch 28 oder 29, bei dem am oberen und unteren Ende der Abscherplatte (46) eine Verbindungsplatte (48, 50) vorgesehen ist.
31. Verfahren zur Installation einer Offshore-Struktur nach einem der Ansprüche 28 bis 30, bei dem die Abscherplatte (46) und die Verbindungsplatte (48, 50) miteinander verschweißt sind.

Revendications

1. Construction en mer comprenant une base (4), un pont (8) présentant deux bords latéraux sensiblement parallèles, et une pluralité de pieds (6) s'étendant entre la base et le pont, dans laquelle les pieds sont arrangés à l'extérieur des côtés latéraux parallèles, et une connexion permanente est prévue entre chacun desdits pieds et le pont, **caractérisée en ce que** chacun desdits pieds comprend un pied en treillis comprenant une corde s'étendant verticalement (34) à chaque coin de ceux-ci, et **en ce que** la connexion permanente est prévue entre une face orientée vers l'intérieur de chacun desdits pieds et le pont et comprend une plaque de cisaillement (46) attachée essentiellement verticalement entre le pont et chacune desdites cordes de pied.
2. Construction en mer selon la revendication 1, dans laquelle chacune desdites cordes de pied (34) est de section transversale circulaire.
3. Construction en mer selon la revendication 1 ou 2, dans laquelle chacun desdits pieds en treillis (6) est triangulaire.
4. Construction en mer selon l'une quelconque des revendications précédentes, dans laquelle la connexion comprend en outre une plaque de raidissement (52) s'étendant à travers un diamètre de la corde de pied (34), dans laquelle un premier bord latéral de ladite plaque de cisaillement (46) est soudé à ladite plaque de raidissement, et ladite plaque de cisaillement et ladite plaque de raidissement sont essentiellement alignées.
5. Construction en mer selon la revendication 4, dans

laquelle la plaque de raidissement (52) s'étend sur une plus grande longueur de la corde de pied (34) que la plaque de cisaillement (46).

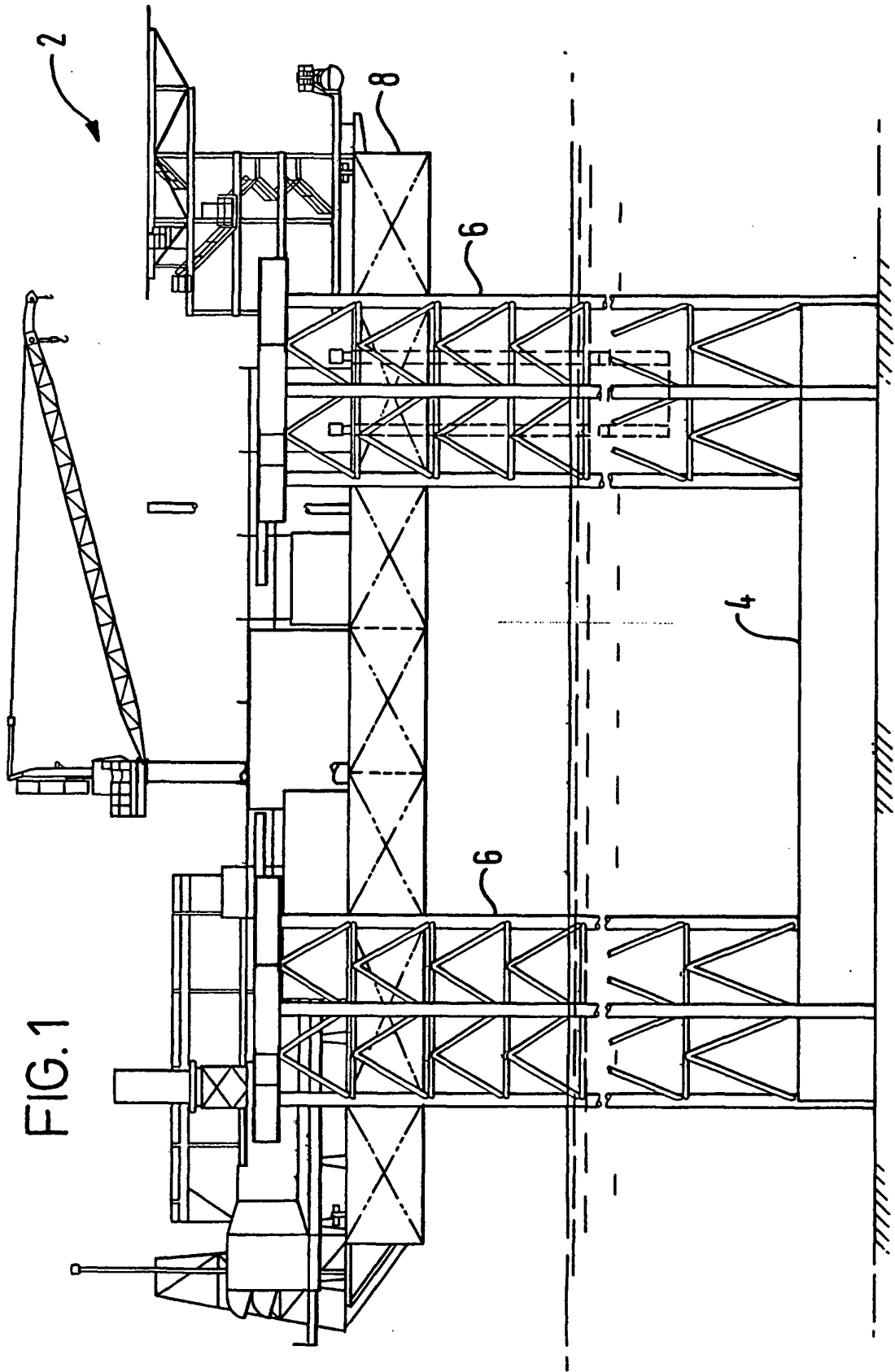
6. Construction en mer selon l'une quelconque des revendications précédentes, dans laquelle l'extrémité intérieure de ladite plaque de cisaillement (46) est soudée entre deux plaques (54, 56) s'étendant vers l'extérieur à partir du bord du pont. 5
7. Construction en mer selon l'une quelconque des revendications précédentes, dans laquelle la connexion comprend en outre une plaque de couplage métallique supplémentaire (48, 50) attachée horizontalement entre le pont et la corde de pied. 10
8. Construction en mer selon la revendication 7, dans laquelle la plaque de couplage comporte une entaille (58) dans un bord opposé à la corde de pied (34) de telle sorte qu'une partie de la périphérie de la corde de pied soit maintenue à l'intérieur de l'entaille. 20
9. Construction en mer selon la revendication 8, dans laquelle l'entaille est de forme elliptique. 25
10. Construction en mer selon l'une quelconque des revendications 7 à 9, dans laquelle une bande horizontale (60) est attachée au pont (8), et la plaque de couplage (48, 50) est soudée bout à bout à celle-ci. 30
11. Construction en mer selon l'une quelconque des revendications 7 à 10, dans laquelle des raidisseurs de plaque (64) s'étendant à partir de l'extrémité intérieure jusqu'à l'extrémité extérieure sont prévus dans la plaque de couplage (48, 50). 35
12. Construction en mer selon l'une quelconque des revendications 7 à 11, dans laquelle une plaque de couplage (48, 50) est prévue en haut et en bas de la plaque de cisaillement (46). 40
13. Construction en mer selon la revendication 12, dans laquelle chaque plaque de couplage (48, 50) est soudée à la plaque de cisaillement (46) à la jonction entre les plaques. 45
14. Construction en mer selon l'une quelconque des revendications précédentes, dans laquelle la connexion est formée entre le pont (8) et deux desdites cordes de pied (34) situées aux deux extrémités de la face orientée vers l'intérieur des pieds en treillis (6). 50
15. Procédé d'installation d'une construction en mer comprenant une base (4), un pont (8) présentant deux bords latéraux sensiblement parallèles, et une pluralité de pieds en treillis (6) situés à l'extérieur des bords latéraux parallèles, chacun desdits pieds 55

en treillis comprenant un corde s'étendant verticalement (34) à chaque coin de ceux-ci, le procédé comprenant les étapes suivantes: installer la base sur le fond de la mer; placer le pont à la hauteur requise en employant des vérins; former une connexion permanente entre le pont et la face orientée vers l'intérieur de chacun des pieds en attachant une plaque de cisaillement s'étendant essentiellement verticalement (46) entre une corde de chaque pied en treillis et le bord du pont; et enlever le système de vérins de la construction.

16. Procédé d'installation d'une construction en mer selon la revendication 15, dans lequel des guides (14) sont prévus sur le pont (8) pour guider le pont lorsque celui-ci est monté sur les pieds (6).
17. Procédé d'installation d'une construction en mer selon la revendication 16, comprenant en outre les étapes suivantes: attacher quatre pieds (6) à la base (4); attacher deux guides (14) au pont (8); faire flotter le pont au-dessus de la base de telle sorte qu'il passe entre les pieds jusqu'à ce que les guides viennent buter contre deux desdits pieds; et attacher deux autres guides (14) au pont.
18. Procédé d'installation d'une construction en mer selon la revendication 16 ou 17, dans lequel les guides (14) comprennent des poutres attachées à et saillant à partir de la surface supérieure du pont (8) et configurées pour engager une corde (34) dudit pied (6).
19. Procédé d'installation d'une construction en mer selon l'une quelconque des revendications 15 à 18, dans lequel le pont (8) est positionné par rapport aux pieds (6) avant de former la connexion permanente.
20. Procédé d'installation d'une construction en mer selon la revendication 19, dans lequel le pont (8) est positionné en tirant le pied (6) vers le pont de manière à maintenir la corde de pied (34) contre le guide (14).
21. Procédé d'installation d'une construction en mer selon la revendication 20, dans lequel un chariot tracteur hydraulique (38) est prévu entre un bord extérieur du pied (6) et le pont (8) de manière à tirer le pied vers le pont.
22. Procédé d'installation d'une construction en mer selon l'une quelconque des revendications 19 à 21, dans lequel des vérins de support hydrauliques (44) sont prévus à la base du pont (8) de manière à pousser les cordes de pied intérieures (34) à s'écarter du bord de pont inférieur.
23. Procédé d'installation d'une construction en mer selon l'une quelconque des revendications 20 à 22, dans lequel le pont (8) est tiré vers chacun des pieds

(6).

24. Procédé d'installation d'une construction en mer selon l'une quelconque des revendications 15 à 23, dans lequel la plaque de cisaillement s'étendant essentiellement verticalement (46) est attachée entre une corde (34) du pied en treillis (6) et le bord du pont par soudage. 5
25. Procédé d'installation d'une construction en mer selon la revendication 24, dans lequel une plaque de raidissement (52) est prévue à travers un diamètre du pied (6), et un premier bord latéral de ladite plaque de cisaillement (46) est soudé à ladite plaque de raidissement, et ladite plaque de cisaillement et ladite plaque de raidissement sont essentiellement alignées. 10 15
26. Procédé d'installation d'une construction en mer selon la revendication 25, dans lequel la plaque de raidissement (52) s'étend sur une plus grande longueur de la corde de pied (34) que la plaque de cisaillement (46). 20
27. Procédé d'installation d'une construction en mer selon la revendication 25 ou 26, dans lequel deux plaques (54, 56) sont soudées au bord du pont sur des côtés respectifs de la plaque de cisaillement (46) et s'étendant vers l'extérieur à partir du bord du pont, et l'extrémité intérieure de ladite plaque de cisaillement est soudée entre les deux plaques. 25 30
28. Procédé d'installation d'une construction en mer selon l'une quelconque des revendications 24 à 27, dans lequel la connexion comprend en outre une plaque de couplage métallique supplémentaire (48, 50) attachée horizontalement entre le pont (8) et la corde de pied (34), la deuxième plaque de couplage métallique comportant une entaille (58) dans un bord opposé à la corde de pied, de telle sorte qu'une partie de la périphérie de la corde de pied soit maintenue à l'intérieur de l'entaille. 35 40
29. Procédé d'installation d'une construction en mer selon la revendication 28, dans lequel l'entaille (58) est de forme elliptique. 45
30. Procédé d'installation d'une construction en mer selon la revendication 28 ou 29, dans lequel une plaque de couplage (48, 50) est prévue en haut et en bas de la plaque de cisaillement (46). 50
31. Procédé d'installation d'une construction en mer selon l'une quelconque des revendications 28 à 30, dans lequel la plaque de cisaillement (46) et la plaque de couplage (48, 50) sont soudées l'une à l'autre. 55



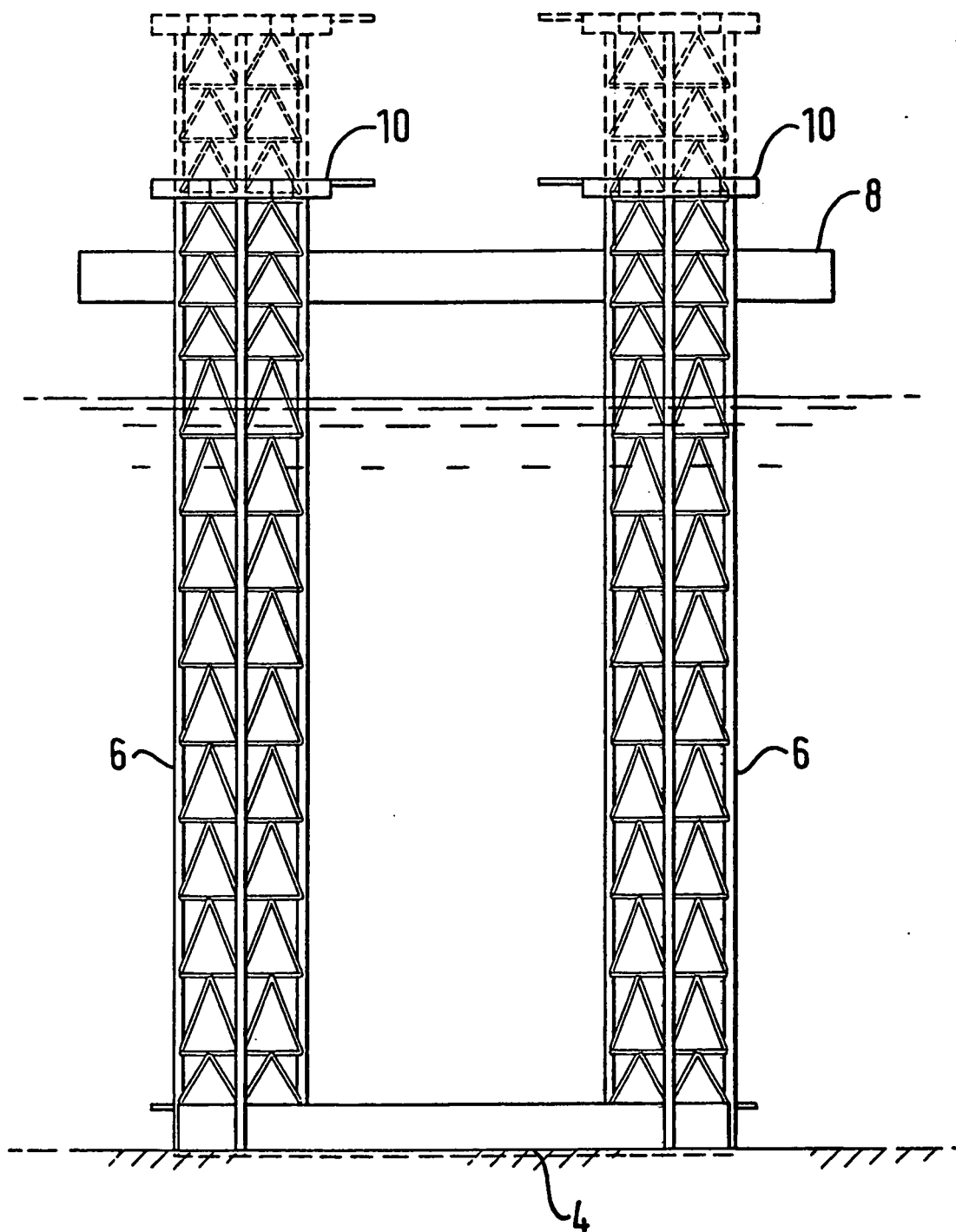


FIG. 2

FIG. 3

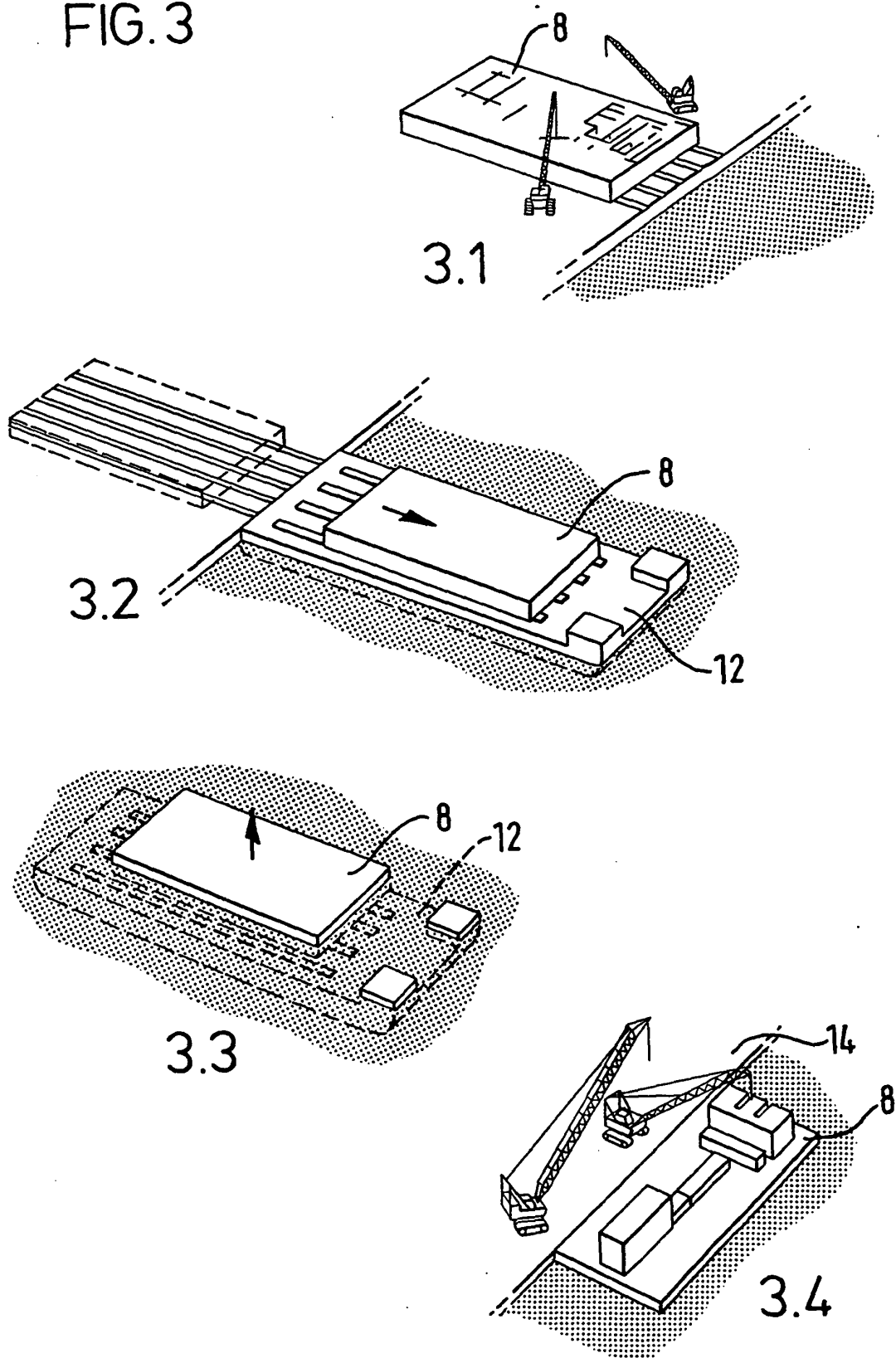


FIG. 3 CON'D

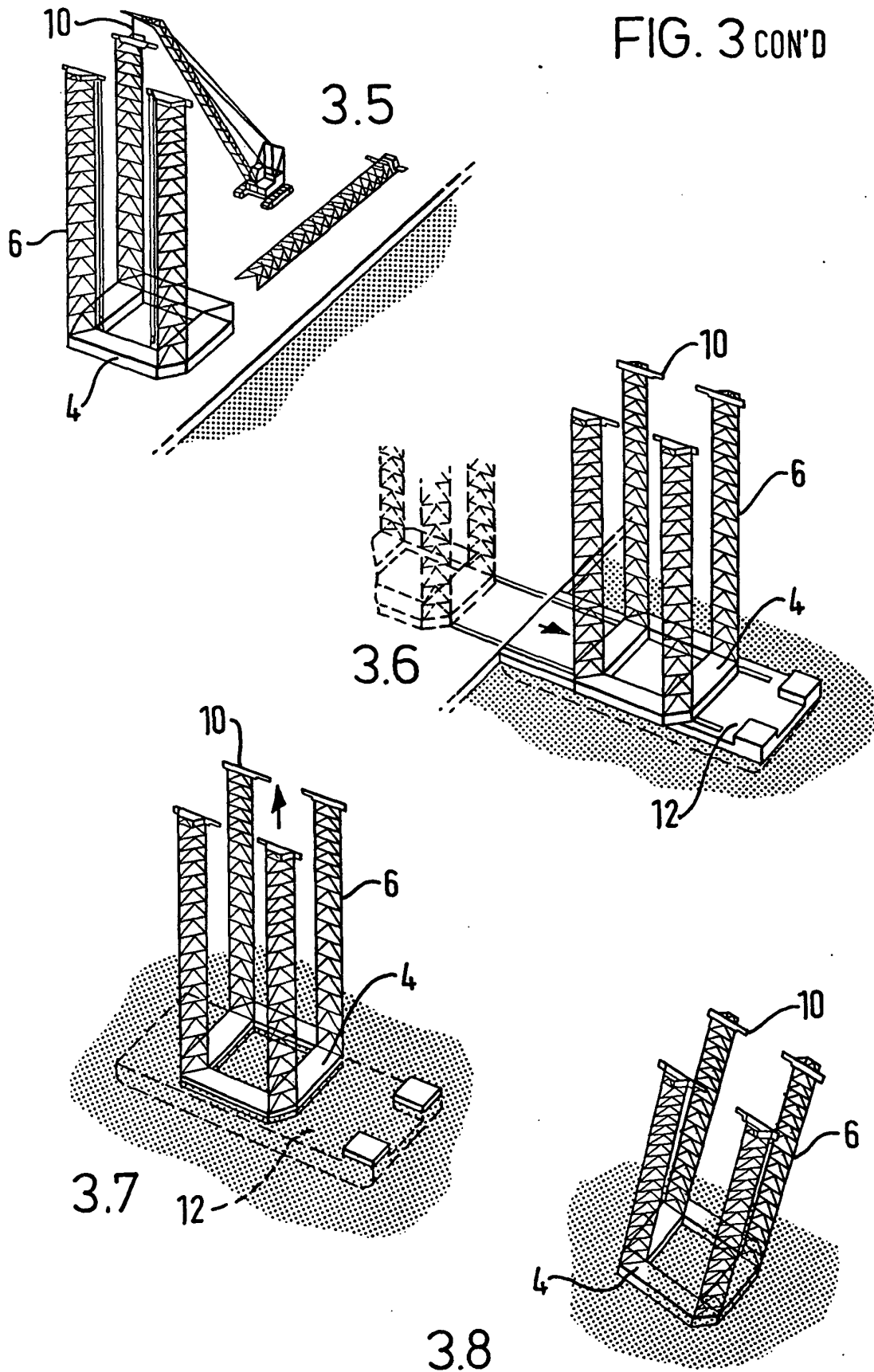
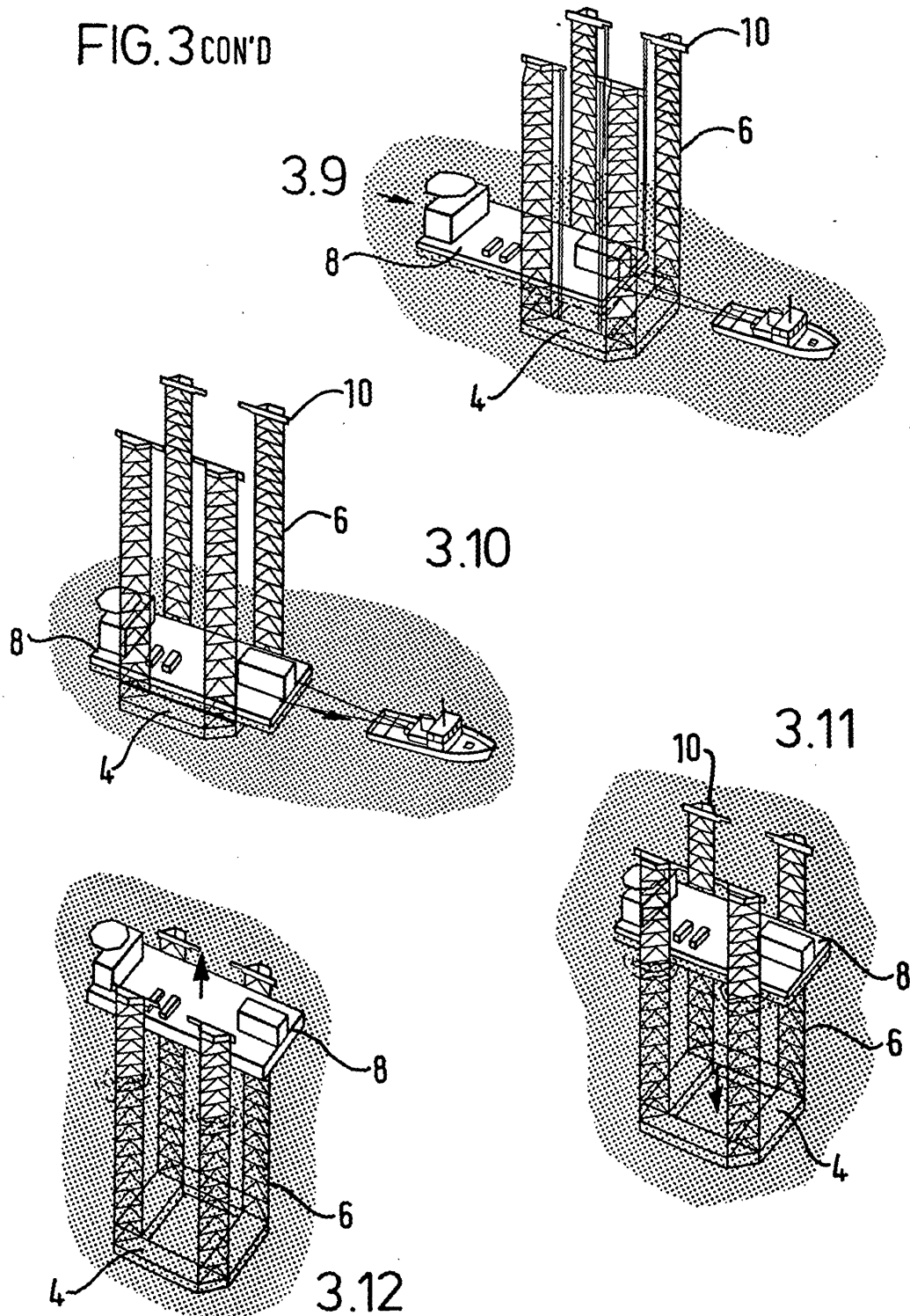
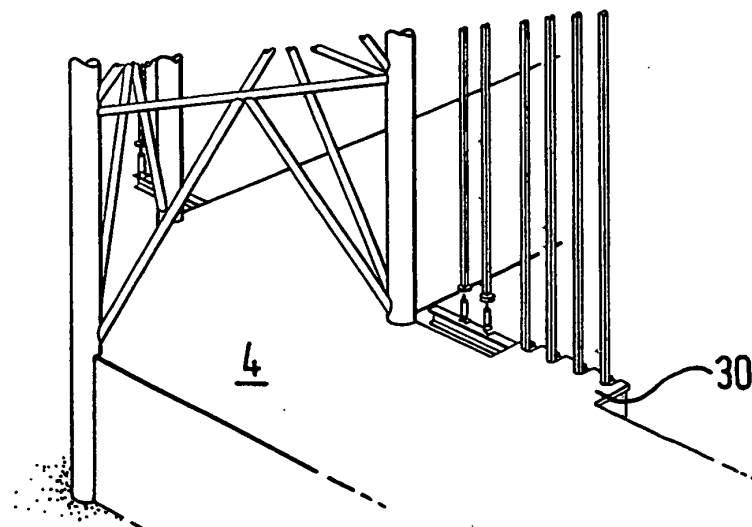
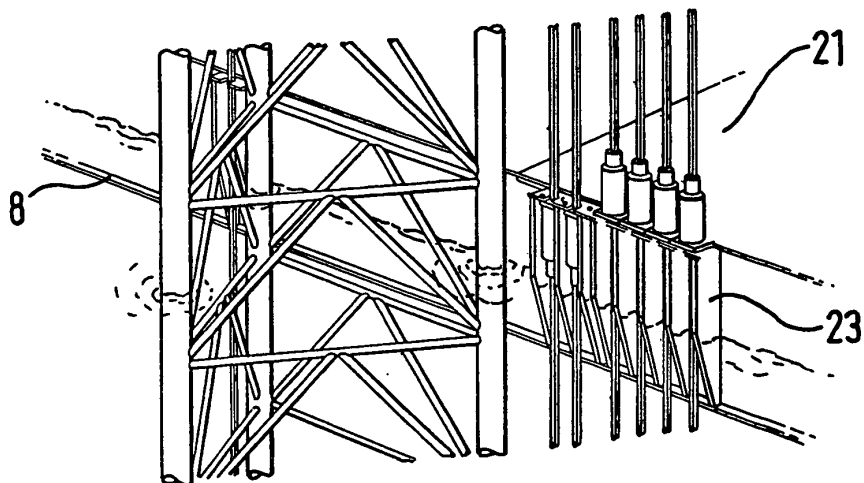
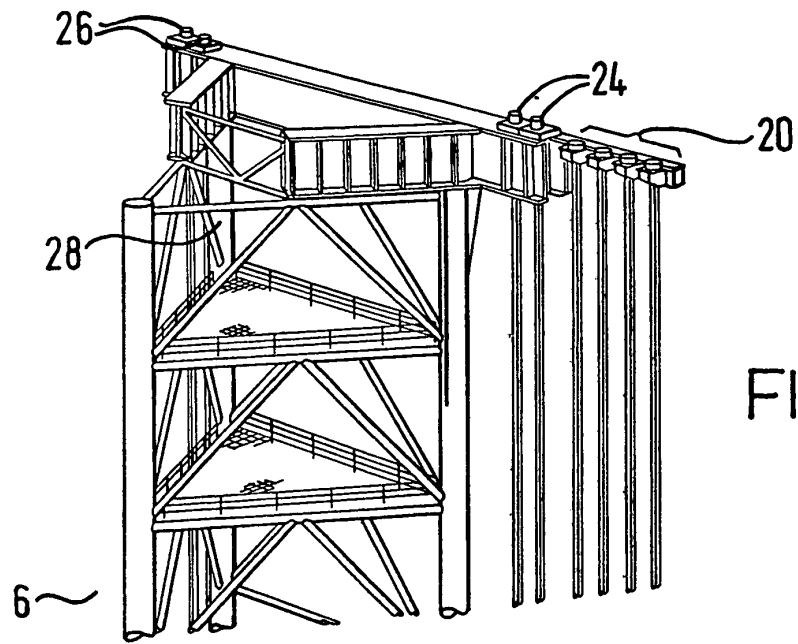


FIG. 3 CON'D





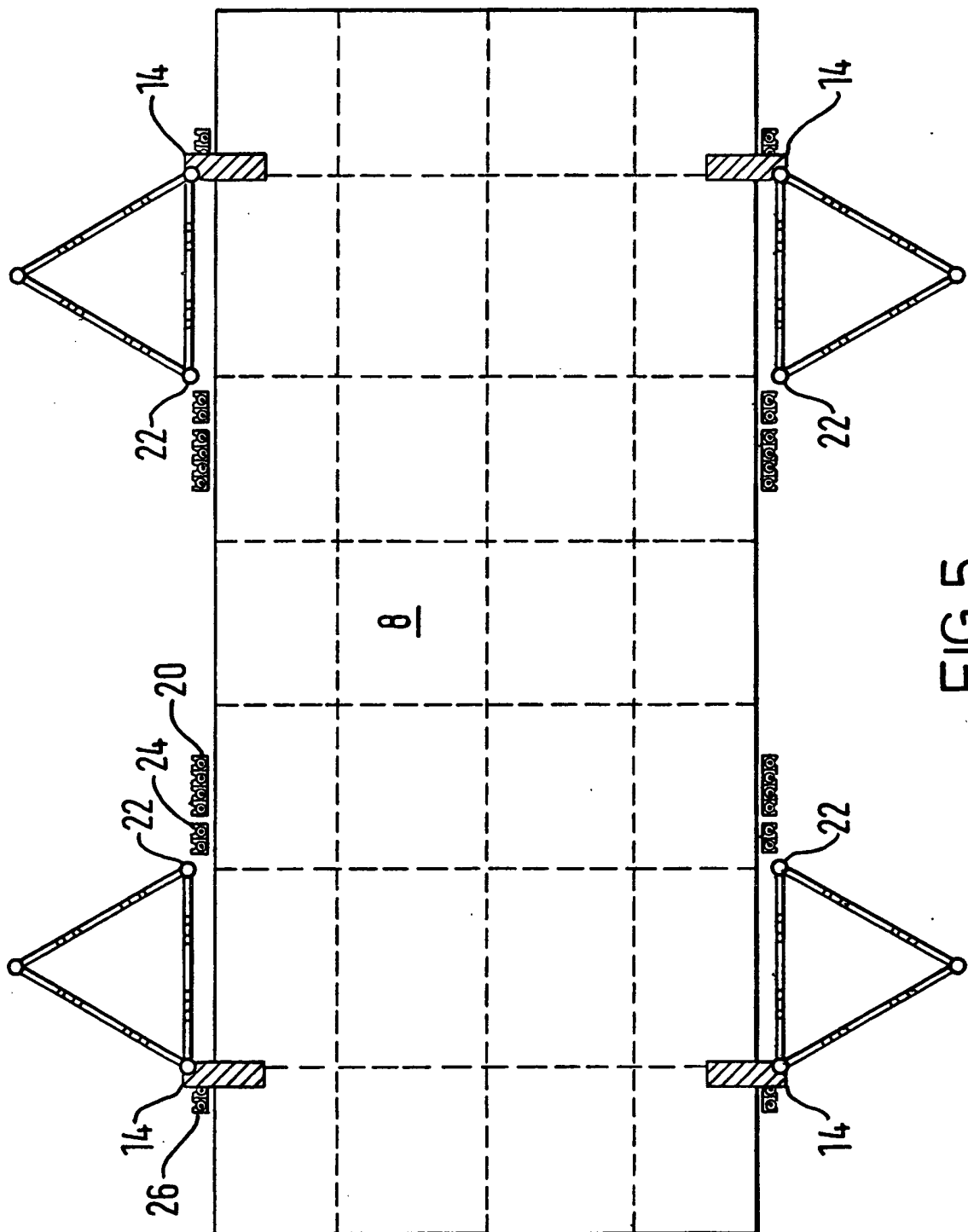
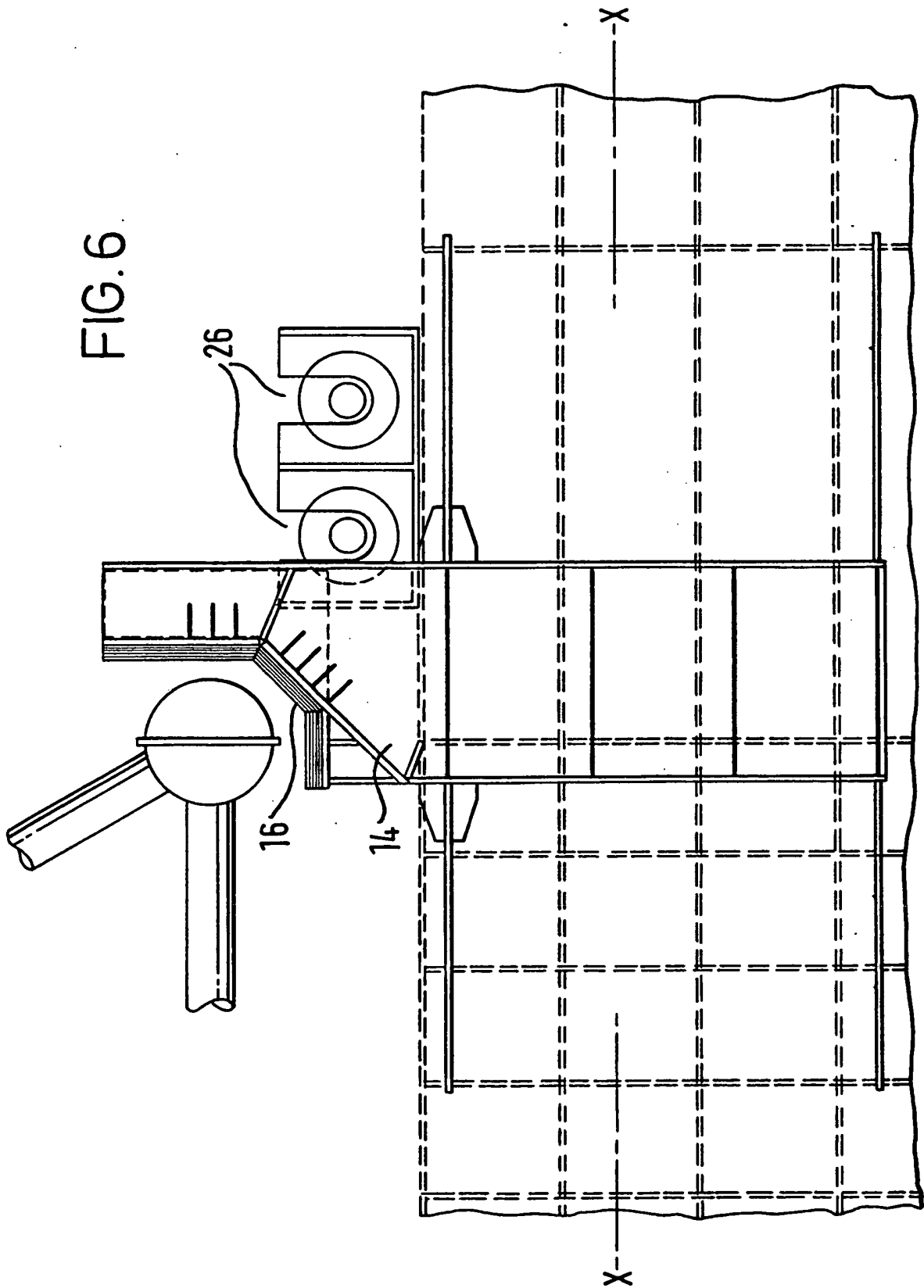


FIG. 5



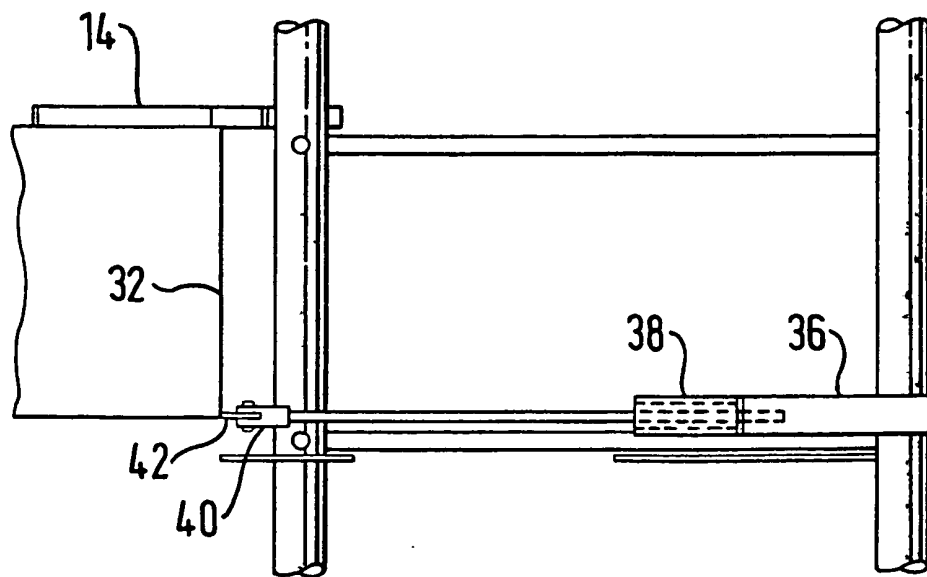
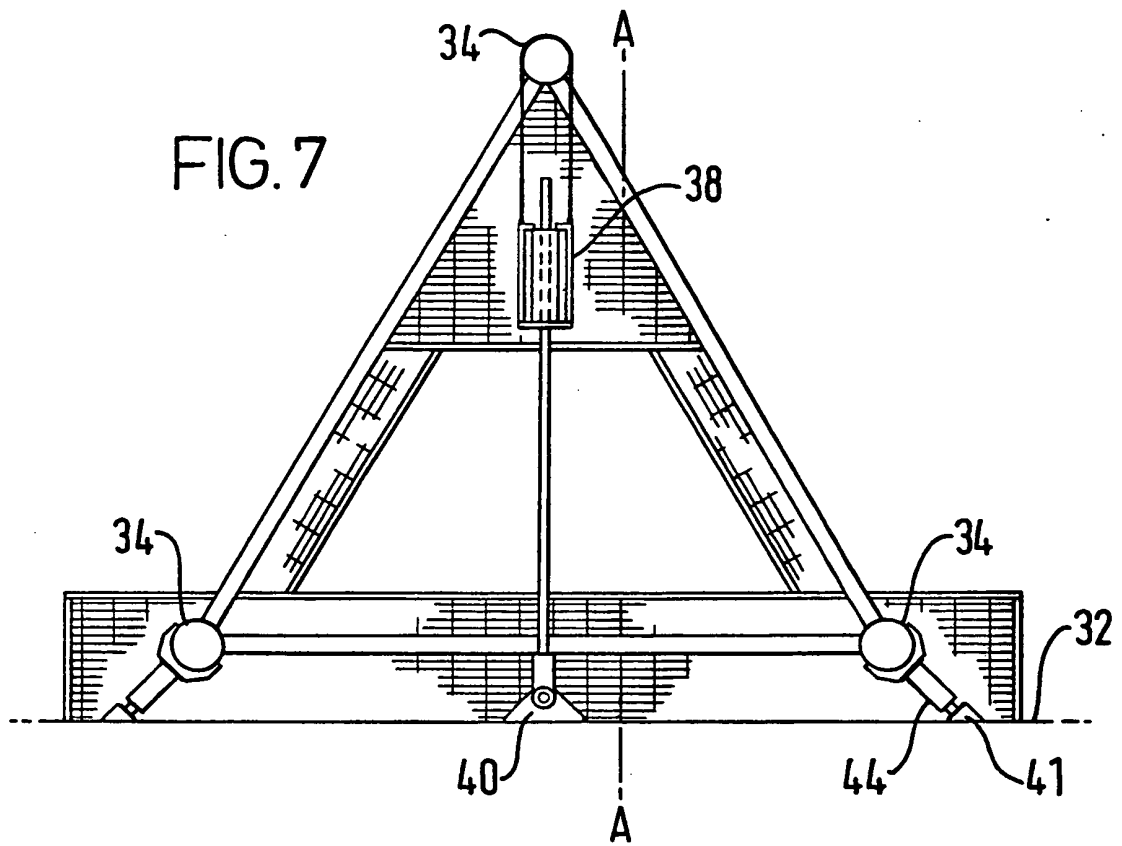


FIG. 8

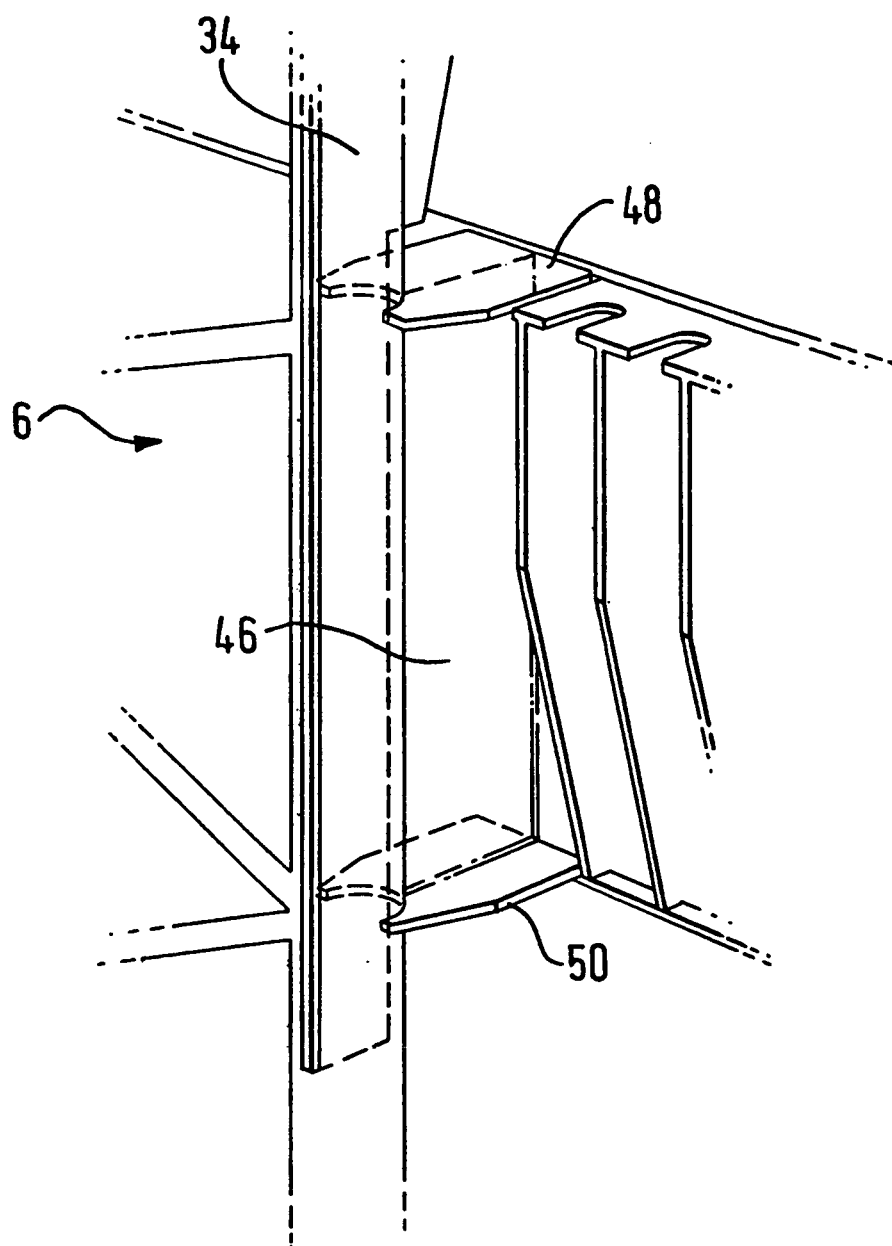


FIG. 9

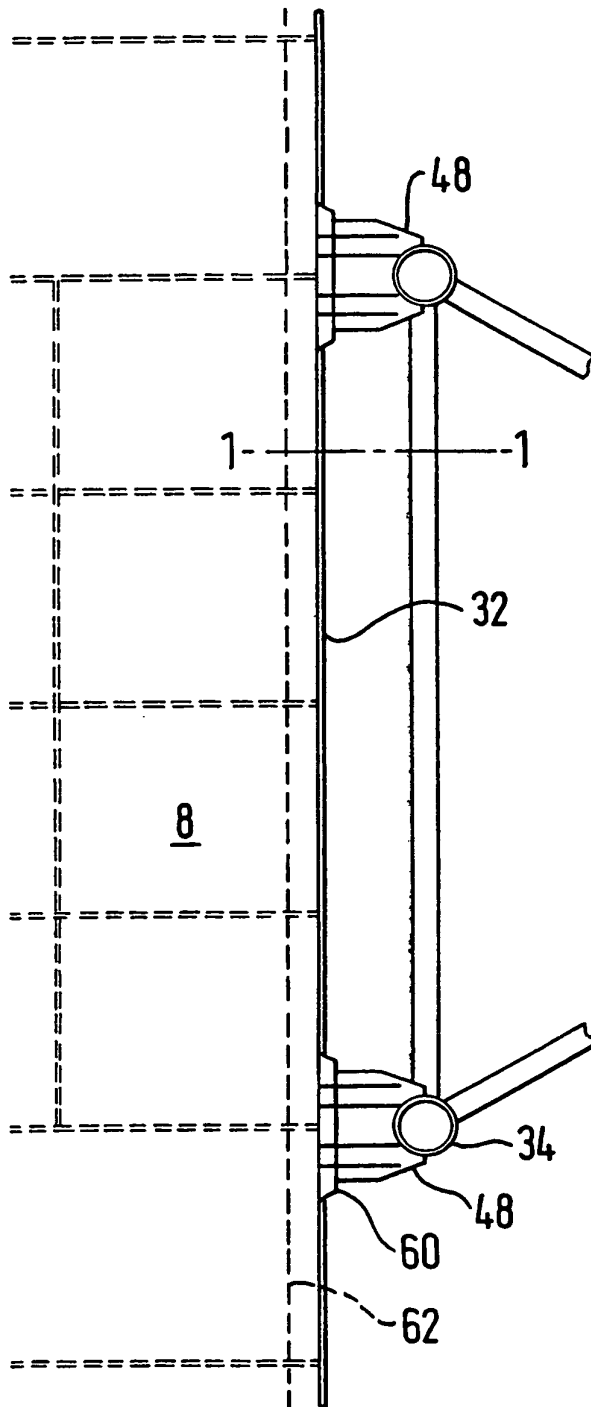


FIG. 10

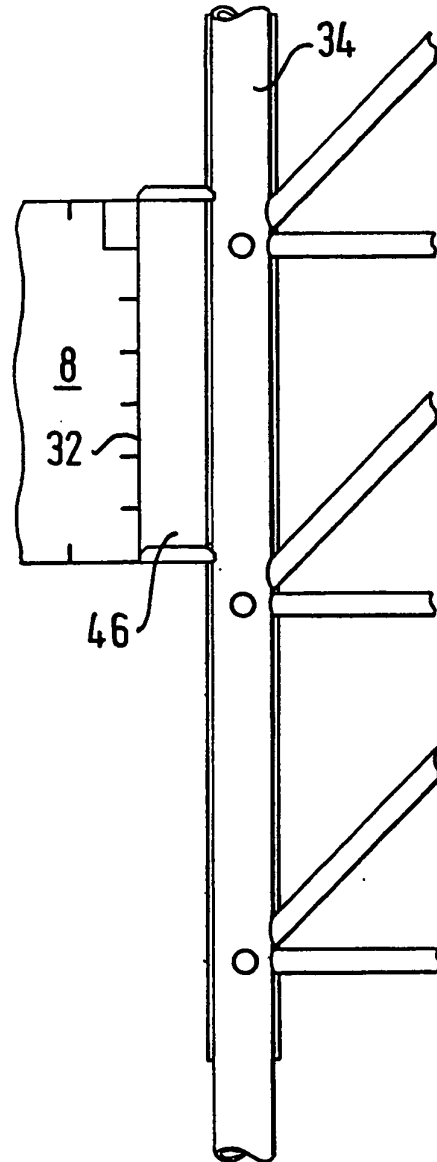
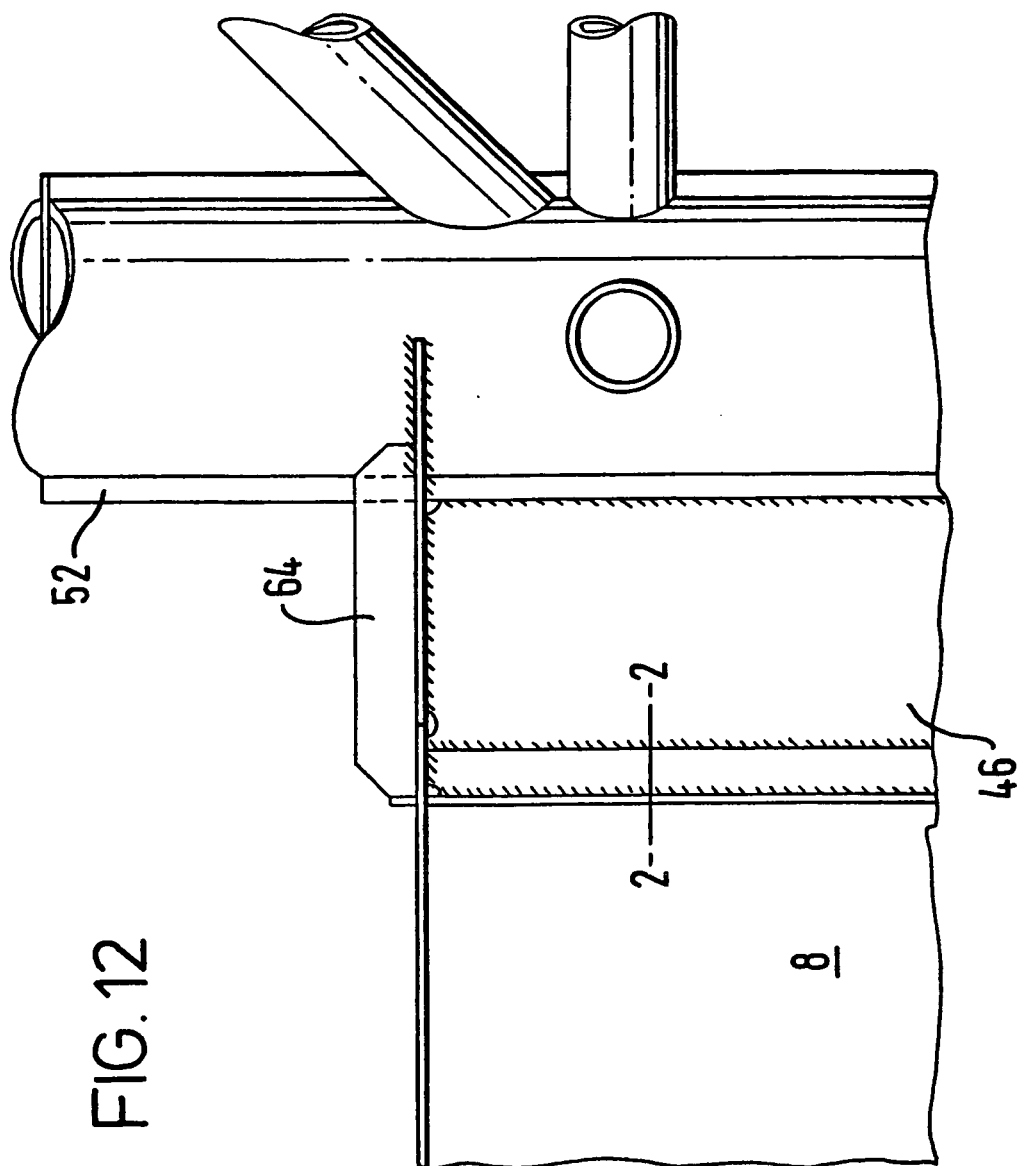


FIG. 11



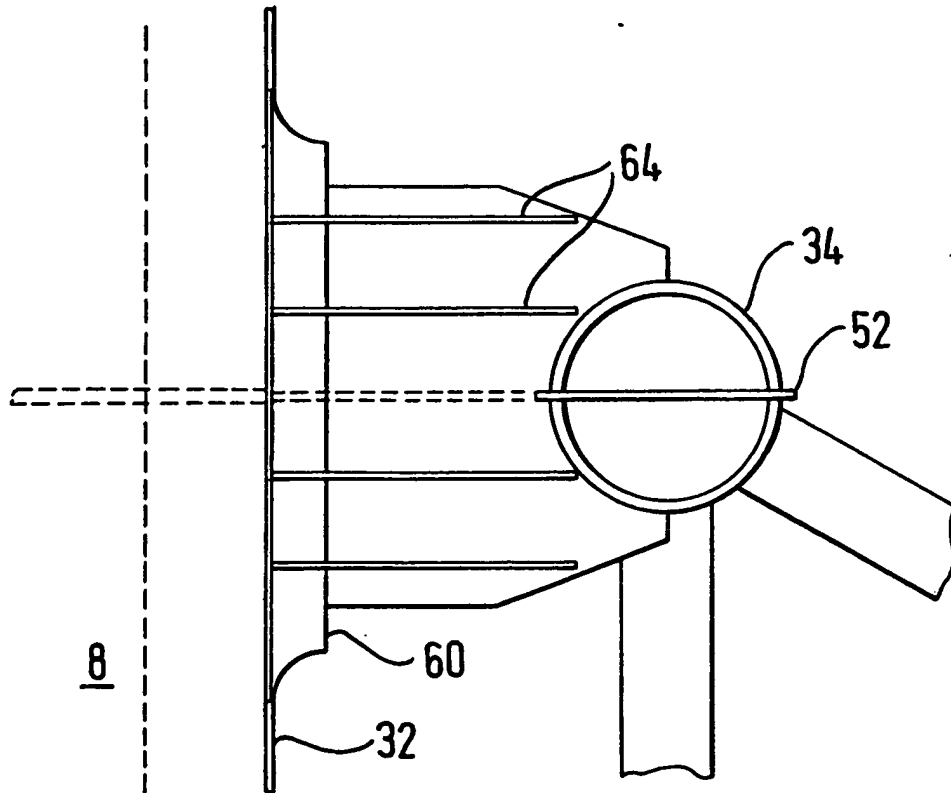


FIG. 13

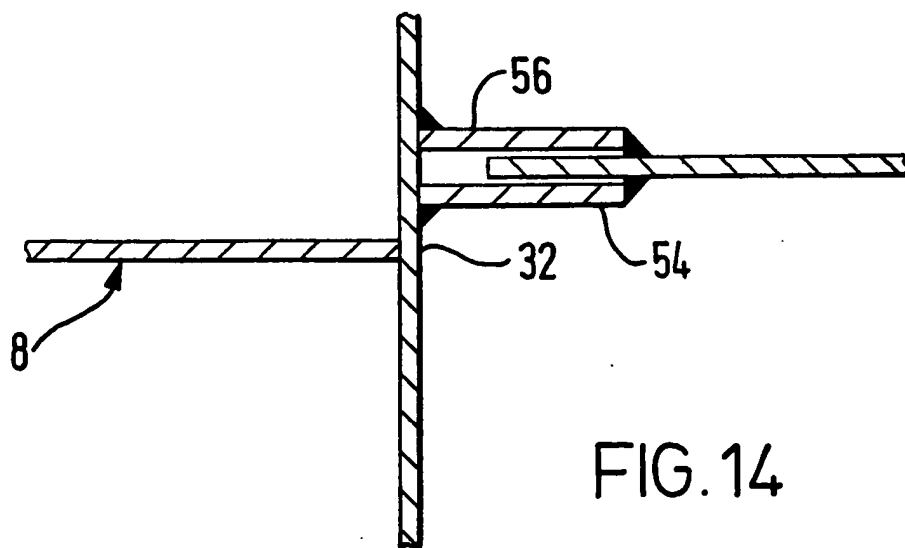


FIG. 14