The invention relates to a rig assembly for use in the oil and gas exploration and production industry. In an embodiment of the invention, a rig assembly (12) for a drill ship (10) is disclosed. The rig assembly (12) comprises a rig floor receiving area (14); a plurality of movable rig floor units (18, 20, 22 and 24), each rig floor unit (18, 20, 22 and 24) configured for location in the rig floor receiving area (14), to thereby define a rig floor of the rig assembly (12); and a transporter (26) configured to receive any one of the rig floor units (18, 20, 22 and 24), for transporting a selected one of the rig floor units (18, 20, 22 and 24) from a storage area (28) to the rig floor receiving area (14).
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments. For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
The present invention relates to a rig assembly for use in the oil and gas exploration and production industry. In particular, but not exclusively, the present invention relates to a rig assembly with an improved rig floor, as well as to an improved rig floor, a transporter and a method of providing a rig floor of a rig assembly.

In the oil and gas exploration and production industry, access to subterranean oil and gas reserves is typically achieved by drilling a well from surface and installing and cementing a series of concentric casing strings in the drilled borehole, extending from a wellhead. The borehole is then extended to a desired depth and a liner installed in the extended section, the liner extending from the bottom or 'shoe' of the lowermost casing string. Following cleaning and testing of the lined borehole, production tubing is installed extending from surface down through the casing and liner to a producing formation. Well fluids flow into the production tubing from the formation and are thereby recovered to surface.
In an offshore environment, it is necessary to install a large diameter tubing, known as a riser, extending from the wellhead to a surface facility such as a drillship, floating production storage and offloading vessel (FPSO), drilling rig or the like. Tubing strings including liner, drill strings, production tubing and other intervention or tool strings are all run into the borehole through the riser. A blow-out preventer (BOP) is also provided as part of the riser string, and is either located at seabed level on the wellhead, or is located nearer to surface, if prevailing weather conditions permit. As is well known in the art, the BOP permits safe shut-down of the well in the event of an emergency situation arising.

Other types of procedures have been proposed for gaining access to well fluids, including the method proposed by one of the present co-inventors in International Patent Application No. PCT/GB2005/002885, whereby a subsea shut-off device including a ball gripping mechanism is latched to a template at surface, and drilled in casing is suspended from the device at any position using the gripping mechanism so that the device is run to the sea floor on a casing string. The casing string is drilled into place and converted into a riser, and this is all done on a single trip to speed up the operation and reduce risk. The casing string is captured and sealed within the subsea shut-off device after installing and spacing out a surface BOP.

A vast array of equipment is required in order to bring a well into production, whether following conventional techniques, or alternatives such as that proposed in
Much of the equipment utilised must be brought to a location adjacent a rig floor of the surface facility, for subsequent deployment, or is deployed from a level below the rig floor. Conventionally, this has been achieved utilising handling equipment including cranes, elevators and the like. In more recent years, dedicated equipment has been developed specifically for handling apparatus to be deployed from the rig, particularly large, heavy apparatus such as BOPs, which may weigh several hundred tonnes.

The handling of equipment utilising cranes and elevators is generally undesired, and can lead to accidents, particularly on vessels which are subject to relatively large movements under applied wind, wave and tidal loading. Additionally, the handling of apparatus using such equipment is typically time-consuming and laborious.

It will be appreciated that, in view of the high rental costs involved in leasing offshore equipment such as floating rigs and drillships, it is generally desired to minimise the time taken to carry out all types of procedure in the industry.

Where dedicated equipment has been provided for handling apparatus to be deployed, this equipment has conventionally been very large, which presents a particular problem in the offshore environment, where space is severely restricted. Additionally, the handling equipment is suited only for a single use or purpose; is typically slow moving; and is not capable of being used to handle other types of apparatus.
Whilst space restrictions are less pronounced in onshore facilities, it will be understood that many of the above problems are of equal concern.

It is amongst the objects of embodiments of the present invention to obviate or mitigate at least one of the foregoing disadvantages.

According to a first aspect of the present invention, there is provided a rig assembly comprising:

- a rig floor receiving area;
- a plurality of movable rig floor units, each rig floor unit configured for location in the rig floor receiving area, to thereby define a rig floor of the rig assembly;
- and
- a transporter configured to receive any one of the rig floor units, for transporting a selected one of the rig floor units from a storage area to the rig floor receiving area.

It will be understood that the transporter may also be for transporting a rig floor unit from the rig floor receiving area to the storage area, when it is desired to locate an alternative selected rig floor unit in the rig floor receiving area. The transporter may therefore serve for transporting rig floor units between the two areas.

It will also be understood that a rig floor of a rig assembly is generally defined as the work area in which a rig crew conducts operations.

Providing a rig assembly with a plurality of movable rig floor units, a rig floor receiving area, and a
transporter for transporting a selected rig floor unit from a storage area to the rig floor receiving area, facilitates a rapid changeover at the rig floor area when different tasks or operations are to be performed, when compared with prior practice in the industry.

Each rig floor unit may be adapted for performing a different task or operation or a step in a task or operation. Thus switching of equipment necessary to carry out the desired task, operation or step may be rapidly achieved simply by switching around the rig floor units. To facilitate this, each rig floor unit may be adapted to carry different equipment suited to the particular task, operation or step.

The storage area may comprise a plurality of rig floor storage locations, each configured to receive a respective rig floor unit. Accordingly, each rig floor unit may be adapted to be located in a respective storage location in the storage area. The selected rig floor unit may be adapted to be transferred from its storage location on to the transporter, which may then transport the rig floor unit to the rig floor receiving area.

The transporter may be movable along a path extending between the storage area and the rig floor receiving area, for transporting the rig floor units between the storage area and the rig floor receiving area. The transporter may therefore be movable to a position where it can access any one of the rig floor units, such that the selected rig floor unit may be transferred on to the transporter, and such that a rig floor unit returned from
the rig floor receiving area to the storage area by the
transporter may be transferred off the transporter.
The rig floor units may each be configured to be
releasably secured, locked or located relative to or
within the transporter. This may permit safe
transportation of the rig floor units between the storage
area and the receiving area, as well as safe operation in
use of the rig floor defined by the rig floor unit. One
or both of the rig floor units and the transporter may
comprise a locking assembly for securing the rig floor
units relative to the transporter. The transporter may
be configured to be releasably secured, locked or located
relative to or within the rig floor receiving area. In
this fashion, the transporter, carrying the selected rig
floor, may be secured within the rig floor receiving area
and may thereby locate the rig floor unit in the
receiving area, to define the rig floor. It will
therefore be understood that the transporter may remain
within the receiving area during the time when the
selected rig floor unit is in the receiving area.

The transporter may be configured to be secured to a
support structure provided in the rig floor receiving
area. One or both of the transporter and the support
structure may comprise a locking assembly for securing
the transporter in the receiving area. The locking
assembly may comprise at least one, and preferably a
plurality of locking dogs, pins, latches or the like.
The locking assembly may be hydraulically actuated, or in
alternative embodiments, may be electro-mechanically or
electrically actuated or a combination thereof.
In alternative embodiments, the rig floor units may each be configured to be releasably secured, locked or located relative to or within the rig floor receiving area. In this fashion, the transporter may be removed from the receiving area, if desired, following location of the rig floor unit within the rig floor receiving area.

The rig floor units may be configured to be secured to a support structure provided in the rig floor receiving area. One or both of the rig floor units and the support structure may comprise a locking assembly for securing the rig floor units in the receiving area. The locking assembly may comprise at least one, and preferably a plurality of locking dogs, pins, latches or the like. The locking assembly may be hydraulically actuated, or in alternative embodiments, may be electro-mechanically or electrically actuated or a combination thereof.

The rig assembly may comprise a transfer system for transferring the rig floor units between a storage location within the storage area and the transporter. The transfer system may comprise a translation device for translating the rig floor units between their storage locations and the transporter. The translation device may be adapted to transfer the rig floor units directly between their respective storage locations and the transporter. However, in embodiments of the invention, the transfer system may comprise a lift, elevator or the like for raising and/or lowering the rig floor units between a level of the storage locations and a level of the transporter. In use, a rig floor unit may be translated on to the lift and the lift may then raise or lower the rig floor unit into a position where the unit
may be received within the transporter. The transporter may be shaped to define a space in which the rig floor units are received, to facilitate transfer of the units from the lift into the transporter. In particular, the transporter may be shaped to straddle the rig floor units, and may comprise first and second sides spaced and connected by a connecting structure, with a space defined between the sides in which the rig floor units are received. In a variation, the transporter may be height adjustable for raising and lowering to a level of the unit storage locations.

The rig assembly may be modular and may therefore be adaptable for various different types of rig, according to the space available. Accordingly, the rig assembly may be configured as required to suit a particular rig.

The rig assembly may comprise handling equipment which may be coupled to and movable with the transporter, or which may be independently movable relative to the transporter. The handling equipment may comprise a tubing handling device for picking up and/or supporting a length of tubing, and which may serve for transferring tubing on to the transporter. This may facilitate subsequent deployment of the tubing on to and/or through the rig floor defined by the selected rig floor unit. It will be understood that the tubing may be a length of casing, liner, riser, drill tubing, production tubing or any other tubing utilised in the industry. The handling device may comprise one or more electromagnetic supports for selectively picking up and/or supporting the tubing. The handling device may be adapted to incline the tubing to assist in transfer on to the rig floor, and may
comprise a support for supporting an end of the tubing during transfer.

The rig floor receiving area may be adapted to be provided on or in a deck of a surface facility on which the rig assembly is provided. The rig floor receiving area may be provided around or adjacent to a moonpool in the facility. It will be understood that the moonpool is the opening in the hull or structure of the surface facility through which equipment/apparatus passes. The transporter may be for transporting the selected rig floor unit to a location above the moonpool, for the deployment of equipment into the moonpool. It will be understood that the surface facility may be a vessel such as a drillship, FPSO or FSO, or a rig such as a semi-submersible, submersible or jack-up rig. Alternatively, the rig floor receiving area may be adapted to be provided on or in a frame or support which may extend overboard.

The rig floor units may each comprise handling apparatus for handling equipment to be deployed from the rig floor. The rig floor units may be selected from a group comprising: a drill unit having a rotary drive for driving and rotating a string of tubing; a BOP unit for supporting a BOP; a coiled tubing injector unit for supporting a coiled tubing injector to be used for running coiled tubing; and a subsea shut-off device unit, for running a subsea shut-off device such as that disclosed in International Patent Application No. PCT/GB2005/002885. However, it will be understood that, in principle, any desired rig floor unit may be provided. At least one of the rig floor units may be adapted for
deploying equipment from the rig assembly. For example, in embodiments of the invention, at least one of the rig floor units may comprise an aperture through which equipment may be deployed.

At least one of the rig floor units may be adapted to selectively support a tubing string and may therefore serve for suspending at least part of the load of a tubing string from the rig. The rig assembly may comprise a support for supporting a load of a tubing string during changeover of rig floor units.

If desired, the transporter may be configured to receive a plurality of selected rig floor units. Thus, for example, where the rig assembly comprises three or more rig floor units, the transporter may be configured to receive two units, for faster changeover.

The transporter may be self-driven, and may therefore comprise a drive system for moving the transporter between the storage area and the rig floor receiving area. The drive system preferably comprises a plurality of drive wheels which are adapted to run on guide rails, but may alternatively comprise wheels, tracks or the like.

According to a second aspect of the present invention, there is provided a movable rig floor unit, the rig floor unit configured for location in a rig floor receiving area of a rig assembly to thereby define a rig floor of the rig assembly, the rig floor unit further configured to be received in a transporter for transportation from a storage area to the rig floor receiving area.
According to a third aspect of the present invention, there is provided a rig floor transporter, the transporter configured to receive any one of a plurality of rig floor units, for transporting a selected one of the rig floor units from a storage area to a rig floor receiving area of a rig assembly.

Further features of the rig floor unit and the transporter of the second and third aspects of the invention, respectively, are defined above in relation to the first aspect of the invention.

According to a fourth aspect of the present invention, there is provided a rig comprising a rig assembly according to the first aspect of the present invention.

According to a fifth aspect of the present invention, there is provided a vessel comprising a rig, the rig comprising a rig assembly according to the first aspect of the present invention.

According to a sixth aspect of the present invention, there is provided a method of providing a rig floor of a rig assembly, the method comprising the steps of: providing a plurality of movable rig floor units, each rig floor unit configured for location in a rig floor receiving area of a rig assembly, the rig floor units located in a storage area on a rig; selecting one of the rig floor units; mounting the selected rig floor unit on a transporter configured to receive any one of the rig floor units;
transferring the selected rig floor unit from the storage
area to the rig floor receiving area using the
transporter; and
locating the selected rig floor unit in the rig floor
receiving area, to thereby form a rig floor of the rig
assembly.

Preferably, the method further comprises the steps of:
returning the selected rig floor unit from the rig floor
receiving area to the storage area using the transporter;
selecting an alternative rig floor unit;
mounting the alternative rig floor unit on the
transporter;
transporting the alternative rig floor unit from the
storage area to the rig floor receiving area using the
transporter; and
locating the alternative rig floor unit in the rig floor
receiving area, to thereby form an alternative rig floor
of the rig assembly. These steps may be repeated as
necessary or as desired in order to define a number of
different rig floors, which may permit a range of
operations to be carried out. Indeed, the method may
further comprise the steps of performing an operation or
a step in an operation from the rig floor defined by the
selected rig floor unit, before returning the unit to the
storage area and, following location of the alternative
unit in the receiving area, performing an operation or a
further step in an operation from the alternative rig
floor.

The method may comprise securing the selected rig floor
unit relative to the transporter, transporting the
selected rig floor unit to the receiving area and
securing the transporter within the receiving area. An operation or step in an operation may then be carried out from the rig floor. Alternatively, the selected rig floor unit may be secured within the receiving area and the transporter moved away from the receiving area.

The rig floor units may be stored in respective rig floor unit storage locations within the storage area, and may be transferred on to the transporter by a transfer system. The storage locations may be at a level above or below that of the transporter, therefore the method may comprise lowering or raising the units from their respective storage locations to the level of the transporter, for transferring the units on to the transporter.

According to a seventh aspect of the present invention, there is provided a rig assembly comprising:

- a rig floor receiving area;
- a plurality of movable rig floor units, each rig floor unit configured for location in the rig floor receiving area, to thereby define a rig floor of the rig assembly; and
- a transporter configured to receive any one of the rig floor units, for transporting a rig floor unit between a storage area and the rig floor receiving area.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:
Figs 1 and 2 are plan and side views respectively, of a vessel incorporating a rig assembly, in accordance with an embodiment of the present invention;

Fig 3 is an enlarged plan view of the rig assembly shown in Figs 1 and 2;

Fig 4 is an enlarged side view of part of the rig assembly shown in Figs 1 and 2;

Figs 5 and 6 are enlarged plan and side views, respectively, of a transporter forming part of the rig assembly shown in Figs 1 and 2;

Figs 7 and 8 are enlarged plan and side views, respectively, of a first rig floor unit forming part of the rig assembly shown in Figs 1 and 2;

Figs 9 and 10 are enlarged plan and side views, respectively, of a second rig floor unit forming part of the rig assembly shown in Figs 1 and 2;

Figs 11, 12 and 13 are enlarged plan, side and further side views, respectively, of a third rig floor unit forming part of the rig assembly shown in Figs 1 and 2;

Figs 14, 15 and 16 are enlarged plan, side and further side views, respectively, of a fourth rig floor unit forming part of the rig assembly shown in Figs 1 and 2;

Figs 17 and 18 are enlarged plan and side views of handling equipment forming part of the rig assembly shown in Figs 1 and 2;
Figs 19 to 24 are schematic side views illustrating use of the handling equipment shown in Figs 17 and 18;

Figs 25, 26 and 27 are enlarged plan, side and end views, respectively, of a tail loader provided on the transporter shown in Figs 1 to 6;

Fig 28 is a perspective view of part of a support frame, forming part of a rig assembly in accordance with an alternative embodiment of the present invention; and

Fig 29 is a perspective view of a tubing gripping assembly forming part of the support frame shown in Fig 28.

Turning firstly to Figs 1 and 2, there are shown plan and side views, respectively, of a vessel in the form of a drillship 10 incorporating a rig assembly indicated generally by reference numeral 12, in accordance with an embodiment of the present invention. The rig assembly 12 is shown in more detail in the enlarged plan view of Fig 3 and comprises a rig floor receiving area 14 formed in a deck 16 of the drillship 10, and a plurality of moveable rig floors, decks or deck units 18, 20, 22 and 24 which are initially spaced from the rig floor receiving area 14. Each of the rig floor units 18, 20, 22 and 24 are configured for location in the rig floor receiving area 14, to thereby define a rig floor of the rig assembly 12. The rig assembly 12 also includes a transporter 26, which is shown in more detail in the enlarged side view of Fig 4, showing part of the rig assembly 12, and in the enlarged plan and side views of Figs 5 and 6.
respectively. The transporter 26 is configured to receive any one of the rig floor units 18, 20, 22 and 24, for transporting a selected one of the rig floor units 18, 20, 22 and 24 from a storage area 28 (Figs 1 to 4) to the rig floor receiving area 14.

The rig assembly 12 is shown in the Figures with all of the rig floor units 18, 20, 22 and 24 in respective storage locations 30, 32, 34 and 36 in the storage area 28 and thus prior to transportation of a selected one of the rig floor units from the storage area 28 to the rig floor receiving area 14.

A ram rig 38 is provided in the rig floor receiving area 14 above a moonpool 40 (Figs 1 and 3) extending through a hull 41 of the drillship 10. The ram rig 38 serves for suspending tubing strings from the drillship 10 and for running equipment downhole. It will be understood that a conventional derrick (not shown) may be provided in place of the ram rig 38, if desired. As shown particularly in Figs 1 and 3, an upper end 42 of the moonpool 40 is open prior to location of a selected one of the rig floor units 18, 20, 22 or 24 above the moonpool 40.

As will be described in more detail below, each of the rig floor units 18, 20, 22 and 24 are designed for carrying out different operations, or different steps in an operation, and carry various different types of equipment suited to the particular operation to be carried out. By providing rig floor units 18, 20, 22 and 24 suited for such different operations, the different operations or steps can be carried out by transporting the desired rig floor unit from the storage area 28 to
the rig floor receiving area 14 to a position above the moonpool 40, to thereby define a rig floor of the rig assembly 12. Once located in the receiving area 14, the desired operation or steps are carried out and, following completion of the operation, the selected rig floor unit 18, 20, 22 or 24 may then be returned from the rig floor receiving area 14 to the storage area 28 and an alternative rig floor unit selected and transported to the rig floor receiving area 14. This alternative rig floor unit 18, 20, 22 or 24 is then located above the moonpool 40 to define a different rig floor, and permits an alternative operation, or a further step in an operation, to be carried out.

The present invention therefore offers significant advantages over conventional procedures where apparatus required for conducting different operations must be separately transported to the rig floor receiving area using handling equipment such as cranes and elevators and, in certain circumstances, specialised handling equipment suited only for the particular apparatus to be transported. As described above, such procedures are time-consuming and laborious. In contrast, it is anticipated that changeover of a rig floor unit 18, 20, 22 or 24 in place above the moonpool 40 with an alternative rig floor unit will take around 15 minutes to complete, and the operation will offer significant advantages in terms of safety when compared to conventional handling methods using cranes, elevators and the like.
The rig assembly 12 and method of providing a rig floor of the rig assembly 12 will now be described in more detail.

The rig floor units 18, 20, 22 and 24 are shown in more detail in the views of Figs 7 to 16. Of these, Figs 7 and 8 are enlarged plan and side views of the rig floor unit 18; Figs 9 and 10 are enlarged plan and side views of the rig floor unit 20; Fig 11 is an enlarged plan view of the rig floor unit 22, whilst Figs 12 and 13 are enlarged side views of the unit 22 shown before and during deployment of BOP assembly; and Fig 14 is an enlarged plan view of the rig floor unit 24 whilst Figs 15 and 16 are enlarged side views of the unit 24 prior to and during deployment of a subsea shut-off device of the type disclosed in International Patent Application Number PCT/GB2005/002885.

As shown in Figs 7 and 8, the rig floor unit 18 comprises a frame 48 and a deck surface 50 provided on the frame 48. An aperture 52 extends through the deck surface 50, and handling equipment in the form of a support structure 54 for a coiled tubing injector 56 is provided on the frame 48. It will therefore be understood that the rig floor unit 18 comprises an injector deck. When the injector deck 18 is provided in the receiving area 14 above the moonpool 40, the injector deck 18 defines a rig floor which supports the coiled tubing injector 56 and permits running and control of coiled tubing through a guide 58 (indicated in broken outline), fed from a reel 60 shown in Figs 1 and 2.
As shown particularly in Figs 4 to 6, the transporter 26 includes hydraulically actuated lock-down pins or cylinders 62 which, on actuation, are movable between retracted and extended positions. The pins 62 are shown in Fig 5 in an extended position where the pins engage lock-down tubes 64 mounted on the frame 48 of the injector deck 18. The lock-down pins 62 and lock-tubes 64 together form part of a locking assembly for securing the injector deck 18 relative to the transporter 26.

The transporter 26 also comprises two side frame members 66, 68, coupled by a connecting gantry 67. A space 70 is defined between the side frame members 66 and 68 which is sized to receive the injector deck 18. It will therefore be understood that when the injector deck 18 is located within the space 70 and locked by the pins 62, the transporter 26 may safely transport the injector deck 18 from the storage area 28 to the rig floor receiving area 14.

The rig assembly 12 also includes a transfer system, best shown in Fig 3, which is indicated generally by reference numeral 72. The transfer system 72 serves for transferring the selected rig floor unit 18, 20, 22 or 24 from its respective storage location 30, 32, 34 and 36 onto the transporter 26, and also for returning the respective rig floor unit from the transporter 26 to its storage location. To achieve this, the transfer system 72 includes a lift 74 which can be raised and lowered. The lift 74 is positioned along a length of a path 76 which the transporter 26 traverses during transportation of rig floor units between the storage area 28 and the rig floor receiving area 14. The transfer system 72 also includes two lateral (thwartships) translation assemblies.
78 and 80, which serve for translating selected rig floor
units in the direction X-X' (Fig 3) and onto the lift 74
by virtue of respective lateral drives 82, 84. The
lateral translation assemblies 78 and 80 also include
bow-stern drives 86, 88 for translating the rig floor
units in the direction of the arrows Y-Y'. The drives
82, 84 and 86, 88 each take the form of conveyors of a
conventional type.

Further, similar translation assemblies 90, 92 and 94 are
provided which include bow-stern drives 96, 98 and 100,
respectively. It will therefore be understood that the
rig floor units 18, 20, 22 and 24 may be moved around the
storage locations 30, 32, 34 and 36 in the storage area
28, for positioning a desired rig floor unit adjacent the
lift 74 and thus for transferring the selected unit onto
the lift 74.

Returning now to Figs 9 and 10, where the rig floor unit
20 is shown, the unit 20 takes the form of a drill deck
suitable for drilling a well bore and includes a rotary
table 102. Like components of the drill deck 20 with the
injector deck 18 share the same reference numerals, with
the addition of the suffix a. The rotary table 102 is of
a conventional type, save that the table 102 is moveably
mounted within the deck 50a. This facilitates deployment
of apparatus through the deck 50a, if desired, and
enables a string of tubing (not shown) to be supported by
the ram rig 38 and/or a compensated support frame 104
(Figs 1 and 2), which will be described in more detail
below. Lock-down tubes 64a are provided integrally
within the frame 48a.
Returning to Figs 11 to 13, where the rig floor unit 22 is shown, the unit 22 takes the form of a BOP deck. Like components of the BOP deck with the injector deck 18 share the same reference numerals, with the addition of the suffix b. A BOP support structure 54b on a frame 48b of the BOP deck 22 serves both for supporting the BOP 44, and for raising and lowering the BOP 44 by virtue of a deployment cylinder 106 of the ram rig 38, for lowering the BOP 44 through the aperture 52b and into the moonpool 40. This facilitates coupling of tubing (not shown) to the BOP 44, for deploying the BOP 44 from the drillship 10. Typically, a first tubing section is suspended from the ram rig 38 and coupled to the BOP 44. The BOP 44 and first tubing section are then lowered down through the BOP deck aperture 52b and through the support frame 104, and the BOP 44 is positioned below the frame 104. Following the teachings of PCT/GB2006/001822 to one of the present co-inventors, the disclosure of which is incorporated herein by way of reference, the BOP is suspended from the frame 104 by a tubing gripper device on the frame, an example of which will be described in more detail below.

With the BOP 44 suspended below the support frame 104, the BOP 44 is lowered through the moonpool 40 and from the drillship 10 towards a seabed. Successive tubing sections are coupled together to end-to-end in a fashion known in the art, to progressively extend the tubing string. This is achieved by lowering the frame 104 out of the moonpool 40; suspending the tubing string and BOP 44 from the deck 50b using slips or the like (not shown); releasing the gripping device on the frame 104 from the tubing; and stripping the frame 104 back along the tubing
up the moonpool 40. The tubing string/BOP 44 is then
once again supported from the frame 104 using the
gripping device, the slips released and the tubing/BOP 44
lowered a further distance. Additional tubing, suspended
from the ramrig 38, is then coupled to the tubing section
extending up through the moonpool 40, and the tubing
string/BOP 44 lowered a further distance. This process
is repeated until the BOP 44 has been deployed down to
the seabed and connected to a wellhead.

In accordance with the teachings of PCT/GB2 006/001822,
the support frame 104 forms part of a compensating system
for compensating movement of the drillship 10 relative to
the seabed, and can be operated in both active and
passive compensation modes.

Returning now to Figs 14 to 16, where the rig floor unit
24 is shown, the unit 24 takes the form of a deck for
deploying the subsea shut-off device 46, and like
components of the deck 24 with the injector deck 18 share
the same reference numerals, with the addition of the
suffix c. A support structure 54c supports the shut-off
device 46 during transportation, in the position shown in
Fig 15, and this also permits access to the device 46 for
maintenance purposes. When the device 46 is to be
deployed into the moonpool 40, the device 46 is rotated
to the position shown in Fig 16 and is suspended from the
ram rig 38. The device 46 is then released from the
support structure 54a, tubing (not shown) coupled to the
shutoff device 46, and the deck 50c released from the
receiving area 14 and removed from its position above the
moonpool 40, using the transporter 26. The shutoff
device 46 is then lowered through the moonpool 40 to a
position below the support frame 104, and is suspended from the frame 104 using a gripping device. The deck 50c can then be returned above the moonpool 40, and the shutoff device 46 deployed from the drillship 10 with the assistance of slips or the like on the deck 50c, in the fashion described above in relation to the BOP 44 of Figs 11 to 13.

Returning once more to Figs 4 to 6, it will be noted that the transporter 26 includes transporter lock-down pins 108, which are hydraulically actuated in a similar fashion to the pins 62. The transporter pins 108 are shaped for engaging lock-down tubes 110 provided in deck areas 112, 114, which thereby form support structures for the transporter 26. The transporter 26 is mounted for movement along a pair of guide rails and includes powered track runners 118 (Fig 6) for moving the transporter 26 along the rails 116.

The rig assembly 12 is operated to bring a selected rig floor unit 18, 20, 22 or 24 to the rig floor receiving area 14 as follows. Initially, each of the units 18, 20, 22 and 24 are located in their respective storage locations 30, 32, 34 or 36 and the transporter is in the position shown in Figs 1 to 4. In a first procedure, it is desired to locate the drill deck 20 above the moonpool 14. This is achieved by raising the lift 74 up to the level of the drill deck 20 (Fig 4) and translating the drill deck 20 from its storage location 32 using the lateral drives 82. It will be noted that the lift 74 includes similar drives 120 for positioning the drill deck 20 on the lift. The lift 74 then lowers the drill deck 20 to the level of the lock-down pins 62 on the
transporter 26, and the transporter 26 is driven along
the guide rails 116 to a position where the drill deck 20
is received within the space 70, with the drill deck
lock-down tubes 64 in alignment with the pins 62. This
movement is permitted by virtue of the connecting gantry
67 of the transporter 26, which passes over the top of the
drill deck 20. However, it will be understood that where
larger equipment, such as the BOP assembly 44, has to be
carried by the transporter 26, it may be necessary for
the lift 74 to carry the BOP assembly 44 further down in
to the hull 41 of the drillship 10, and then to raise it
up following positioning of the transporter 26.

With the drill deck 20 in position, the lock-down pins 62
are actuated, engaging in the tubes 64, and the drill
deck 20 is then locked and secured relative to the
transporter 26. The transporter 26 is then returned
along the guide rails 116, and moves to a position where
the drill deck 20 is above the moonpool 40, with the
transporter lock-down pins 108 aligned with the
transporter lock-down tubes 110. The pins 108 are then
actuated, to lock and secure the transporter 26 within
the rig floor receiving area 14. This therefore secures
the drill deck 20 within the receiving area 14, and the
drill deck 20 now forms the rig floor.

Following completion of a drilling procedure utilising
the drill deck 20, it is desired to return the drill deck
20 to the storage area 28 and to select an alternative
rig floor unit from the injector deck 18, BOP deck 22 and
shut-off device deck 24. To achieve this, the
transporter lock-down pins 108 are disengaged, and the
transporter returned to a position where the drill deck
20 is above the lift 74. The lift 74 is then raised to bear the load of the drill deck 20, and the lock-down pins 62 disengaged. The transporter 26 is then translated back along the guide rails 116, and the drill deck 20 returned to the storage location 32, utilising the lift drives 120 and the lateral drives 82. If it is now desired to transfer the injector deck 18 from its storage location 30 to the receiving area 14, the drill deck 20 is firstly transferred to a holding storage location 122 by the bow-stern drives 86 on the translation assembly 78, and the injector deck 18 is then transferred on to the lateral translation assembly 78 by the bow-stern drives 96 on the assembly 90. The injector deck 18 is then transferred on to the lift 74, and secured to the transporter 26 before being carried to the receiving area 14 and secured as described above. Following completion of a procedure utilising the injector deck 18, the injector deck 18 is returned to the storage location 30 in a similar fashion to the drill deck 20, and the BOP deck 22 or shut-off device deck 24 may then be carried to the receiving area 14 in the fashion described.

The rig assembly 12 additionally includes tubing handling equipment in the form of a casing car, which is shown in the enlarged plan and side views of Figs 17 and 18, respectively, and indicated generally by reference numeral 124. The casing car 124 is self-driven, in a similar fashion to the transporter 26, but is powered and controlled by the transporter 26 and connected by an umbilical or the like (not shown).
The casing car 124 includes a lifting arm 126 which is pivotally mounted to a beam 128, the beam 128 being driven and rotatable about an axis 132 relative to the frame 130. Additionally, the beam 128 can be driven along the length of a cross-frame arm 133. The lifting arm 126 carries a pair of electromagnets 134 which, when actuated, collect a casing section 136 from a store 138 on the deck 16. Lifting of the casing section 136, deployment onto the transporter 26 and thus onto the rig floor is shown in the schematic views of Figs 19 to 24. The lifting arm 126 is initially positioned relative to the casing section 136 to be lifted such that the section 136 lies horizontally when lifted, on rotation of the beam 128. The support arm 140 carries a bucket 142 which, when in the position indicated by broken outline in Fig 18, inclines the casing section 136 from the horizontal, to facilitate transfer of the casing section 136 from the casing car 124 on to the transporter 26. The support arm 140 is also rotatable to the position shown in solid outline in Fig 18, where the bucket 142 forms a support for an end 144 of the casing section 136. Following movement to the position shown in Fig 24, the casing section 136 is vertical and ready for deployment utilising the ram rig 38.

To assist in deployment of the casing section 136, a tail loader 146 is provided in the transporter 26 and is shown in more detail in the plan, side and end views, respectively, of Figs 25 to 26. The tail loader 146 includes a V-ramp 148 for receiving the casing section 136, and a pair of arms 150 which are mounted to the V-ramp and which carry a roller 152. As shown in Fig 27, the roller 152 tapers towards a central section 154 which
co-operates with the V-ramp 148 to support the casing section 136. As shown particularly in Figs 22 to 24, the arms 150 are rotatable in the direction of the arrow Z (Fig 26), to bring the roller 150 into contact with the casing-section 136 and to support the casing section safely during deployment into the ram rig 38, and indeed during deployment through the moonpool 40.

Considering now the support frame 104 in more detail, the support frame 104 includes a leader frame 156 which is supported on a tension frame 158. The leader frame 156 is movable within the moonpool 40 and locks out towards a lower end 160 of the moonpool, whilst the tension frame 158 can be deployed into the water below the drillship 10, following the teachings of PCT/GB2006/001822. Four arms 162, best shown in Fig 3, are pivotally coupled to the tension frame 158 and, in the position of Fig 3, provide a mounting for the gripper device (not shown). When it is desired to have full access down the moonpool 40 through the tension frame 158, the gripper device is removed from its location on the arms 162, and the arms pivoted to folded positions. This provides unrestricted passage through the tension frame 158, for example, for the BOP 44.

Turning now to Fig 28, there is shown a perspective view of part of an alternative support frame 104'. Like components of the support frame 104' with the support frame 104 share the same reference numerals, with the addition of the suffix '. Only the differences between the frames 104' and 104 will be described herein in detail.
Fig 28 in fact shows a tension frame 158' of the support frame 104'. The tension frame 158' includes four main columns 164, each of which carries a respective inwardly extending lug or boss 166. These lugs 166 are provided in place of the pivoting arms 162 of the frame 104, and provide mountings for a tubing gripping assembly 168, which is shown in the perspective view of Fig 29. The gripping assembly 168 includes a releasable gripper device 170, and is shown gripping and supporting tubing in the form of a drill collar 172. The gripper device 170 is provided within a central hub 174, from which four mounting arms 176 extend. Each of the mounting arms 176 include a pair of shaped wedges 178, which are shaped to engage around the lugs 166, such that the gripping assembly 168 can be releasably mounted on the lugs 166 and thus located within the tension frame 158'. The gripping assembly 168 can be selectively removed from its location within the tension frame 158' when full clearance through the support frame 104' is required, for example, for the passage of the BOP 44, simply by lifting the assembly 168 up off the lugs 166. Following passage of the BOP 44 through the support frame 104', the gripping assembly 168 can be returned to its position within the tension frame 158'.

The gripper device 170 includes a pair of hinged gripper arms 180, each of which carries a half-cylindrical slip or tubing grip 182. The arms 180 are pivotally mounted to the hub 174 by pins 181, and are moved between disengaged and engaged positions by hydraulic pistons 184. The arms 180 are shown in Fig 29 in their engaged positions, where the slips 182 are seated in an upper end of a bore of a hollow mounting 186 which is located
within the hub 174, defining a cylindrical collar. The slips 182 are each shaped to engage an upset or shoulder on the drill collar 172, for suspending a tubing string including the drill collar 172 from the tension frame 158'. To release the drill collar 172, the pistons 184 are actuated to rotate the slips 182 away from the upper end of the mounting 186 bore. It will be understood that this facilitates release of the tension frame 158' from the tubing string, such that the frame 158' may be stripped along the tubing for coupling further tubing sections, such as a further drill collar 172.

Movement of the tension frames 158, 158' is controlled using winches and tensioner devices according to the teachings of PCT/GB2006/001822. In an active compensation mode, movement of the tension frame 158 or 158' is controlled such that the location of equipment relative to a seabed is precisely controlled during deployment of the equipment from the drillship 10. This is particularly important, for example, during lowering of a tubing string carrying the BOP 44 where the drillship 10 is pitching, rolling and heaving under applied wind, wave and tidal loads. In a passive compensation mode, movement of the tension frame 158 or 158' relative to the drillship 10, due to movement of the drillship 10, is damped out using the winches and tensioner devices.

The rig assembly described herein, including the rig floor units 18-24, transporter 26 and support frame 104 offers particular advantages in that the load of tubing/equipment can be transferred between the frame 104.
and the drillship 10 deck, facilitating changeout of the
deck units.

Various modifications may be made to the foregoing
without departing from the spirit and scope of the
present invention.

For example, the locking assemblies may comprise locking
dogs, latches or the like. The locking assemblies may be
hydraulically actuated, electro-mechanically or
electrically actuated, or indeed a combination thereof.

The rig floor units may each be configured to be
releasably secured, locked or located relative to or
within the rig floor receiving area. In this fashion,
the transporter may be removed from the receiving area,
if desired, following location of the rig floor unit
within the rig floor receiving area.

The translation devices may be adapted to transfer the
rig floor units directly between their respective storage
locations and the transporter.

The transporter may be height adjustable for raising and
lowering to a level of the unit storage locations.

The tubing handling device may serve for picking up
and/or supporting any desired type of tubing, which may
be a length of casing, liner, riser, drill tubing,
production tubing or any other tubing utilised in the
industry. In place of electromagnets, any other suitable
support may be provided.
Where the rig assembly is for a surface facility, the surface facility may be an alternative vessel such as an FPSO or FSO, or a rig such as a semi-submersible, submersible or jack-up rig.

The rig floor receiving area may be provided on or in a frame or support which may extend overboard.

Any desired rig floor unit may be provided, including suitable support/deployment apparatus or equipment.

The transporter may be configured to receive a plurality of selected rig floor units. Thus, for example, where the rig assembly comprises three or more rig floor units, the transporter may be configured to receive two units, for faster changeover.

Instead of being self-driven, a separate drive system may be provided for moving the transporter/handling equipment.
1. A rig assembly comprising:
   a rig floor receiving area;
   a plurality of movable rig floor units, each rig floor unit configured for location in the rig floor receiving area, to thereby define a rig floor of the rig assembly; and
   a transporter configured to receive any one of the rig floor units, for transporting a selected one of the rig floor units from a storage area to the rig floor receiving area.

2. A rig assembly as claimed in claim 1, wherein the transporter is also for transporting a rig floor unit from the rig floor receiving area to the storage area.

3. A rig assembly as claimed in either of claims 1 or 2, wherein each rig floor unit is adapted for performing a different task.

4. A rig assembly as claimed in claim 3, wherein each rig floor unit carries different equipment suited to the particular task to be performed.

5. A rig assembly as claimed in any preceding claim, wherein the storage area comprises a plurality of rig floor storage locations, each configured to receive a respective rig floor unit.

6. A rig assembly as claimed in any preceding claim, wherein the transporter is movable along a path.
extending between the storage area and the rig floor receiving area, for transporting the rig floor units between the storage area and the rig floor receiving area.

7. A rig assembly as claimed in any preceding claim, wherein the rig floor units are each configured to be releasably secured to the transporter.

8. A rig assembly as claimed in claim 7, wherein at least one of the rig floor units and the transporter comprise a locking assembly for securing the rig floor units relative to the transporter.

9. A rig assembly as claimed in any preceding claim, wherein the transporter is configured to be releasably secured within the rig floor receiving area.

10. A rig assembly as claimed in any preceding claim, wherein the transporter is configured to be secured to a support structure provided in the rig floor receiving area.

11. A rig assembly as claimed in claim 10, wherein at least one of the transporter and the support structure comprise a locking assembly for securing the transporter in the receiving area.

12. A rig assembly as claimed in any one of claims 1 to 10, wherein the rig floor units are each configured to be releasably secured within the rig floor receiving area.
13. A rig assembly as claimed in claim 12, wherein the rig floor units are each configured to be secured to a support structure provided in the rig floor receiving area.

14. A rig assembly as claimed in claim 13, wherein at least one of the rig floor units and the support structure comprise a locking assembly for securing the rig floor units in the receiving area.

15. A rig assembly as claimed in any preceding claim, comprising a transfer system for transferring the rig floor units between a storage location within the storage area and the transporter.

16. A rig assembly as claimed in claim 15, wherein the transfer system comprises a translation device for translating the rig floor units between their storage locations and the transporter.

17. A rig assembly as claimed in either of claims 15 or 16, wherein the transfer system comprises a lift for raising and/or lowering the rig floor units between a level of the storage locations and a level of the transporter.

18. A rig assembly as claimed in any preceding claim, wherein the transporter is shaped to straddle the rig floor units.

19. A rig assembly as claimed in claim 5, or any one of claims 6 to 18 when dependent on claim 5, wherein
the transporter is height adjustable for raising and lowering to a level of the unit storage locations.

20. A rig assembly as claimed in any preceding claim, comprising tubing handling equipment coupled to and movable with the transporter.

21. A rig assembly as claimed in claim 20, wherein the handling equipment comprises a tubing handling device for picking up and supporting a length of tubing, and for transferring the tubing on to the transporter.

22. A rig assembly as claimed in any preceding claim, wherein the transporter is for transporting the selected rig floor unit to a location above a moonpool of a surface facility, for the deployment of equipment into the moonpool.

23. A rig assembly as claimed in any one of claims 1 to 21, wherein the rig floor receiving area is adapted to be provided on a frame extending overboard from a surface facility.

24. A rig assembly as claimed in any preceding claim, wherein the rig floor units each comprise handling apparatus for handling equipment to be deployed from the rig floor.

25. A rig assembly as claimed in any preceding claim, wherein the rig floor units are selected from the group comprising: a drill unit having a rotary drive for driving and rotating a string of tubing; a BOP
unit for supporting a BOP; a coiled tubing injector
unit for supporting a coiled tubing injector to be
used for running coiled tubing; and a subsea shut-
off device unit, for running a subsea shut-off
device.

26. A rig assembly as claimed in any preceding claim,
wherein at least one of the rig floor units
comprises an aperture through which equipment may be
deployed.

27. A rig assembly as claimed in any preceding claim,
comprising a support for supporting a load of a
tubing string during changeover of rig floor units.

28. A rig assembly as claimed in any preceding claim,
wherein the transporter is configured to receive a
plurality of selected rig floor units
simultaneously.

29. A rig assembly as claimed in any preceding claim,
wherein the transporter comprises a drive system for
moving the transporter between the storage area and
the rig floor receiving area.

30. A rig comprising a rig assembly according to any one
of claims 1 to 29.

31. A vessel comprising a rig, the rig comprising a rig
assembly according to any one of claims 1 to 29.

32. A method of providing a rig floor of a rig assembly,
the method comprising the steps of:
providing a plurality of movable rig floor units,
each rig floor unit configured for location in a rig
floor receiving area of a rig assembly, the rig
floor units located in a storage area on a rig;
selecting one of the rig floor units;
mounting the selected rig floor unit on a
transporter configured to receive any one of the rig
floor units;
transporting the selected rig floor unit from the
storage area to the rig floor receiving area using
the transporter; and
locating the selected rig floor unit in the rig
floor receiving area, to thereby form a rig floor of
the rig assembly.

33. A method as claimed in claim 32, further comprising
the steps of:
returning the selected rig floor unit from the rig
floor receiving area to the storage area using the
transporter;
selecting an alternative rig floor unit;
mounting the alternative rig floor unit on the
transporter;
transporting the alternative rig floor unit from the
storage area to the rig floor receiving area using
the transporter; and
locating the alternative rig floor unit in the rig
floor receiving area, to thereby form an alternative
rig floor of the rig assembly.

34. A method as claimed in either of claims 32 or 33,
comprising the steps of performing an operation from
the rig floor defined by the selected rig floor
1 unit; returning the unit to the storage area; and,
2 following location of the alternative unit in the
3 receiving area, performing an operation from the
4 alternative rig floor.
5
6 35. A method as claimed in any one of claims 32 to 34,
7 comprising securing the selected rig floor unit
8 relative to the transporter, transporting the
9 selected rig floor unit to the receiving area and
10 then securing the transporter within the receiving
11 area.
12
13 36. A method as claimed in any one of claims 32 to 35,
14 comprising securing the selected rig floor unit
15 within the receiving area and moving the transporter
16 away from the receiving area.
17
18 37. A method as claimed in any one of claims 32 to 36,
19 comprising storing the rig floor units in respective
20 storage locations within the storage area, and
21 transferring the units from their storage locations
22 on to the transporter using a transfer system.
23
24 38. A movable rig floor unit, the rig floor unit
25 configured for location in a rig floor receiving
26 area of a rig assembly to thereby define a rig floor
27 of the rig assembly, the rig floor unit further
28 configured to be received in a transporter for
29 transportation from a storage area to the rig floor
30 receiving area.
31
32 39. A rig floor transporter, the transporter configured
33 to receive any one of a plurality of rig floor
units, for transporting a selected one of the rig floor units from a storage area to a rig floor receiving area of a rig assembly.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

<table>
<thead>
<tr>
<th>INV.</th>
<th>E21B15/00</th>
<th>E21B3/04</th>
<th>E21B19/00</th>
<th>E21B15/02</th>
</tr>
</thead>
</table>

According to International Patent Classification (IPC) or to both national classification and IPC

**B. DOCUMENTS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

E21B  E02B  B63B  B65B

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>GB 2 071 734 A (LITTLE BROTHER RIG INC)</td>
<td>1-4,20, 21,24, 25, 30-32, 38,39</td>
</tr>
<tr>
<td></td>
<td>23 September 1981 (1981-09-23)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>page 9, line 74 - line 95; figure 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>page 1, line 78 - line 106</td>
<td></td>
</tr>
<tr>
<td></td>
<td>page 3, line 73 - page 4, line 7</td>
<td></td>
</tr>
</tbody>
</table>

|           | column 2, line 37 - line 51; claim 1;                                           |                     |
|           | figures 7,8                                                                       |                     |
|           | column 7, line 66 - column 8, line 50                                             |                     |

Further documents are listed in the continuation of Box C

See patent family annex

---

Date of the actual completion of the international search: 13 June 2007

Date of mailing of the international search report: 21/06/2007

Name and mailing address of the ISA:
European Patent Office
P B 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel (+31-70) 340-2040, Tx 31 651 epo nl
Fax (+31-70) 340-3016

Authorized officer:
Dantinne, Patrick

---

Form PCT/ISA/210 (second sheet) (April 2005)
## DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>FR 2 594 459 A1 (TECHNIP GEOPRODUCTION [FR]) 21 August 1987 (1987-08-21) claim 1; figures 1,3-5</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>US 6 217 258 B1 (YAMAMOTO HIROMITSU [JP] ET AL) 17 April 2001 (2001-04-17) abstract; figures 1,3,4</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>GB 1 468 635 A (FINN TVETEN CO AS; AKERS MEK VERKSTED AS) 30 March 1977 (1977-03-30) claims 1,4; figures 1,2</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>US 4 063 650 A (HOMER JOSEPH F) 20 December 1977 (1977-12-20) abstract; figures 2,3</td>
<td>1</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>GB 2071734 A 23-09-1981</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 6048135 A 11-04-2000</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>FR 2594459 A 21-08-1987</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JP 10169355 A 23-06-1998</td>
<td></td>
</tr>
<tr>
<td>GB 1468635 A 30-03-1977</td>
<td>CA 1022455 A1 13-12-1977</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DK 107375 A 19-09-1975</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ES 435704 A1 01-02-1977</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JP 1286216 C 31-10-1985</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JP 50131801 A 18-10-1975</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JP 60005757 B 13-02-1985</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US 4007782 A 15-02-1977</td>
<td></td>
</tr>
<tr>
<td>US 4063650 A 20-12-1977</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>