METHOD AND SYSTEM FOR BUILDING MODULAR STRUCTURES FROM WHICH OIL AND GAS WELLS ARE DRILLED

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ABSTRACT
A method and system for building modular platform structures from which oil and gas wells are drilled and maintained is disclosed, wherein a plurality of easily transportable, multifunctional platform modules are interconnected on-site to form a unitary platform structure. The interconnected platform modules are elevated above a ground surface on one or more legs coupled to at least one of the platform modules. The elevated, interconnected platform modules support both drilling and production operations in land-based, arctic, inaccessible, near-offshore and environmentally sensitive locations.
METHOD AND SYSTEM FOR BUILDING MODULAR STRUCTURES FROM WHICH OIL AND GAS WELLS ARE DRILLED

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The instant application is a continuation of 11/366, 188, filed Mar. 2, 2006, still pending, which is a continuation of 10/434,436, filed May 8, 2003, now abandoned, which is a continuation-in-part of U.S. application Ser. No. 10/142,741, filed May 8, 2002, now issued as U.S. Pat. No. 6,745,852 B2, to which application priority is hereby claimed.

FIELD OF THE INVENTION

[0002] The present invention relates generally to the field of oil and gas drilling and production. In a specific, non-limiting embodiment, the invention comprises a method and system for building modular platform structures from which oil and gas wells are drilled and maintained in remote or environmentally sensitive locations while minimizing ground disturbance beneath the structures.

DESCRIPTION OF THE PRIOR ART

[0003] The drilling and maintenance of land oil and gas wells requires a designated area on which to dispose a drilling rig and associated support equipment. Drilling locations are accessed by a variety of means, for example, by roadway, waterway or other suitable access routes. In particularly remote locations, access to a drilling site is sometimes achieved via airlift, either by helicopter, fixed wing aircraft, or both.

[0004] Some potential oil and gas exploration and development sites are constrained by special circumstances that make transportation of drilling equipment to the drilling site difficult or impossible. For example, oil and gas may be found in terrain with near-surface water accumulations, such as swamps, tidal flats, jungles, stranded lakes, tundra, muskegs, and permafrost regions. In the case of swamps, muskegs, and tidal flats, the ground is generally too soft to support trucks and other heavy equipment. In the case of tundra and permafrost regions, heavy equipment can be supported only during the winter months.

[0005] Moreover, certain oil and gas drilling sites are disposed in environmentally sensitive regions, such that surface access by conventional transport vehicles can damage the terrain or affect wildlife breeding areas and/or migration paths. Such environmental problems are particularly acute in, for example, arctic tundra and permafrost regions. In such areas, road construction is either prohibited or limited to temporary seasonal access.

[0006] For example, substantial oil and gas reserves exist in the far northern reaches of Canada and Alaska. However, drilling in such regions presents substantial engineering and environmental challenges. The current art of drilling onshore in arctic tundra is enabled by the use of special purpose vehicles, such as Rolligons™, that can travel across ice roads built on frozen tundra.

[0007] Ice roads are built by spraying water on a frozen surface at very cold temperatures. Ice roads are typically constructed about 35 feet wide and 6 inches thick. At strategic locations, the ice roads are made wider to allow for staging and turn around capabilities.

[0008] Land drilling in arctic regions is currently performed on square-shaped ice pads, the dimensions of which are about 500 feet on a side; typically, the ice pads comprise 6-inch thick sheets of ice. The rig itself is built on a thicker ice pad, for example, a 6 to 12-inch thick pad. A reserve pit is typically constructed with about a two-foot thickness of ice, plus an ice berm, which provides at least two feet of freeboard space above the pit’s contents. These reserve pits, which are also referred to as ice-bermed drilling waste storage cells, typically have a volume capacity of about 45,000 cubic feet, suitable for accumulating and storing about 15,000 cubic feet of cuttings and effluent. In addition to the ice roads and the drilling pad, an arctic drilling location typically includes an airstrip, which is essentially a broad, extended ice road formed as described above.

[0009] Ice roads can run from tens of miles to hundreds of miles in length, depending upon the proximity or remoteness of the existing infrastructure. The fresh water needed for the ice to construct the roads and pads is usually obtained from lakes and ponds that are typically numerous in such regions. The construction of an ice road typically requires around 1,000,000 gallons of water per linear mile. Over the course of a winter season, another 200,000 gallons or so per mile are required to maintain the ice road. Therefore, for a ten-mile ice road, a total of 2,000,000 gallons of water would have to be picked up from nearby lakes and sprayed on the selected route to maintain the structural integrity of the ice road.

[0010] An airstrip requires about 2,000,000 gallons of water per mile to construct, and a single drill pad requires about 1,700,000 gallons. For drilling operations on a typical 30-day well, an additional 20,000 gallons per day are required, for a total of about 600,000 gallons for the well. A 75-man camp requires another 5,000 gallons per day, or 150,000 gallons per month, to support. Sometimes, there are two to four wells drilled from each pad, frequently with a geological side-track in each well, and thus even more water is required to maintain the site.

[0011] Thus, for a winter drilling operation involving, for example, 7 wells, 75 miles of road, 7 drilling pads, an airstrip, a 75-man camp, and the drilling of 5 new wells plus re-entry of two wells left incomplete, the fresh water requirements are on the order of tens of millions of gallons.

[0012] Currently, arctic land drilling operations are conducted only during the winter months. Typically, roadwork commences in the beginning of January, simultaneous with location building and rig mobilization. Due to the lack of ice roads, initial mobilizations are done with special purpose vehicles such as Rolligons™, suitable for use even in remote regions of the arctic tundra. Drilling operations typically commence around the beginning of February, and last until the middle of April, at which time all equipment and waste-pit contents must be removed before the ice pads and roads melt. However, in the Alaskan North Slope, the tundra is closed to all traffic from May 15 to July 1 due to nesting birds. If the breakup is late, then drilling prospects can be fully tested before demobilizing the rig. Otherwise, the entire infrastructure has to be removed, and then rebuilt the following season.

[0013] From the foregoing, it is seen that there are several drawbacks associated with current arctic drilling technology. Huge volumes of water are pumped out of ponds and lakes and then allowed to thaw out and become surface run-off again. Also, the ice roads can become contaminated with lube oil and grease, antifreeze, and rubber products. In addition to the environmental impact, the economic costs associated with
drilling in arctic regions are very high. Operations may be conducted only during the coldest parts of the year, which is typically less than 4 or 5 months. Thus, actual drilling and testing may be conducted in a window of only two to four months or less. Therefore, development can occur during less than half the year. At the beginning of each drilling season, the roads and pads must all be rebuilt, and equipment must again be transported to and removed from the site, all at substantial financial and environmental cost.

SUMMARY OF THE INVENTION

[0014] According to one example embodiment, the present invention provides a method and system for building interconnected platform modules from which oil and gas wells are drilled and maintained, either on land or in relatively shallow water, for example, in water having a minimum depth of about 8 feet or less. Thus, the invention admits to practice in many different drilling and production environments, for example, dry land, swamps, marshes, tundra, permafrost regions, shallow lakes, near-offshore sites, etc.

[0015] In one example embodiment, the interconnected platform modules and associated drilling facility are disposed above the surface of the ground. In other embodiments, modular platforms suitable for accommodating other equipment and structures besides a drilling facility are provided. In various other embodiments, the modular platform structures are transportable to a drilling site by a wide variety of transport means, for example, by truck, railcar, boat, hovercraft, helicopter, etc. In still other embodiments, the modular platform structures are multifunctional, and can be interconnected in a variety of ways to form different portions of a drilling site, for example, a drilling platform, a storage platform for auxiliary drilling equipment, a waste retention platform disposed beneath a drilling platform suitable for accumulating and storing cuttings and production effluent, etc.

[0016] According to one example of the invention, a modular platform structure comprises a plurality of expandable, multifunctional platform modules, which are interconnected to one another on-site to form a unitary platform structure. In some embodiments, legs for affixing the interconnected platform modules have already been embedded in the ground or otherwise installed at the drilling site prior to delivery of the platform modules. In other embodiments, modular sections of the platform structure are assembled in a remote location and then transported to the drilling site, where the assembled sections are connected to one another and secured in place by legs that have been embedded in the ground prior to delivery. In still other embodiments, the legs are driven or otherwise installed after the modules have been delivered to the drilling site by, for example, a crane or other suitable device.

[0017] In other example embodiments, the modular sections are connected such that portions of the platform structure are affixed at different elevation levels, so that certain portions of the structure are isolated for drilling and other operations, while other portions are disposed for support functions such as material storage, housing, waste collection, etc. For example, in some embodiments of the invention, two or more vertical tiers of platform modules (i.e., one installed above or nearly above the other) are affixed to common leg members to create platform work spaces dedicated to various functions associated with oil and gas drilling and production.

[0018] In various other example embodiments, the interconnected platform modules are assembled on-site, and then elevated above the ground surface on one or more legs coupled to at least one of the platform modules. In still other embodiments, a plurality of platform modules are connected beneath a main drilling platform, and support the drilling and auxiliary operations disposed above, as well as other structures, for example, storage facilities, living quarters, etc.

[0019] Regardless of whether platform assembly occurs on-site or in sections from a remote location, the modular platform structures are of a size and shape capable of being transported to a drilling site by a variety of means, for example, truck, railcar, helicopter, hovercraft, etc. According to a further example embodiment, the modules are also configured to float, so they can be towed over water to the drilling location by a water-borne vessel such as a skiff or hovercraft, etc.

[0020] According to one example embodiment, some of the platform modules comprise structural, weight-bearing members for supporting derricks and heavy equipment, such as draw-works, engines, pumps, cranes, etc. In further embodiments, some of the platform modules comprise purpose modules, for example, pipe storage modules; material storage modules for storing materials, for example, cement, drilling fluid, fuel, water, etc.; and equipment modules for housing equipment, for example, generators, fluid handling equipment, etc. Other example embodiments comprise modules formed with legs affixed in desired locations, whereas in other example embodiments the platform modules have spaces cut out from the corners (or elsewhere) where legs can be fastened (or passed through) and then connected to one or more receiving members disposed on the platform modules. In some example embodiments, the legs are attached to the platform modules using the same types of connectors as are employed to connect the modules to one another, although in other examples the legs are affixed using a different connection means, for example, a high-load heavy-duty fastener, depending on the weight load to which the module will ultimately be subjected. In other embodiments, the legs themselves are load bearing, and the load imposed by equipment or a structure installed above is distributed across both the legs and connected platform modules; in still other embodiments, the load-bearing legs bear the entire load of equipment or a structure installed above.

[0021] In one specific embodiment of the invention, the legs are adapted to be driven or otherwise inserted into the ground to support the elevated drilling platform. In further embodiments, leg members terminate at a foot structure, for example, a flat, metal brace formed either structurally integral with or bracketed to an outer portion of the leg, used to support the platform structure. In other embodiments, a foot structure is used in conjunction with other bracing techniques, for example, by passing a leg through the body of a foot structure and driving the lower end of the leg into a shallow hole in which the terminus point is distended.

[0022] In still further embodiments, the legs comprise sections that are connected together to form legs of a desired length. In another example embodiment, the legs are all approximately the same length after the platform structure is assembled, while in still other embodiments the legs are of different lengths to accommodate various elevation differences between and amongst various portions of the platform and/or inconsistent terrain elevations below the structure.

[0023] In further embodiments, the legs include passageways for the flow of fluids such as air, refrigerants, cement, etc. In still further embodiments, the legs comprise a bladder that is inflated with air or other fluids to provide increased...
support for the legs. In other examples of the invention, the bladder extends out of the bottom of the leg into the ground as it is being inflated to provide increased support.

[0024] In a presently preferred embodiment of the invention, the legs are removable from the ground when drilling is complete, so as to minimize ground disturbance around the drilling site. In other embodiments, the legs disassemble at a joint or fastening, etc., disposed near ground level, or in a still more preferred embodiment, beneath ground level, so that the only portion of a leg that remains when the site is evacuated is embedded in the ground and can later be covered over with cement, dirt, etc., as desired.

[0025] According to an example method of the invention, a plurality of platform modules are transported to a first drilling location using a known transportation means. The platform modules are easily transportable by, for example, helicopter, railcar, or hovercraft, etc., or by a special purpose vehicle adapted to minimize harm to the environment while in passage when necessary. The platform modules are suitable for mutual interconnection, and are assembled either on-site or in sections at a remote location prior to transport. In one embodiment of the invention, functionally related portions of the structure are connected prior to transport, so that sections that will later be adjoining, e.g., housing units, equipment storage platforms, waste collection units, etc., are already connected prior to transport.

[0026] According to one example method, a modular structure is assembled on-site and affixed to legs driven into the ground prior to delivery of the modules to the drilling site; this portion of the structure is then elevated over the drilling location. According to various other methods, drilling equipment is installed on the elevated modular structure, either prior to or following elevation over the drilling site. After the drilling equipment is installed, one or more wells are drilled.

[0027] According to a method of the invention particularly useful in hostile climates, for example, in arctic regions, the modules are transported to the drilling site, and a first platform structure is built and elevated during the winter season, while the ground can still support the weight of transport vehicles and the drilling equipment. After the platform structure has been elevated, drilling continues throughout the year.

[0028] According to a still further method of the invention, a second platform module is transported to a second drilling location. The second platform module is affixed to one or more legs, and elevated to form either a complete second drilling platform or the nucleus for a second drilling platform. When it is desired to drill from the second drilling platform, all or some of the drilling equipment is transported from the first platform structure to the second platform structure, and then installed on the second drilling platform. In a further example embodiment, the drilling equipment is transferred from a nearby storage area, for example, the first drilling platform or a nearby transport vessel, etc. According to a still further example embodiment, the drilling equipment is used to drill wells from the second platform as part of a multi-season, multi-location drilling program, or as a relief well for wells drilled from the first platform.

[0029] In other example embodiments, the platform sections are vertically modular, such that a first elevated platform section is affixed to the same legs as a second platform section disposed above (or nearly so). According to further embodiments of the invention, drilling equipment stored on a lower platform module, for example, drill bits, drill string, etc., is passed from the lower platform to an upper platform for use with drilling, while cuttings and effluent generated by operations on the upper platform section are allowed to fall through a grating, or drain, etc., so as to be accumulated and stored either on or within the lower platform module, thereby reducing the amount of waste generated during the drilling and production process that would otherwise fall to the ground. In other embodiments, the entire platform structure (or, in certain instances, portions of the platform structure), has a secondary waste retention device, for example, a tarpaulin or canvas sheet, etc., disposed beneath it to catch and store cuttings or effluent, etc., that fall from above. In other embodiments, the secondary waste retention device can itself serve as a redundant platform space, suitable for storing equipment that is not currently in use, or for capturing equipment or other items that fall from the platform and would otherwise land in the water below the drilling site. In still further embodiments, the secondary waste retention device has a perimeter boundary width greater than the width of the drilling platform, so that waste and effluent ejected from the site horizontally are also captured.

[0030] As will be appreciated by one of ordinary skill in the appropriate art, the transportable, modular platform sections disclosed herein can be connected into many shapes and sizes, and can be employed to form either an essentially unitary drilling structure or a number of smaller structures erected nearby and serviced in a hop-scotch fashion (or a combination of the two approaches), to create a movable series of land-based, semi-permanent structures that will improve the overall efficiency of drilling platforms disposed in remote or inaccessible locations, minimize the environmental impact of associated drilling and production operations, and which will later be removed without significantly disturbing the ground surface beneath the operation site(s). The multifunctional nature of the interconnectible modules encourages efficient equipment disposition between and amongst neighboring drilling sites, and reduces the impact of associated drilling operations on the environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] FIG. 1 is a perspective view of a drilling platform according to the present invention.

[0032] FIG. 2 is a perspective view of a plurality of platform modules and legs awaiting assembly according to the present invention.

[0033] FIG. 3 is a perspective view of the platform modules and legs of FIG. 2 assembled according to the present invention.

[0034] FIGS. 4A-4C are perspective views of examples of special purpose platform modules according to the present invention.

[0035] FIGS. 5A and 5B are perspective views of alternative leg attachment arrangements according to the present invention.

[0036] FIGS. 6A and 6B illustrate elevation of assembled platform modules according to the present invention.

[0037] FIGS. 7A-7E illustrate features of platform legs according to the present invention.

[0038] FIG. 8 illustrates renewable energy production facilities installed on a platform according to the present invention.

[0039] FIGS. 9A-9D illustrate a multiple well drilling program according to the present invention.
FIGS. 10A-10C illustrate a further multiple well drilling program according to the present invention.

DETAILED DESCRIPTION

Referring now to the example embodiment shown in FIG. 1, a drilling platform 11 is illustrated comprising a plurality of interconnected platform modules 13 elevated above the ground on a plurality of legs 15. According to a further embodiment of the invention, platform 11 is adapted to support various types of equipment and facilities used in oil and gas drilling or production operations, for example, a derrick 17, a crane 19, a helicopter pad 21, a drilling fluid handling enclosure 23, bulk storage tanks 25, and oilfield tubular goods 27. The equipment and facilities illustrated in FIG. 1 are non-limiting, and those of ordinary skill in the art will appreciate that many other types of facilities and equipment may be included on platform 11 without departing from the scope or spirit of the present invention.

According to a further example embodiment, drilling platform 11 is constructed by transporting a plurality of interconnected platform modules 13 and a plurality of legs 15 to a drilling site, and then assembling the various modules 13 and legs 15 into an essentially unitary structure. Platform modules 13 are of a size and weight as to be transportable to the drilling site by a wide variety of transport means, for example, by helicopter, truck, railcar, hovercraft, etc. In the example embodiment illustrated in FIG. 1, interconnected platform modules 13 are constructed as box-like structures made of steel or other materials, for example, composite metals, etc., and are about 40 feet in length and from 10 to 20 feet in width. However, the shapes and sizes of the modules described herein are solely for the purpose of example and illustration, and those of ordinary skill in the art will recognize that the modules may be of other shapes, sizes and configurations, without limiting the scope of the invention. For example, platform modules may be formed without a load bearing bottom member, or even lacking a bottom entirely, without departing from the scope of the present invention.

According to one embodiment of the invention, some of the platform modules comprise structural, weight-bearing members for supporting derricks and heavy equipment, such as draw-works, motors, engines, pumps, cranes, etc. In further embodiments, some of the platform modules comprise special purpose modules, for example, pipe storage modules; material storage modules for storing, for example, cement, drilling fluid, fuel, water, etc.; and equipment modules for storing equipment, for example, generators, fluid handling equipment, etc.

According to one embodiment of the invention, legs 15 comprise tubular members with joints at their ends connected together to form legs of appropriate lengths. However, the legs may be of other cross-sections or configurations, for example, driven piles, etc. In one example embodiment, the legs are adapted to be driven or otherwise inserted into the ground to support an elevated drilling platform or other weight-bearing structures. In other embodiment, the load of a weight-bearing structure is distributed by affixing the structure to one or more of the legs as well as the modular platform structures. In still other embodiments, various structures are entirely affixed to the legs instead of the platform structures as a matter of convenience, for example, a communications center affixed at about eye level on a leg that extends vertically between two or more levels of the platform.

In further embodiments, the legs comprise sections that are connected together to form legs of a desired length. In another example embodiment, the legs are all approximately the same length after the platform structure is assembled, while in still other embodiments the legs are of different lengths to accommodate various elevation differences between and amongst various portions of the platform and/or inconsistent terrain elevations below the structure. In further embodiments, the legs include passageways for the flow of fluids such as air, refrigerants, cement, etc. In still further example embodiments, the legs comprise a bladder that may be inflated with air or other fluids to provide increased support for the legs. In other examples of the invention, the bladder extends out of the bottom of the leg into the ground as it is being inflated to provide increased support.

Still further example embodiments comprise platform modules formed with legs already affixed in desired locations when the platform modules are delivered to the drilling site, whereas in other example embodiments modules have spaces cut out from the corners (or elsewhere) where legs are fastened (or passed through) and then connected to one or more receiving members disposed on the modules. In some example embodiments, the legs are attached to the modules using the same types of connectors as are employed to connect the modules to one another, although in other examples the legs are affixed using a different connection means, depending on the weight load to which the module will ultimately be subjected.

According to a presently preferred embodiment of the invention, said plurality of legs 15 are removable from the ground when drilling operations have been completed. In a further example embodiment, the legs are detachable at a joint or fastening disposed near ground level, and are detached at said joint or fastener after drilling is complete, leaving only a lowermost portion of said plurality of legs 15 embedded in the ground, so as to minimize ground disturbance around the drilling site. According to a further aspect of the invention, the portions of legs 15 left embedded in the ground after detachment are covered over by cement or dirt, etc., when the site is ultimately evacuated.

In still further embodiments, the entire platform structure (or, in certain instances, portions of the platform structure), has a secondary waste retention device (not shown), for example, a tarpaulin or canvas sheet, etc., disposed beneath it to catch and store cuttings or effluent, etc., that fall from above. In other embodiments, the secondary waste retention device can itself serve as a redundant platform space, suitable, for example, for storing equipment that is not currently in use, or for capturing equipment or other items that fall from the platform and would otherwise land on the ground or in the water below the drilling site. In still further embodiments, the secondary waste retention device has a perimeter boundary width greater than the width of the drilling platform, so that waste and effluent ejected from the site in a horizontal direction may also captured.

Referring now to the example shown in FIG. 3, the platform modules 13 are interconnected and at least partially raised on legs 15. According to one embodiment of the invention, a complete drilling platform is assembled, formed from modules 13 while the structure is still on the ground, and then lifted as a unit on a plurality of legs 15. In another example embodiment, one or more of modules 13 are interconnected, and then elevated to form a nucleus about which other modules are elevated and connected together.
Referring now to the embodiments of the invention illustrated in FIGS. 4A-4C, various platform modules according to the present invention are provided to partially demonstrate the platform modules’ multifunctional nature. For example, in FIG. 4A, there is illustrated a fluid storage module 13a. In one embodiment of the invention, fluid storage module 13a includes at its corners holes 27 for the insertion of legs. In other example embodiments, fluid storage module 13a is essentially a box-like hollow tank that includes a port or pipe 29, which is useful for the flow of fluids or waste into and out of the interior of fluid storage module 13a. In various other embodiments, fluid storage modules 13a are used, for example, in place of a conventional reserve pit to drain and/or store effluent produced by a rig during production, or to flush and store cuttings and other waste products from the drilling platform. In one embodiment of the invention especially useful in environmentally sensitive drilling regions, fluid storage modules 13a are hauled away with the contents, e.g., cuttings, effluent, etc., contained inside, thereby eliminating the handling of waste fluids and reducing the risk of spillage into the surrounding environment.

Referring now to the example embodiment of FIG. 4B, a structural, load-bearing module 13b is depicted. In some example embodiments, load-bearing module 13b is a box-like structure having leg holes 31 disposed in its corners, though in other embodiments load-bearing module 13b is constructed without providing receiving members for legs and is instead adapted only for interconnection with other modules. According to one example embodiment, load-bearing module 13b includes internal structural reinforcement plating 33 to provide greater strength and lend greater structural integrity to module 13b. Internal structural reinforcement plating 33 is illustrated solely for purposes of example, and other reinforcement structures, for example, trusses, I-beams, honeycombs, etc., are utilized as required. In further example embodiments, module 13b is constructed into different shapes to form various types of structures, for example, floors for housing units, support members for derricks and other heavy pieces of drilling equipment, etc. In still further embodiments, a variety of different materials, for example, Aluminum, Titanium, steel, composite metals, etc., are used to make the platform modules 13.

Referring now to the example embodiment illustrated in FIG. 4C, a box-like equipment module 13c is provided, wherein various types of equipment adapted for use in drilling or auxiliary operations are disposed. According to one example embodiment, the equipment includes centrifuges 37, powered by motors 39 connected by various manifolds 41, for controlling solids and fluid flow. In further example embodiments, equipment modules 13c comprise other types of equipment, e.g., pumps, hydrocyclones, drilling string, etc. From the foregoing, it should be apparent to one of ordinary skill in the art that the various types of equipment modules 13c are assembled to provide both a structural platform and a means for storing basic equipment and services for use during drilling operations.

Referring now to FIGS. 5A and 5B, there are shown various example embodiments for the connection of a leg to a platform module. In FIG. 5A, a module 13d comprises one or more tubular leg holes 43 disposed in the corners of said module. A leg (not shown) is simply adapted to slide through leg hole 43. In various example embodiments, the leg is fixed in place with respect to leg hole 43 by any suitable means, such as slips, pins, flanges, or the like. In the example of FIG. 5B, an example embodiment of module 13e is shown comprising a right angle cutout 45 formed at one or more corners of the module. In some embodiments, cutout 45 is adapted to receive either a blanket insert 47 or a leg-engaging insert 49. In other embodiments, a leg insert 47 may be fastened into notch 45 in the event that no leg needs to be positioned at a corner of module 13. In further embodiments, leg-engaging insert 49 includes a bore 51 having a shape adapted to slidingly engage a leg (not shown). In still further embodiments, one of either blank insert 47 or leg-engaging insert 49, as appropriate, is fastened into notch 45 with bolts or other suitable fastening means.

Referring now to the examples illustrated in FIGS. 6A and 6B, a series of interconnected modules 13-13j are depicted in structural communication with a plurality of legs 15. According to one embodiment of the invention, a sufficient number of legs 15 is selected in order to provide adequate support for both the interconnected modules 13-13j and the equipment to be supported thereby (not shown). According to one example embodiment, modules 13-13j in FIG. 6 are of the type illustrated in FIG. 5B. Accordingly, blank inserts 47 or leg-engaging inserts 49 are affixed at corners of the modules 13, as appropriate. In further example embodiments, legs of appropriate length are inserted through the leg inserts and then drilled, driven or otherwise inserted to an appropriate depth in the ground. In still further embodiments, the legs include passageways for the flow of fluids such as air, refrigerants, cement, etc. In still further embodiments, the legs comprise a bladder that is inflated with air or other fluids to provide increased support for the legs. In other examples of the invention, the bladder extends out of the bottom of the leg into the ground as it is being inflated to provide increased support.

In a presently preferred embodiment of the invention, the legs are removable from the ground when drilling is complete, so as to minimize ground disturbance around the drilling site. In other embodiments, the legs disassemble at a joint or fastening, etc., disposed near ground level, or in a still more preferred embodiment, beneath ground level, so that the only portion of a leg that remains when the site is vacated is embedded in the ground and can later be covered over with cement, dirt, etc., as desired.

According to one example embodiment, after the legs 15 have been secured, the interconnected modules 13-13j are raised, to a position as shown in FIG. 6B. In the embodiment shown in FIG. 6A, lifting mechanisms 55 are employed to assist in lifting the interconnected platform modules. Appropriate lifting mechanisms may comprise, for example, hydraulic or mechanical lifting mechanisms to assist in lifting the platform modules. In other example embodiments, the interconnected modules are lifted with, for example, cranes, helicopters, or other suitable lifting devices, as would be apparent to one of ordinary skill in the art. Although legs 15 are illustrated as being tubular in FIGS. 6A and 6B, other cross-sections and leg structures are also employed according to further embodiments of the present invention.

Referring now to the examples of FIGS. 7A-7E, various details of legs according to the present invention are illustrated. As seen in the example of FIG. 7A, a portion of a module 13s is shown elevated with respect to a leg 15. In the illustrated embodiment, leg 15s is a tubular member having a main flow area 61 and an annular flow area 63. Leg 15s is thus configured to accommodate a circulating flow of fluids, for
example, refrigerants or water, etc. According to certain embodiments, leg 15n includes a retrievable section 65 disposed at its lower end to allow the pumping of cement or the circulation of other fluids down the main flow area 61. In the embodiment illustrated in FIG. 7A, cement 67, or another deposit of material, for example, a combination of water and stone, is pumped into the ground below retrievable 65. Cement 67 provides a footing for leg 15n.

[0058] As indicated by pipe section 69, additional lengths of pipe are, in some embodiments, inserted to lengthen leg 15n in order to provide sufficient support for module 13. According to further example embodiments, leg 15n may include a separable connection 71, for example, a fastener, which allows the lower end of leg 15n to separate and be left in the ground when the platform is ultimately removed from the site. In certain environmentally sensitive environments, the lower end of the leg left embedded in the ground is covered over by, for example, cement or dirt, etc.

[0059] In the example of FIG. 7B, a configuration is shown in which a leg 15m includes at its lower end an inflatable bladder 73. According to some embodiments of the invention, the inflatable bladder 73 is inflated with a fluid, for example, air, cement, or another suitable fluid, to compact the earth around the lower end of leg 15m and provide an additional footing for leg 15m.

[0060] In the examples of FIGS. 7C and 7D (top view), an embodiment is shown in which a leg member 15 is supported by a foot structure 74, for example, a flat, metal brace bracketed to an outer portion of leg 15, used to support the platform structure. As seen in the embodiment of FIG. 7E, foot structure 74 can be used in conjunction with other bracing techniques, for example, the embodiments shown in FIGS. 7A and 7B, or with a shallow hole in which the terminus point of leg 15 is distended.

[0061] Referring now to the example embodiment of FIG. 8, renewable energy sources, for example, solar panel array 75, wind mill power generators 77, etc., are supported by the platform. In further embodiments, renewable power sources 75 and 77 provide energy for a variety of drilling-related equipment, for example, pumps, compressors, centrifuges, etc. According to still further embodiments, renewable power sources 75 and 77 also provide energy for large production fluids.

[0062] Referring now to the embodiments of FIGS. 9A-9B, there is illustrated a multi-year, multi-seasonal drilling program according to the present invention. In the embodiment of FIG. 9A, three platforms 11a-11c are transported to and erected at various, suitably spaced, locations. In embodiments comprising an arctic drilling program, platforms 11a-11c are transported and installed during the winter using aircraft, for example, helicopters; or surface vehicles on ice roads, for example, trucks or Rolligons™, or a combination thereof. In a specific, non-limiting, example embodiment, platform 11b is positioned 100 miles from platform 11a, and platform 11c is positioned 300 miles from platform 11b. The distances recited herein are solely for purposes of illustration, and other spacings and numbers of platforms can also be provided as desired.

[0063] As shown in the example of FIG. 9A, platform 11a has installed thereon a complete set of drilling equipment, for example, a derrick 17, a crane 19, and the other equipment described with respect to FIG. 1. In the example embodiments shown in FIGS. 9A-9B, platforms 11b and 11c do not have a complete set of drilling equipment installed thereon, instead, comprising only structural platform features and other sets of fixed equipment, for example, pumps, manifolds, generators, etc. According to one example embodiment, platforms 11b and 11c await installation of additional drilling equipment.

According to the present invention, one or more wells are drilled from platform 11, while platforms 11a and 11c remain idle.

[0064] Referring now to the example embodiment of FIG. 9B, after the well or wells drilled from platform 11a are complete, the necessary drilling equipment is transported from platform 11a to platform 11b. In the illustrated embodiment, the drilling equipment is transferred using aircraft such as helicopters. Since the transport is by air, the transfer may occur during a warm season. Also, since platform 11b is elevated above the ground surface on legs that are supported below the fall thaw zone, operations on platform 11b can be conducted during the warm season. The transport by air is for purposes of illustration, and those of ordinary skill in the pertinent arts will appreciate that in differing terrains and seasons, equipment transport may be by a variety of transport means, for example, truck, railcar, hovercraft, Rolligon™ vehicle, barge, surface effect vehicle, etc.

[0065] In the example embodiment of FIG. 9A, the platform 11b has been transported to and installed upon platform 11b, the remaining structural assembly of platform 11b is left idle. In other embodiments, after drilling equipment is completely installed on platform 11b, drilling of one or more wells commences, as shown, for example, in the embodiment of FIG. 9C.

[0066] In a still further embodiment, after drilling from platform 11b has been completed, drilling equipment is transferred from platform 11b to platform 11c, as illustrated, for example, in FIG. 9D. Again, in the depicted embodiment, the drilling equipment is preferably transported from platform 11b to platform 11c by aircraft, though differing terrain and operating environments will call for other transport means, as described above. In each of the example embodiments, transportation of drilling equipment may occur during any season of the year. Thus, according to the invention illustrated in FIGS. 9A-9B, installation and operation of drilling equipment is also performed during any season of the year and not only during the coldest parts of the year. Thus, the time spent drilling may be doubled or even tripled according to the method of the present invention without substantial additional environmental impact. Also, the method and system of the present invention enable wells to be drilled and completed in the normal course of operations without the possibility of having to transport equipment to and from a drilling site multiple times.

[0067] Referring now to the example embodiment depicted in FIG. 10A, a primary platform 11a is transported to and erected at a first location, and a secondary platform 11b is transported to and erected at a second location geographically spaced apart from the first location. In the example of FIG. 10A, platform 11a is a complete drilling platform, while platform 11b comprises only a single module erected on legs. According to some embodiments, platform 11b provides a nucleus about which a second complete platform is erected when the need arises. The system illustrated in FIGS. 10A-10C is well adapted, for example, to the drilling of a relief well for another well drilled from platform 11a.
Referring to the example embodiment of FIG. 10B, when it is necessary or desired to drill a well from the location of platform 11b, platform modules are transported to the location of platform 11b by aircraft, for example, by helicopter. According to a further embodiment, workers use previously installed modules as a base for installing new modules. According to a still further embodiment, a crane is positioned on the installed modules and skidded about to drill or drive legs and position new modules. As shown in the example embodiment of FIG. 10C, after the second platform 11b is completed, drilling equipment is transported thereto by helicopter or another suitable transport means.

The foregoing specification is provided for illustrative purposes only, and is not intended to describe all possible aspects of the present invention. Moreover, while the invention has been shown and described in detail with respect to several exemplary embodiments, those of ordinary skill in the pertinent arts will appreciate that minor changes to the description, and various other modifications, omissions and additions may also be made without departing from either the spirit or scope thereof.

1. A method of drilling wells, wherein said wells are drilled at drilling sites have a water depth of less than about seven feet, said method comprising:

   constructing a plurality of modular drilling platforms at a plurality of drilling sites;

   installing a set of drilling equipment on a first of said modular drilling platforms;

   drilling a well from said first modular drilling platform;

   transporting said set of drilling equipment from said first modular drilling platform to a second of said modular drilling platforms;

   installing said set of drilling equipment on said second modular drilling platform;

   drilling a well from said second modular drilling platform.

2. The method of drilling wells of claim 1, wherein said method further comprises:

   transporting said set of drilling equipment from said second modular drilling platform to a third of said modular drilling platforms;

   installing said set of drilling equipment on said third modular drilling platform;

   drilling a well from said third modular drilling platform.

3. The method of drilling wells of claim 1, wherein said constructing a plurality of modular drilling platforms further comprises:

   transporting at least one platform module to at least one of said plurality of drilling sites; and

   elevating said at least one platform module over said at least one of said plurality of drilling sites.

4. The method of drilling wells of claim 3, wherein said transporting at least one platform module further comprises transporting a plurality of mutually interconnectible platform modules.

5. The method of drilling wells of claim 3, wherein said transporting at least one platform module further comprises transporting a plurality of multifunctional platform modules.

6. The method of drilling wells of claim 5, wherein said transporting a plurality of multifunctional platform modules further comprises transporting at least one waste retention platform module.

7. The method of drilling wells of claim 3, wherein said elevating said at least one platform module further comprises:

   transporting at least one leg to said at least one of said drilling sites; and

   raising said at least one platform module on said at least one leg.

8. The method of drilling wells of claim 7, wherein said elevating said at least one platform module further comprises:

   inserting said at least one leg into a surface region disposed beneath said drilling site.

9. The method of drilling wells of claim 8, wherein said inserting said at least one leg into said surface region further comprises driving said at least one leg into said surface region.

10. The method of drilling wells of claim 8, said method further comprising injecting a fluid into said at least one leg.

11. The method of drilling wells of claim 10, wherein said fluid further comprises cement.

12. A system for drilling wells, wherein said wells are drilled at drilling sites have a water depth of less than about seven feet, said system comprising:

   a plurality of interconnected platform modules;

   at least one leg coupled to at least one of said plurality of interconnected platform modules to support said plurality of interconnected platform modules above a surface region; and

   drilling equipment supported by said plurality of interconnected platform modules.

13. The system of claim 12, wherein each of said platform modules is transportable by aircraft.

14. The system of claim 12, wherein each of said platform modules is transportable by boat.

15. The system of claim 12, wherein each of said platform modules is transportable by at least one of a truck, a railcar, a hovercraft, and a helicopter.

16. The system of claim 12, wherein at least one of said plurality of interconnected platform modules further comprises:

   a body portion; and

   a leg attachment member coupled to said body portion.

17. The system of claim 16, wherein said leg attachment member is structurally integral with said body portion.

18. The system of claim 16, wherein said leg attachment member is separable from said body portion.