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(54) PILE SYSTEM AND METHOD OF MAKING A PILE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a pile system, and in particular, but not exclusively, to a pile system for installation subsea.

BACKGROUND TO THE INVENTION

[0002] The technique of securing piles within the earth to provide structural foundations is well known. Some conventional piling methods involve hammering a pile structure into the earth, such as is disclosed in, for example, GB 699615, GB 1066154, GB 1340355, GB 2414032 and US 1558127. Other methods involve drilling a hole in the earth and locating a pile, or part of a pile in the drilled hole. Examples of locating piles in drilled holes are found in JP-A-2003-268767, US 1,164,085 and GB 2162224.

[0003] AT 363044 A discloses a pile system according to the preamble of claim 1.

[0004] Piles are frequently installed in offshore environments, for example to provide suitable foundations or anchors for marine structures, such as offshore oil and gas platforms, piers, harbours and the like. Offshore pile installation is typically achieved by utilising specialised vessels, such as crane vessels, which are limited in number and attract premium rental rates.

[0005] In many offshore environments the ocean or sea floor is typically formed with a top layer of relatively soft material, such as mud, silt or sand or the like, overlying more substantial consolidated material and bedrock. Where the softer top layer is sufficiently thick it may be possible to install a complete pile foundation by hammering a pile through the top layer to the required depth, without reaching the layer of bedrock. However, in some locations the top layer is relatively thin such that sufficient pile installation length cannot be achieved without extending into the hard bedrock. In such circumstances it is difficult to ensure sufficient pile sidewall friction using conventional hammering and drilling techniques.

[0006] In recent years there has been growing activity in the development of renewable energy devices, and in particular devices which operate in offshore environments, for example wave and tidal energy devices. Such devices typically require to be anchored to the seabed, and thus require some form of foundation support. This support may be provided by, for example, gravity based anchors, which involves locating a large block of several hundred tonnes on the seabed, which presents significant handling issues. Other support methods include pile systems. However, the nature of offshore renewable devices requires installation in energy dense regions, where extreme sea conditions are typical. Such extreme sea conditions, for example strong wave, tidal and current activity, do not normally permit deep layers of silt or soil to accumulate on the lower layers of bedrock, and as

such any pile system will need to accommodate this.

[0007] Also, offshore energy devices typically operate by being displaced by a natural fluid motion, and as such the support anchor utilised must be capable of reacting against the forces produced. These forces may comprise downwardly or laterally applied forces, for example, which may be adequately taken on hammered piles. However, some devices, such as the applicant's Archimedes Waveswing™ device, apply significant upward forces on associated support anchors which must therefore be capable of resisting being lifted from the seabed.

SUMMARY OF THE INVENTION

[0008] According to a first aspect of the present invention there is provided a pile system comprising:

- a base assembly adapted to be mounted on a ground surface;
- a first pile adapted to be extended through the base assembly and into the ground; and
- a drilling assembly comprising a drill bit unit secured relative to a lower region of the first pile to drill a hole to accommodate the first pile therein,

wherein the base assembly is adapted to engage the first pile to prevent rotation thereof.

[0009] Accordingly, the first pile may be installed within the ground by simultaneously drilling the hole with the drill bit unit while lowering the first pile through the base. Thus, the system may define a self-drilling pile system.

[0010] Furthermore, interengagement of the first pile and the base assembly will advantageously prevent the first pile from rotating, for example due to the reaction torque from the drill bit unit when in use.

[0011] The system may further comprise a spoolable medium adapted to be secured to the first pile. The spoolable medium may be utilised to lower, insert or raise and recover the first pile relative to the base. The spoolable medium may comprise a wire, rope, chain, coiled tubing or the like, or any suitable combination thereof. This arrangement is particularly advantageous in that a substantial support and delivery arrangement for the first pile is not required. Furthermore, this arrangement permits a significant degree of installation flexibility to be achieved. For example, the system may be readily installed offshore by deploying the first pile from a water surface location on the spoolable medium. Additionally, the system may be installed onshore without requiring substantial specialised drilling machinery and handling equipment.

[0012] The spoolable medium may be secured to a support. The support may comprise an A-frame, gantry or crane arrangement, winch drum, support platform or the like, or any suitable combination thereof. The support may be provided on a land based structure. Alternatively, the support may be provided on a floating structure, such as a vessel, platform or the like.

[0013] The base assembly may comprise a pile passage adapted to receive the first pile to extend there-through and into the ground. The pile passage may assist to align the first pile for entry into the ground at a required inclination. The pile passage may assist to stabilise the first pile while extending into the ground.

[0014] The first pile may be adapted to engage the base assembly via interengaging profiles. The interengaging profiles may extend longitudinally relative to the base assembly and the first pile. This arrangement may prevent relative rotation of the first pile and base assembly while permitting relative axial movement to allow the first pile to extend through the base assembly and into the ground. In one embodiment the interengaging profiles may comprise a spline arrangement. The interengaging profiles may comprise interengaging fins, slots, detents, channels, pins or the like. The interengaging profiles may be provided on the outer and inner surfaces, respectively, of the first pile and base assembly. For example, an inner surface of the pile passage extending through the base assembly may comprise a profile adapted to be engaged by a corresponding profile on an outer surface of the first pile.

[0015] The first pile and base assembly may be adapted to directly interengage. For example, interengaging profiles or the like may be directly installed or provided on both the base assembly and the first pile. Alternatively, the first pile and base assembly may be adapted to indirectly engage. For example, the system may further comprise a sleeve adapted to be interposed between the first pile and the base assembly. The sleeve may be defined as an adaptor sleeve. The sleeve may comprise an inner profile adapted to engage an outer profile formed on the first pile. The sleeve may comprise an outer profile adapted to engage an inner profile formed on the base assembly, for example formed on or in an inner surface of the pile passage.

[0016] The sleeve may be adapted to assist insertion of the first pile into the base assembly. The sleeve may function as a running tool, for example. The sleeve may be releasably secured to a lower end of the first pile, for example via a latching arrangement, shearable connection or the like. In this arrangement lowering of the first pile towards and into the base assembly may cause initial engagement of the sleeve with the base assembly, to assist in alignment of the first pile relative to the base, prior to insertion into the ground. The sleeve may be received within the pile passage of the base assembly. Advantageously the sleeve may be retained within the pile passage while the first pile is being inserted into the ground. The sleeve may be adapted to be released from the lower end of the first pile once said sleeve is engaged with the base assembly such that the first pile may be translated therethrough to extend into the ground, while the sleeve provides the necessary interengagement between the first pile and the base assembly to prevent rotation of the first pile.

[0017] The drilling assembly may comprise a drive

source adapted to drive the drill bit unit. The drive source may comprise a motor, such as an electric motor, hydraulic motor or the like. The entire drilling assembly may be located at an end region of the first pile. In this arrangement power, such as electrical or hydraulic power, may be delivered through the first pile, for example via conduits, umbilicals or the like, to the drill bit. Alternatively, portions of the drilling assembly may be located remotely from the drill bit, and the lower region of the first pile. For example, a drive source may be located remotely from the drill bit. The drilling assembly may comprise a drive shaft extending between the drill bit and the drive source. The drive shaft may extend through the first pile.

[0018] At least a portion of the drill bit unit may be releasably secured to the first pile. At least a portion of the drill bit unit may be retrievable from within the first pile, and thus recoverable to surface level, for example when the first pile has been installed to the required depth. Alternatively, the drill bit unit may be arranged to remain fixed to the first pile after installation thereof.

[0019] The drill bit unit may comprise a drill bit. The drill bit may be retrievable relative to the first pile. The drill bit may be mounted on a drill body.

[0020] The drill bit may be expandable such that said drill bit may be configured between a first diameter and a larger second diameter. The drill bit may be configured to define a third diameter. The first diameter may be equal to or less than an inner diameter of the first pile. The second diameter may be equal to or greater than an outer diameter of the first pile. The third diameter may be greater than the second diameter. Providing an expandable drill bit in this manner may permit the drill bit to drill a hole of sufficient diameter to receive the first pile when said drill bit is configured in the second diameter. This arrangement may also permit the drill bit and drill bit unit to be installed through the first pile while configured to define the first diameter, and subsequently reconfigured to define the second diameter once located at the lower region of the first pile. Additionally, this arrangement may permit the drill bit to be reconfigured from the second diameter to the first diameter to permit retrieval through the first pile.

[0021] The drill bit unit may comprise at least one underreamer arrangement, fly cutter or the like.

[0022] The drill bit unit may comprise a sealing arrangement adapted to prevent ingress or outflow of drilling fluids and cuttings.

[0023] The drill bit unit may comprise a contra-rotating drill bit. This may assist to balance drilling torque to reduce the rotational loading applied to the first pile, and thus base assembly while drilling. The contra-rotating drill bit may comprise a first component adapted to rotate in a first direction, and a second component adapted to rotate in a second opposite direction. The first and second components may be separated by a bearing arrangement, for example. The first and second components may be adapted to be driven by a common drive source, or alternatively by separate drive sources. The first and sec-

ond components may be gear-coupled together. The first and second components may define the same of different diameters.

[0024] The drilling assembly may comprise a pumping arrangement adapted to pump a fluid toward the region of the drill bit. The fluid may be pumped through the first pile, for example directly through the first pile, via a conduit extending through the first pile or the like. The fluid may be utilised for, for example, cooling, lubrication, drill cuttings removal or the like, or any suitable combination thereof. The fluid may comprise seawater, drilling mud or the like.

[0025] The pumping arrangement may be adapted to remove the fluid after being pumped toward the region of the drill bit. This may permit cuttings and the like to be removed for disposal. The fluid may be removed directly through the first pile, via a conduit extending through the first pile or the like.

[0026] The pumping arrangement may comprise a single pumping unit. Alternatively, the pumping arrangement may comprise at least two pumping units, a first unit configured for injection of fluid towards the drill bit, and a second unit for retrieval and return of the fluid from the region of the drill bit.

[0027] The pumping arrangement may be adapted to be mounted on an upper region of the first pile. A sealing arrangement may be provided between the pumping arrangement and the first pile.

[0028] The base assembly may be secured to the ground surface to secure the base against rotation. The base assembly may comprise at least one ground engaging element adapted to pierce the surface of the ground to secure the base assembly against rotation. The at least one ground engaging element may comprise a fin, rib or the like. In one embodiment the at least one ground engaging element may comprise a pin or plate arranged to pierce the surface of the ground.

[0029] A plurality of ground engaging elements may be provided to assist to secure the base assembly against rotation.

[0030] The system may comprise a drive arrangement to assist piercing of the ground surface with the at least one ground engaging element. The drive arrangement may comprise an impact or hammer arrangement, a propelling arrangement, such as a bolting gun, a screw arrangement, hammered pile or the like. The drive arrangement may be mounted on the base assembly, and in some embodiments may form part of the base assembly.

[0031] The base assembly may comprise at least one leg assembly. The at least one ground engaging element may be mounted on the at least one leg assembly.

[0032] The system may further comprise a levelling arrangement adapted to control the level or orientation of the base assembly, for example relative to the ground surface. The levelling arrangement may comprise a hydraulic levelling system or the like. The levelling arrangement may be provided in combination with a leg assembly of the base assembly. For example, a leg may be pivotally

mounted on the base assembly, wherein pivoting motion of the leg is achieved to arrange the base assembly in the required orientation.

[0033] The base assembly may be adapted to be lowered or raised relative to the ground surface by a spoolable medium. This arrangement may permit the base assembly to be installed from a location elevated above the ground surface, such as an offshore floating platform utilised to lower the base on to a sea bed. The offshore floating platform may be provided by a crane barge or the like. The spoolable medium for lowering or raising the base assembly may be commonly used for lowering or raising the first pile relative to the base assembly.

[0034] The base assembly may be provided in segments adapted to be releasably secured together. This arrangement may permit ease of installation or retrieval.

[0035] The base assembly may be adapted to be engaged by at least one guide member extending from the base assembly to a location elevated above the ground surface. The guide member may be adapted to guide at least the first pile between the elevated location and the base assembly, for example to assist in ensuring correct alignment of the first pile and base assembly.

[0036] The system may comprise an outer pile adapted to be inserted within the ground, wherein the system is arranged such that the first pile is inserted through the outer pile. The outer pile may be inserted through the base assembly and into the ground. Alternatively, the outer pile may define the base assembly.

[0037] The outer pile may be inserted into the ground simultaneously with the first pile. Alternatively, the outer pile may be inserted into the ground prior to insertion of the first pile.

[0038] The outer pile may be inserted into a hole drilled in the ground. Alternatively, the outer pile may be inserted in the ground by a jetting arrangement. For example, the system may comprise a jetting assembly adapted to jet a fluid in the region of a lower end of the outer pile, wherein said jetted fluid is utilised to disturb the earth at the insertion location to permit insertion of the outer pile. The jetting assembly may comprise a jetting pump for this purpose. The jetting assembly may further comprise a suction pump adapted to remove the jetted fluid and disturbed earth.

[0039] Inserting the outer pile by a jetting arrangement may be selected in circumstances where ground conditions are unconsolidated material such as mud, sand, gravel or the like.

[0040] The outer pile may be adapted to engage the first pile to secure the outer and first piles from relative rotation. This may be achieved by a spline arrangement or the like.

[0041] In one embodiment of the present invention the outer pile may be shorter than the first pile, such that the outer pile may be located in the ground to a desired depth, and the first pile be drilled and located in the ground to a greater depth. This combined outer and first pile arrangement may therefore provide a robust piling system.

[0042] The outer pile may be utilised to extend through relatively soft material overlying a layer of bedrock or other consolidated layer, wherein the first pile is arranged to extend into the bedrock. This arrangement may be particularly useful in offshore applications.

[0043] The system may further comprise a second pile adapted to be inserted within the ground and to extend through the first pile. The first and second piles may be inserted in the ground simultaneously. Alternatively, the second pile may be inserted within the ground subsequent to the first pile.

[0044] The second pile may comprise a drilling assembly having a drill bit unit secured relative to a lower end of the second pile. The drill bit unit may comprise a drill bit. In this arrangement the second pile may be arranged to be inserted into a hole drilled by the drilling assembly. The drilling assembly may be similar to the drilling assembly secured relative to the first pile.

[0045] The second pile may be arranged to engage with the base assembly to prevent rotation of the second pile, for example from drilling torque. The second pile may directly engage the base assembly, for example through a profiled connection or the like. Alternatively, the second pile may indirectly engage the base assembly, for example via the first pile, a sleeve, an adaptor sleeve or the like, or any suitable combination thereof.

[0046] The first pile may be shorter than the second pile, such that the first pile may be located in the ground to a desired depth, and the second pile located in the ground to a greater depth. This combined pile arrangement may therefore provide a robust piling system.

[0047] The pile system may comprise further piles, which may be inserted within the ground via a drilled hole.

[0048] The system may further comprise a grouting assembly adapted to grout at least the first pile within the ground. The grouting assembly may be arranged to deliver grout at least between an outer surface of the first pile and a wall of the bore drilled by the drilling assembly. The grouting system may also be arranged to grout other piles of the piling system, such as the outer pile and the second pile, within the ground.

[0049] The grouting assembly may comprise a first grout member. The first grout member may be arranged to be inserted within the first pile. The first grout member may comprise a plug adapted to be delivered into the first pile, wherein the plug permits the passage of grout therethrough. The plug may be adapted to establish a seal with the inner surface of the first pile. The seal may assist to prevent leakage of grout within the first pile. The first grout plug may be coupled to at least one conduit arranged to communicate a fluid to the grout plug. The at least one conduit may comprise a conduit for communicating a fluid (gas or liquid) to energise grout seals. The at least one conduit may comprise a conduit for communicating grout to the grout plug.

[0050] The first grout member may be retrievable. Alternatively, the first grout member may be arranged to be retained within the first pile.

[0051] The first grout member may be adapted to provide an anchor attachment point, such as a socket, lug, eyelet or the like. The anchor attachment point may be utilised to permit a structure or otherwise to be secured to the pile system, to thus be anchored by the pile system.

[0052] In embodiments of the invention the first grout member may be adapted to be received within the second pile. The first grout member may be arranged to permit grout to be delivered to secure both the second and first piles within the ground, and optionally also the outer pile if utilised.

[0053] The grouting assembly may comprise a second grouting member. The second grouting member may be adapted to be received within the second pile. The second grouting member may be adapted to provide an anchor attachment point.

[0054] The pile system may define a subsea pile system.

[0055] According to a second aspect of the present invention there is provided a method of installing a pile system comprising the steps of:

mounting a base assembly on a ground surface;
lowering a first pile through the base assembly;
drilling a hole in the ground with a drill bit unit secured relative to an end of the first pile while simultaneously inserting the first pile within the drilled hole; and
engaging the first pile with the base assembly to prevent rotation of the first pile.

[0056] The method may comprise the step of inserting an outer pile within the ground, and locating the first pile through and within the outer pile.

[0057] The method may comprise the step of grouting the first pile within the ground, and optionally within the outer pile, if present.

[0058] The method may comprise the step of inserting a second pile within the ground through the first pile. The second pile may be grouted within the ground.

[0059] The method may comprise steps directly or indirectly derived from the features defined above in relation to the first aspect.

[0060] According to a third aspect of the present invention there is provided a pile system comprising:

a first pile to be inserted within the ground; and
a drilling assembly comprising a drill bit unit secured relative to a lower region of the first pile to form a drilled hole to accommodate the first pile;

wherein the first pile is adapted to be lowered into the ground on a spoolable medium.

[0061] The spoolable medium may form part of the system.

[0062] According to a fourth aspect of the present invention there is provided a method of installing a pile system comprising the steps of:

mounting a first pile on a spoolable medium; and drilling a hole in the ground with a drill bit unit secured relative to an end of the first pile while simultaneously lowering the first pile within the drilled hole on the spoolable medium.

[0063] According to a fifth aspect of the present invention there is provided a pile system comprising:

a pile adapted to be inserted into the ground; and a drilling assembly comprising a drill bit unit secured relative to a lower region of the first pile to drill a hole to accommodate the first pile therein, wherein the drill bit unit comprises contra-rotating drill bit.

[0064] It should be understood that various features defined in relation to one or more aspects of the invention may be utilised in combination with features of other aspects of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0065] These and other aspects of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1(a) - (d) show sequential steps of installing a base assembly and outer pile of a pile system according to an embodiment of the present invention; Figures 2(a) - (d) show sequential steps of installing a first pile of the pile system; Figures 3(a) - (d) show sequential steps of grouting the outer and first piles within the ground; Figures 4(a) - (d) show sequential steps of installing a second pile of the pile system; Figures 5(a) - (d) show sequential steps of grouting the second pile in place to provide an anchor, and removing the base assembly; Figures 6(a) - (d) shows various stages of installing the first and second piles and demonstrates the use of an anti-rotation arrangement; Figures 7(a) and (b) show side and top views of the base assembly; Figure 8 is a diagrammatic representation of a drilling assembly according to a first embodiment; and Figure 9 is a diagrammatic representation of a drilling assembly according to a second embodiment.

DETAILED DESCRIPTION OF THE DRAWINGS

[0066] Reference is first made to Figures 1(a) - (d) of the drawings in which there are shown sequential steps of installing a base assembly 10 and an outer pile 12 of a pile system according to an embodiment of the present invention. In the embodiment shown the pile system is installed offshore and into a seabed 14.

[0067] The initial stage of installation is shown in Figure 1 in which the outer pile 12 is located within a pile passage

14 formed in the base assembly 10, and the base assembly 10 and outer pile 12 are lowered together from a surface vessel (not shown). In this respect the base assembly 10 and outer pile 12 are lowered through the seawater 15 on wires 16, 18, 20. As will be described in further detail below, wires 16, 18 are secured to respective guide posts 22, 24 formed on the base assembly 10 and function to guide further components being lowered from the floating vessel.

[0068] The outer pile may be of any suitable length, and in the embodiment may be between 6 and 7 metres long.

[0069] A combined pump arrangement including a jetting pump 26 and a suction pump 28 is installed in an upper region of the outer pile 12. The jetting pump 26 includes a pipe 30 which extends through and terminates in a lower region of the outer pile 12. As will be described in further detail below, the jetting and suction pumps 26, 28 are utilised to locally displace the seabed material to permit insertion of the outer pile 12. Power for the pumps 27, 28 is supplied through an umbilical 29.

[0070] As shown in Figure 1(b), the base assembly 10 is landed on the seabed 14 and feet or pins 32 extend through the surface of the seabed 14. The feet 32 are intended to secure the base assembly 10 against rotation. In the arrangement shown the base assembly 10 includes three feet 32 (only two shown) mounted on respective legs which are uniformly circumferentially distributed around the base assembly 10. As will be described in further detail below, the legs 36 are arranged to be manipulated to assist in achieving the desired orientation and level of the base assembly 10. Each foot 32 may include a hydraulic hammering arrangement 38 (only one shown) for assisting insertion of the feet 32 through the seabed.

[0071] Once the base assembly 10 is located on the seabed 14 the jetting pump 26 is activated, as shown in Figure 1(c), to produce a jet of seawater from the end of the pipe 30 to disturb and liquefy the seabed region 14a at the leading end of the outer pile 12. The suction pump 28 is activated to remove the liquefied seabed material, as indicated by reference numeral 40. The outer pile 12 is simultaneously inserted, under its own weight, within the resulting excavated hole within the seabed 14. The outer pile 12 is guided by a guide plate 27 which engages the guide wires.

[0072] Once the outer pile 12 is inserted to the required depth, the pumps 26, 28 and jetting nozzle 30 are retrieved to the floating vessel on the wire 20, while being guided on the wires 16, 18 by at least the guide plate 27.

[0073] It should be noted that the outer pile 12 may be installed in the manner described above through relatively soft seabed material, such as sand, silt or mud, which overlies more substantial bedrock or other consolidated layer. The outer pile 12 may therefore be inserted until the interface with the bedrock is reached.

[0074] Once the outer pile 12 is inserted, a further pile, in this case conveniently identified as a first drilled pile

50, is installed, as will now be described with reference to Figures 2(a) - (d). The first pile 50 is longer than the outer pile 12 and in the embodiment shown may be in the region of 11 to 12 metres long.

[0075] The first pile 50 is, as shown in Figure 2(a), lowered from the surface vessel on the wire 20, and is guided via an upper guide plate 51 and a lower guide or adaptor sleeve 52 on the guide wires 16, 18. The function of the adaptor sleeve 52 will be described later below. A drill bit unit having a drill bit 54 is releasably secured relative to a lower end region of the first pile 50. A pump arrangement including a cooling pump 56 and a drill cuttings removal pump 58 is releasably secured to an upper end region of the first pile 50. In use the cooling pump 56 supplies seawater to the drill bit 54 for the purposes of cooling, lubrication and cuttings removal and the like, and the cuttings removal pump 58 discharges the cuttings and seawater from the first pile 50. It should be noted that the jetting and suction pumps 26, 28 identified above and shown in Figure 1 may be utilised as the cooling and drill cuttings removal pumps.

[0076] The first pile 50 is received within and extends through the passage 14 in the base assembly 10, and is subsequently run in through the outer pile 12 until the drill bit 54 lands on the bottom of the hole created by the outer pile 12, as illustrated in Figure 2(b). As shown in Figure 2(c), the drill bit 54 is then actuated, for example by a hydraulic motor, to extend further into the earth, wherein the first pile 50 follows the drill bit 54, under its own weight, to become simultaneously located in the hole being drilled. The cooling pump 56 delivers seawater to the interface between the drill bit 54 and the earth or rock being drilled, and the cuttings pump 58 discharges the seawater and drill cuttings, as indicated by region 60.

[0077] The first pile 50 is rotationally fixed relative to the base assembly 10 via the adaptor sleeve 52, as discussed in further detail below, so that the first pile 50 is secured against rotation due to drilling torque. In this respect, any drilling torque will be transmitted to the base assembly 10, and will be reacted against the feet 32 which are secured within the seabed 14.

[0078] It should be noted that the drill bit 54 is expandable so that it may be configured to define a first diameter which is smaller than the inner diameter of the first pile, and reconfigured to define a second diameter which is greater than the outer diameter of the first pile 50. This arrangement permits the drill bit 54 to be inserted or retrieved through the first pile, while permitting a hole of sufficient diameter to be created to receive the first pile 50.

[0079] In the present embodiment it is intended, as described below, to grout the first pile 50 in the ground. Thus, the second diameter, or even a third, larger diameter of the drill bit 54 allows the hole to be undercut to a larger diameter to increase the grout shear area.

[0080] Once the desired depth is reached the drill bit 54 and pumps 56, 58 are released from the first pile 50 and retrieved to the surface vessel on the wire 20, while

being guided by wires 16, 18, as shown in Figure 2(d).

[0081] The subsequent steps, illustrated in Figures 3(a) - (d), involve grouting both the outer pile 12 and the first pile 50 within the ground. Referring initially to Figure 3(a), a grout plug 62 is lowered on umbilicals 64, 66 (and/or optionally the wire 20) while being guided by the guide wires 16, 18. In this respect the plug 62 is located within a carriage 68 which engages the wires 16, 18 via a guide plate 69. The plug includes a plurality of annular expandable seals 70 adapted to be inflated by a hydraulic fluid communicated via umbilical 66 to create a seal against the inner surface of the first pile 50. As shown in Figure 3(b), the plug 62 and carriage 68 are received within the passage 14 of the base assembly, and a lower region of the plug 62 is located in an upper region of the first pile 50. Following this, as shown in Figure 3(c), the plug 62 is released from the carriage 68 and translated to the lower region of the first pile 50 where the seals 70 are activated or energised by fluid supplied via umbilical 66 to create a seal between the pile 50 and plug 62. Grout 72 is then pumped through umbilical 64, through plug 62 and the piles 12, 50 and bored wall surfaces and into annular regions formed between the piles 12, 50. The grout plug 62 may then be retrieved, as shown in Figure 3(d).

[0082] Once the outer and first piles 12, 50 are grouted in place, a further pile, in this case conveniently termed a second drilling pile 80 may be installed, as shown in Figures 4(a) - (d). It should be noted that the process of installing the second pile 80 is similar in most respects to installing the first pile 50, and so only a brief description will be provided. Also, it should be noted that the second pile 80 may be of any suitable length, and in the embodiment may be between 21 and 24 metres long.

[0083] Referring initially to Figure 4(a), it should be noted that the second pile 80 is lowered on the wire 20 while being guided by wires 16, 18 via an upper guide plate 85 and a lower sleeve adaptor 87. As will be described in further detail below, the adaptor sleeve 87 functions to rotationally secure the second pile 80 relative to the base assembly 10 to prevent rotation of the second pile 80 due to drilling torque. Also, a drill bit 82 is secured relative to a lower region of the second pile 80, and a cooling pump 84 and a cuttings removal pump 86 are secured relative to an upper region of the second pile 80. Pumps 84, 86 may be the same as pumps 56, 58 and/or pumps 26, 28.

[0084] In Figures 4(b) and (c) the second pile 80 is lowered through the first pile 50 and the drill bit 82 is actuated to drill a hole while the second pile 80 is advanced therein under its own weight. Operation of the pumps 84, 86 disposes of drill cuttings, identified by reference numeral 88.

[0085] Once the second pile 80 is located at the desired depth the drill bit unit and pumps 84, 86 are retrieved back to the vessel on the wire 20, while being guided by wires 16, 18. The second pile 80 may then be grouted in place, and an anchor attachment point installed for subsequent use, as will now be described with reference to

Figures 5(a) - (d).

[0086] Referring initially to Figure 5(a), an anchor pin 90 is lowered on the umbilicals 64, 66 (and/or optionally the wire 20), guided by a guide plate or sleeve 91 via wires 16, 18, to be received within the passage 14 in the base assembly 10 and the upper region of the second pile 80. The anchor pin 90 includes an elongate body 90a and an anchor attachment point 90b in the form of an eyelet. A plurality of annular grouting rings 92 are axially distributed along the outer surface of the elongate body 90a and function to increase the bonding grip between the pin 90 and grout. An expandable seal 94 is provided at an upper end of the elongate body 90a and in use provides a seal against the inner surface of the second pile 80, to prevent loss of grout. The seal 94 is expanded by hydraulic fluid communicated by umbilical 66.

[0087] As shown in Figure 5(b), the anchor pin 90 is located within the second pile 80 such that the anchor attachment point 90b is positioned above the second pile 80. At this stage the seal 94 is energised. Following this, as shown in Figure 5(c), the base assembly 10, and any remaining adaptor sleeves, guide plates and the like, may be removed and retrieved back to the vessel. Subsequent to this, as shown in Figure 5(d), grout 96 is communicated through umbilical 64, through the anchor pin 90 and into the second pile 80 to grout the second pile 80 within its bore and the first pile 50. Once the grout has cured, a pull force may be applied to the anchor attachment point 90b to test its strength, and the umbilicals 64, 66 may be retrieved, leaving the attachment point 90b exposed for use, for example to provide an anchor point for a marine energy device, such as the applicant's Archimedes Waveswing™ device.

[0088] As mentioned above, the embodiment described rotationally secures the first and second piles 50, 80 relative to the base assembly so that the piles 50, 80 may be secured against rotation caused by drilling torque. An arrangement of achieving this will now be described with reference to Figures 6(a) - (d).

[0089] In Figure 6(a) the outer pile 12 is shown located within the ground, with the base assembly 10 partially shown, and the first pile 50 is shown being lowered towards the base assembly 10. The adaptor sleeve 52, defined as a first adaptor sleeve for convenience, which functions as a running tool is releasably secured to a lower region of the first pile 50, wherein the first adaptor sleeve 52 is arranged to engage with the guide wires (only wire 18 is shown). The first adaptor sleeve 52 includes a plurality of axially extending fins 102 located on the outer surface thereof, and a plurality of axially extending fins 104 located on the inner surface thereof. When the first pile 50 is lowered the first adaptor sleeve 52 is received within the passage 14 of the base assembly 10, wherein the outer fins 102 are received within axial slots 106 formed within the passage 14 of the base assembly 10, as also shown in Figure 7(b). Engagement of the outer fins 102 within the slots 106 on the base assembly 10 thus rotationally fixes the first adaptor

sleeve 52 to the base assembly 10. Once the first adaptor sleeve 52 is located within the base assembly the sleeve 52 may be released from the first pile 50, for example by shearing therefrom, to permit the first pile 50 to be advanced into the ground.

[0090] As shown in Figure 6(a), the first pile 50 includes a plurality of axially extending fins 108 formed on an upper outer surface thereof. The fins 108 on the first pile 50 are adapted to engage the inner fins 104 on the first adaptor sleeve 52 to thus rotationally fix the first pile 50 to the sleeve 52, which sleeve 52 in turn is rotationally fixed to the base 10. The first adaptor sleeve 52 is shown in Figure 6(b) located within the passage 14 of the base assembly 10, with the first pile 50 inserted to its total depth by drilling, as noted above, wherein drilling torque is reacted through the fins 108, 104 and the fin 102 and slot 106 (see Figure 7(b)).

[0091] Referring now to Figures 6(c) and (d), an anti-rotation arrangement associated with the second pile 80 will now be described. In this arrangement the adaptor sleeve 87, defined as a second adaptor sleeve for convenience, is lowered towards the base 10 while mounted on the second pile 80, wherein the second adaptor sleeve 87 is received within the first adaptor sleeve 52. As more clearly shown in Figure 7(b), the second sleeve 87 includes a plurality of axially extending fins 112 located on an outer surface thereof, and a plurality of axially extending fins 114 located on an inner surface thereof. The outer fins 112 are arranged to engage the inner fins 104 of the first sleeve 52, and the inner fins 114 of the second sleeve 87 are arranged to engage axially extending fins 116 formed on an upper outer surface of the second pile 80. Thus, while the second pile 80 is being run through the second adaptor sleeve 87, the second pile 80 will be rotationally fixed to the second adaptor sleeve 87, which in turn is rotationally fixed to the first adaptor sleeve 52, which in turn is rotationally fixed to the base assembly 10 via fins 102 to slots 106 in the base assembly 10.

[0092] Reference is now made to Figures 7(a) and (b) in which there are shown side and sectional top views, respectively, of portions of the base assembly 10. Figure 7(b) shows the first and second adaptor sleeves 52, 87, and the second pile 80 in position. As described above, the base assembly 10 includes three legs 36 which carry respective feet 32 to be secured within a surface. The legs 36 are each secured to the base via a lower pin joint 120. A piston arrangement 122 is secured between an upper region of each leg 36, wherein each piston arrangement 122 is adapted to rotate each leg 36 about the pin joint 120 to thus manipulate or change the orientation of the base assembly 10.

[0093] As shown in Figure 7(b), the base assembly 10 is provided in three segments 10a, 10b, 10c each carrying a respective leg 36. The segments 10a, 10b, 10c are secured together using latching arrangements 124.

[0094] Reference is now made to Figure 8 in which there is shown an arrangement of a drilling assembly according to an embodiment of the present invention.

The drilling assembly described incorporates the drill bit 54 first shown in Figure 2 for use in creating a hole for insertion of the first pile 50. The drill bit 54 forms part of a drill bit unit and is releasably secured relative to the lower region of the pile 50 via a hydraulic lock 130, and hydraulic motors 132, 134 are mounted adjacent to the drill bit 54. The drill bit unit includes a first drilling component 136 drivingly coupled to hydraulic motor 132, and a second drilling component 138 drivingly coupled to hydraulic motor 134. The first and second drilling components 136, 138 are adapted to be rotated in opposite directions to assist to reduce the reaction torque applied to the first pile 50.

[0095] The drill bit unit comprises extendable components 146, 148 in the form of small and large fly or under-reamer cutters such that the drill bit unit may be expanded to a diameter larger than the outer diameter of the first pile 50.

[0096] The cooling pump 56, first shown in Figure 2, is arranged to pump seawater through a conduit 140 extending through the first pile 50 to deliver the seawater to the drill bit 54 for cooling, lubrication, cuttings removal etc. The cuttings removal pump 58, also first shown in Figure 2, is arranged to remove seawater and cuttings etc from the annulus 142 provided between the conduit 140 and the inner wall of the pile 50.

[0097] An alternative embodiment of a drilling assembly is shown in Figure 9, reference to which is now made. This embodiment is similar to the embodiment shown in Figure 8 and as such like components share like reference numerals. Also, for clarity and brevity only the differences between the similar embodiments will be highlighted. In the embodiment shown in Figure 9 the hydraulic locks 130 are provided at an upper region of the pile 50, in addition to the hydraulic motors 132, 134 for driving the first and second drilling components 136, 138 of the drill bit 54. In this case inner and outer drive shafts 150, 152 extend between the respective hydraulic motors 132, 134 and the respective drilling components 136, 138.

[0098] In an alternative embodiment, an auger-type thread arrangement may be utilised to recover drill cuttings in addition to, or in place of, lifting cuttings entrained in the cooling medium.

[0099] It should be understood that the embodiments described above are merely exemplary and that various modifications may be made thereto without departing from the scope of the invention. For example, the outer pile and the second pile are optional. That is, for example, if ground conditions are consolidated rock, the outer pile may not be used and the first pile may be directly drilled into place. Furthermore, additional piles may be utilised. Additionally, the system may be suitable for use in installing the piles onshore. Additionally, the outer pile may define a suitable base assembly, such that the described base assembly 10 may be eliminated. In this arrangement the outer pile may comprise anti-rotation elements, such as webs or the like adapted to engage the ground to prevent rotation of the outer pile. Any other piles within

the system may then be rotationally secured to the outer pile to be secured against rotation.

5 Claims

1. A pile system comprising: a base assembly adapted to be mounted on a ground surface
characterised by at least first and second telescoping piles adapted to be extended through the base assembly and into the ground; and a boring assembly comprising a jetting or cutting means secured relative to a lower region of at least one of the piles to bore a hole to accommodate the at least one of the piles therein, wherein the base assembly is adapted to engage the first pile to prevent rotation thereof and the second pile is arranged to directly or indirectly engage with the base assembly to prevent rotation of the second pile; and wherein the second pile is adapted to be inserted into the ground through the first pile.
2. The pile system according to claim 1, wherein the second and/or a subsequent pile is longer than the first and/or a preceding pile, such that the first or preceding pile is locatable in the ground to a desired depth, and the second or subsequent pile is locatable in the ground to a greater depth.
3. The pile system according to claim 1 or 2, wherein the first pile is adapted to engage the base assembly via interengaging profiles to prevent relative rotation of the first pile and base assembly and optionally, the first pile and base assembly are adapted to indirectly engage and/or the second or subsequent pile is configured to engage the first or preceding pile via inter-engaging profiles to prevent rotation of the second or subsequent pile relative to the base assembly.
4. The pile system according to any preceding claim, further comprising a sleeve adapted to be interposed between the first pile and the base assembly.
5. The pile system according to claim 4, wherein the sleeve comprises an inner profile adapted to engage an outer profile formed on the first pile, and an outer profile adapted to engage an inner profile formed on the base assembly and/or the sleeve is releasably securable to a lower end of the first pile and/or the sleeve is configured to be received within the pile passage of the base assembly and/or the sleeve is configured to be retained within the pile passage while the first pile is being inserted into the ground.
6. The pile system according to any preceding claim, wherein the boring assembly comprises a contra-rotating drill bit.

7. The pile system according to any preceding claim, wherein the boring assembly comprises a pumping arrangement adapted to pump a fluid toward the region of a cutting apparatus of the boring assembly and optionally the pumping arrangement is adapted to remove the fluid after being pumped toward the region of the drill bit. 5
8. The pile system according to any preceding claim, comprising a drive arrangement configured to assist piercing of the ground surface with the at least one ground engaging element adapted to secure the base assembly against rotation. 10
9. The pile system according to any preceding claim, wherein the base assembly and/or piles are adapted to be lowered or raised relative to the ground surface by a spoolable medium. 15
10. The pile system according to any preceding claim, wherein the base assembly is provided in segments adapted to be releasably secured together. 20
11. The pile system according to any preceding claim, further comprising an outer pile adapted to be inserted within the ground, wherein the system is arranged such that the first pile is inserted through the outer pile. 25
12. The pile system according to claim 11, wherein the outer pile is configured to be inserted through the base assembly and into the ground and/or the outer pile is inserted in the ground by a jetting arrangement and/or the outer pile is shorter than the first pile, such that the outer pile may be located in the ground to a desired depth, and the first pile be drilled and located in the ground to a greater depth and/or the outer pile is configured to extend through relatively soft material overlying a layer of bedrock or other consolidated layer, wherein the first pile is arranged to extend into the bedrock. 30 35 40
13. A pile system according to any of the preceding claims, wherein the pile system is adapted to be operable under water for inserting piles in the sea bed. 45
14. The pile system according to any preceding claim, further comprising a grouting assembly adapted to grout at least the first pile within the ground, wherein the grouting assembly optionally comprises a grout member configured to be retained within the pile system and optionally the grout member is configured to function as an anchor. 50
15. A method of installing a pile system comprising the steps of: mounting a base assembly on a ground surface; lowering a first telescoping pile through the base assembly; boring a hole in the ground with a 55

jetting or cutting means secured relative to an end of the first and/or second piles while simultaneously inserting the first pile within the drilled hole; engaging the first pile with the base assembly to prevent rotation of the first pile; and inserting a second telescoping pile into the ground through the first pile, wherein the second pile directly or indirectly engages with the base assembly to prevent relative rotation thereof.

Patentansprüche

1. Pfahlssystem, das aufweist: eine Basisbaugruppe, die so ausgebildet ist, dass sie auf einer Bodenoberfläche montiert werden kann, **gekennzeichnet durch** mindestens einen ersten und einen zweiten Teleskoppfahl, die so ausgebildet sind, dass sie sich **durch** die Basisbaugruppe und in den Boden hinein erstrecken können; und eine Bohrbaugruppe, die ein Jetting- oder Schneidmittel aufweist, das relativ zu einem unteren Bereich von mindestens einem der Pfähle gesichert ist, um ein Loch zu bohren, um den mindestens einen der Pfähle darin aufzunehmen, wobei die Basisbaugruppe ausgebildet ist, um mit dem ersten Pfahl in Eingriff zu kommen, um dessen Drehung zu verhindern, und wobei der zweite Pfahl angeordnet ist, um direkt oder indirekt mit der Basisbaugruppe in Eingriff zu kommen, um die Drehung des zweiten Pfahls zu verhindern; und wobei der zweite Pfahl so ausgebildet ist, dass er **durch** den ersten Pfahl in den Boden eingesetzt wird.
2. Pfahlssystem nach Anspruch 1, bei dem der zweite und/oder ein nachfolgender Pfahl länger ist als der erste und/oder ein vorhergehender Pfahl, so dass der erste oder der vorhergehende Pfahl im Boden bis zu einer gewünschten Tiefe angeordnet werden kann, und wobei der zweite oder der nachfolgende Pfahl im Boden bis zu einer größeren Tiefe angeordnet werden kann.
3. Pfahlssystem nach Anspruch 1 oder 2, bei dem der erste Pfahl ausgebildet ist, um mit der Basisbaugruppe mittels ineinander greifender Profile in Eingriff zu kommen, um eine relative Drehung des ersten Pfahls und der Basisbaugruppe zu verhindern, und wobei wahlweise der erste Pfahl und die Basisbaugruppe ausgebildet sind, um indirekt in Eingriff zu kommen, und/oder wobei der zweite oder der nachfolgende Pfahl ausgebildet ist, um mit dem ersten oder dem vorhergehenden Pfahl mittels ineinander greifender Profile in Eingriff zu kommen, um eine Drehung des zweiten oder des nachfolgenden Pfahls relativ zur Basisbaugruppe zu verhindern.
4. Pfahlssystem nach einem der vorhergehenden Ansprüche, das außerdem eine Hülse aufweist, die so

ausgebildet ist, dass sie zwischen dem ersten Pfahl und der Basisbaugruppe angeordnet werden kann.

5. Pfahlsystem nach Anspruch 4, bei dem die Hülse ein Innenprofil, das ausgebildet ist, um mit einem Außenprofil in Eingriff zu kommen, das auf dem ersten Pfahl ausgebildet ist, und ein Außenprofil aufweist, das ausgebildet ist, um mit einem Innenprofil in Eingriff zu kommen, das auf der Basisbaugruppe ausgebildet ist, und/oder wobei die Hülse lösbar an einem unteren Ende des ersten Pfahls gesichert werden kann, und/oder wobei die Hülse ausgebildet ist, so dass sie innerhalb des Pfahldurchganges der Basisbaugruppe aufgenommen wird, und/oder wobei die Hülse ausgebildet ist, so dass sie innerhalb des Pfahldurchganges festgehalten wird, während der erste Pfahl in den Boden eingesetzt wird. 5 10 15
6. Pfahlsystem nach einem der vorhergehenden Ansprüche, bei dem die Bohrbaugruppe einen gegenläufigen Bohrmeißel aufweist. 20
7. Pfahlsystem nach einem der vorhergehenden Ansprüche, bei dem die Bohrbaugruppe eine Pumpenanordnung aufweist, die ausgebildet ist, um ein Fluid in Richtung des Bereiches einer Schneidvorrichtung der Bohrbaugruppe zu pumpen, und wobei die Pumpenanordnung wahlweise ausgebildet ist, um das Fluid zu entfernen, nachdem es in Richtung des Bereiches des Bohrmeißels gepumpt wurde. 25 30
8. Pfahlsystem nach einem der vorhergehenden Ansprüche, das eine Antriebsanordnung aufweist, die ausgebildet ist, um das Durchstoßen der Bodenoberfläche zu unterstützen, wobei das mindestens eine Bodeneingriffselement ausgebildet ist, um die Basisbaugruppe gegen eine Drehung zu sichern. 35
9. Pfahlsystem nach einem der vorhergehenden Ansprüche, bei dem die Basisbaugruppe und/oder die Pfähle so ausgebildet sind, dass sie relativ zur Bodenoberfläche mittels eines Windenmittels abgesenkt oder angehoben werden können. 40
10. Pfahlsystem nach einem der vorhergehenden Ansprüche, bei dem die Basisbaugruppe in Segmenten vorhanden ist, die so ausgebildet sind, dass sie lösbar miteinander gesichert werden können. 45
11. Pfahlsystem nach einem der vorhergehenden Ansprüche, das außerdem einen äußeren Pfahl aufweist, der so ausgebildet ist, dass er innerhalb des Bodens eingesetzt wird, wobei das System so angeordnet ist, dass der erste Pfahl durch den äußeren Pfahl eingesetzt wird. 50 55
12. Pfahlsystem nach Anspruch 11, bei dem der äußere Pfahl so ausgebildet ist, dass er durch die Basisbau-

gruppe und in den Boden hinein eingesetzt werden kann, und/oder wobei der äußere Pfahl in den Boden mittels einer Jettinganordnung eingesetzt wird, und/oder wobei der äußere Pfahl kürzer ist als der erste Pfahl, so dass der äußere Pfahl im Boden bis zu einer gewünschten Tiefe angeordnet werden kann, und wobei der erste Pfahl bis zu einer größeren Tiefe in den Boden gebohrt und dort angeordnet wird, und/oder wobei der äußere Pfahl so ausgebildet ist, dass er sich durch relativ weiches Material erstreckt, das über einer Schicht des Muttergesteins oder einer anderen verdichteten Schicht liegt, wobei der erste Pfahl angeordnet wird, um sich in das Muttergestein hinein zu erstrecken.

13. Pfahlsystem nach einem der vorhergehenden Ansprüche, bei dem das Pfahlsystem so ausgebildet ist, dass es unter Wasser für das Einsetzen der Pfähle in den Meeresboden funktionsfähig ist.
14. Pfahlsystem nach einem der vorhergehenden Ansprüche, das außerdem eine Einpressbaugruppe aufweist, die ausgebildet ist, um mindestens den ersten Pfahl innerhalb des Bodens einzupressen, wobei die Einpressbaugruppe wahlweise ein Einpresselement aufweist, das so ausgebildet ist, dass es innerhalb des Pfahlsystems festgehalten wird, und wobei das Einpresselement wahlweise ausgebildet ist, um als ein Anker zu funktionieren.
15. Verfahren zum Installieren eines Pfahlsystems, das die folgenden Schritte aufweist: Montieren einer Basisbaugruppe auf einer Bodenoberfläche; Absenken eines ersten Teleskoppfahls durch die Basisbaugruppe; Bohren eines Loches im Boden mittels eines Jetting- oder Schneidmittels, das relativ an einem Ende des ersten und/oder des zweiten Pfahls gesichert ist, während gleichzeitig der erste Pfahl innerhalb des gebohrten Loches eingesetzt wird; Ineingriffkommen des ersten Pfahls mit der Basisbaugruppe, um eine Drehung des ersten Pfahls zu verhindern; und Einsetzen eines zweiten Teleskoppfahls in den Boden durch den ersten Pfahl, wobei der zweite Pfahl direkt oder indirekt mit der Basisbaugruppe in Eingriff kommt, um deren relative Drehung zu verhindern.

Revendications

1. Système de pieux, comprenant : un assemblage de base, adapté pour être monté sur une surface du sol, **caractérisé par** au moins un premier et un deuxième pieu télescopique, adaptés pour s'étendre à travers l'assemblage de base et dans le sol, et un assemblage de forage, comprenant un moyen de lancement ou un moyen de coupe fixé par rapport à une région inférieure d'au moins un des pieux, pour

- forer un trou en vue d'y recevoir le au moins un pieu, dans lequel l'assemblage de base est adapté pour s'engager dans le premier pieu pour empêcher sa rotation, le deuxième pieu étant agencé de sorte à s'engager directement ou indirectement dans l'assemblage de base pour empêcher la rotation du deuxième pieu ; et dans lequel le deuxième pieu est adapté pour être inséré dans le sol à travers le premier pieu.
2. Système de pieux selon la revendication 1, dans lequel le deuxième pieu et/ou un pieu ultérieur est plus long que le premier et/ou un pieu précédent, de sorte que le premier pieu ou le pieu précédent peut être positionné dans le sol à une profondeur voulue, le deuxième pieu ou le pieu ultérieur pouvant être positionné dans le sol à une profondeur plus grande.
 3. Système de pieux selon les revendications 1 ou 2, dans lequel le premier pieu est adapté pour s'engager dans l'assemblage de base par l'intermédiaire de profils à engagement mutuel, pour empêcher un rotation relative du premier pieu et de l'assemblage de base, le premier pieu et l'assemblage de base étant optionnellement adaptés pour s'engager indirectement, et/ou le deuxième pieu ou le pieu ultérieur est configuré de sorte à s'engager dans le premier pieu ou le pieu précédent par l'intermédiaire de profils à engagement mutuel pour empêcher la rotation du deuxième pieu ou du pieu ultérieur par rapport à l'assemblage de base.
 4. Système de pieux selon l'une quelconque des revendications précédentes, comprenant en outre un manchon adapté pour être agencé entre le premier pieu et l'assemblage de base.
 5. Système de pieux selon la revendication 4, dans lequel le manchon comprend un profil interne adapté pour s'engager dans un profil externe formé sur le premier pieu, et un profil externe adapté pour s'engager dans un profil interne formé sur l'assemblage de base, et/ou le manchon peut être fixé de manière amovible sur une extrémité inférieure du premier pieu, et/ou le manchon est configuré de sorte à être reçu dans le passage du pieu de l'assemblage de base, et/ou le manchon est configuré de sorte à être retenu dans le passage du pieu pendant que le premier pieu est inséré dans le sol.
 6. Système de pieux selon l'une quelconque des revendications précédentes, dans lequel l'assemblage de forage comprend un trépan de forage à contre-rotation.
 7. Système de pieux selon l'une quelconque des revendications précédentes, dans lequel l'assemblage de forage comprend un assemblage de pompage, adapté pour pomper un fluide vers la région d'un appareil de coupe de l'assemblage de forage, l'assemblage de pompage étant optionnellement adapté pour éliminer le fluide après son pompage vers la région du trépan de forage.
 8. Système de pieu selon l'une quelconque des revendications précédentes, comprenant un assemblage d'entraînement configuré de sorte à faciliter le perçage de la surface du sol, le au moins un élément d'engagement du sol étant adapté pour fixer l'assemblage de base contre une rotation.
 9. Système de pieux selon l'une quelconque des revendications précédentes, dans lequel l'assemblage de base et/ou les pieux sont adaptés pour être abaissés ou soulevés par rapport à la surface du sol par un moyen à enroulement.
 10. Système de pieux selon l'une quelconque des revendications précédentes, dans lequel l'assemblage de base est fourni par segments, adaptés pour être fixés de manière amovible les uns aux autres.
 11. Système de pieux selon l'une quelconque des revendications précédentes, comprenant en outre un pieu externe, adapté pour être inséré dans le sol, le système étant agencé de sorte que le premier pieu est inséré à travers le pieu externe.
 12. Système de pieux selon la revendication 11, dans lequel le pieu externe est configuré de sorte à être inséré à travers l'assemblage de base et dans le sol, et/ou le pieu externe est inséré dans le sol par un assemblage de lancement, et/ou le pieu externe est plus court que le premier pieu, de sorte que le pieu externe peut être positionné dans le sol à une profondeur voulue, le premier pieu pouvant être foré et positionné dans le sol à une profondeur plus grande, et/ou le pieu externe est configuré de sorte à s'étendre à travers un matériau relativement mou superposé à une couche de fondation rocheuse ou à une autre couche consolidée, le premier pieu étant agencé de sorte à s'étendre dans la fondation rocheuse.
 13. Système de pieux selon l'une quelconque des revendications précédentes, dans lequel le système de pieux est adapté pour être actionné sous l'eau en vue de l'insertion des pieux dans le fond marin.
 14. Système de pieux selon l'une quelconque des revendications précédentes, comprenant en outre un assemblage d'injection, adapté pour sceller au moins le premier pieu dans le sol, l'assemblage d'injection comprenant optionnellement un élément de scellement configuré de sorte à être retenu dans le système de pieux, l'élément de scellement étant optionnellement configuré de sorte à servir de moyen

d'ancrage.

15. Procédé d'installation d'un système de pieux, comprenant les étapes ci-dessous : montage d'un assemblage de base sur une surface du sol ; abaissement d'un premier pieu télescopique à travers l'assemblage de base ; forage d'un trou dans le sol par l'intermédiaire d'un moyen de lançage ou de coupe fixé par rapport à une extrémité du premier et/ou du deuxième pieu, tout en insérant simultanément le premier pieu dans le trou foré ; engagement du premier pieu dans l'assemblage de base pour empêcher la rotation du premier pieu ; et insertion d'un deuxième pieu télescopique dans le sol à travers le premier pieu, le deuxième pieu s'engageant directement ou indirectement dans l'assemblage de base pour empêcher une rotation relative de celui-ci.

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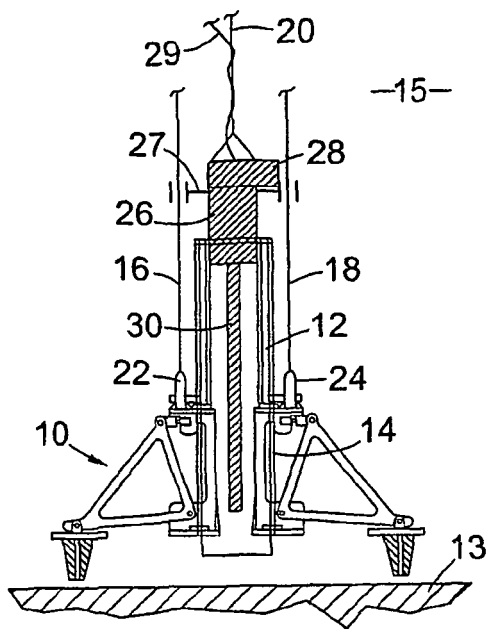


Fig. 1(a)

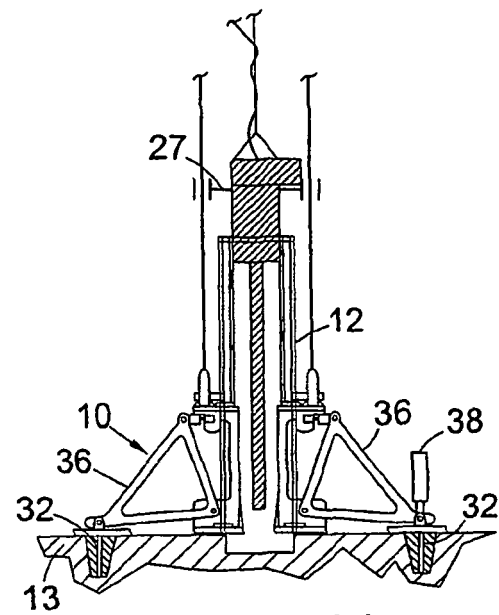


Fig. 1(b)

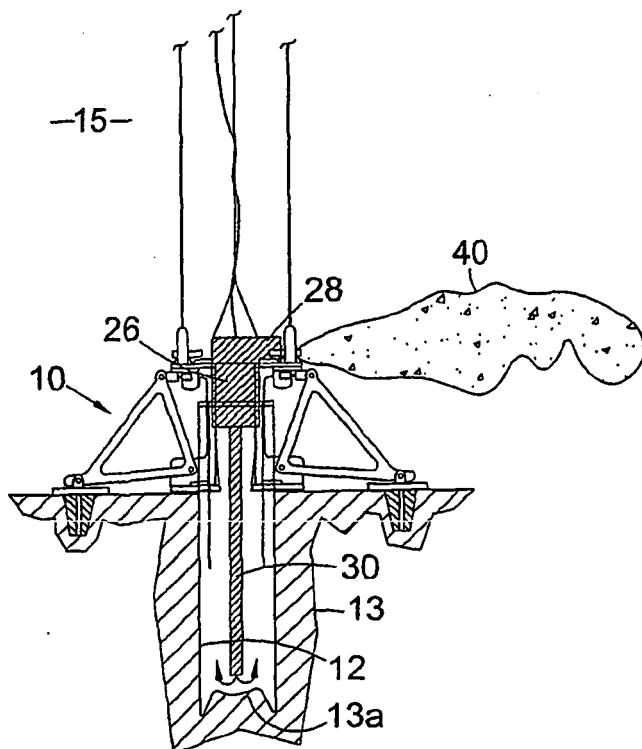


Fig. 1(c)

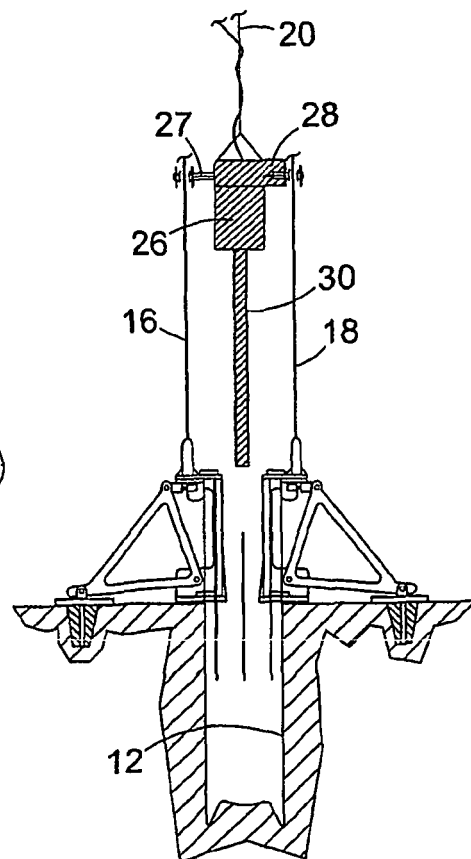


Fig. 1(d)

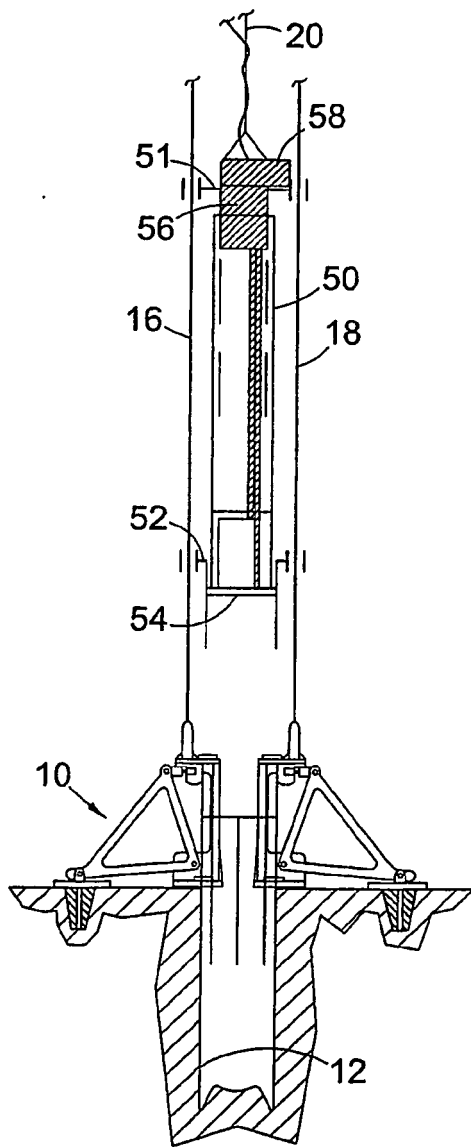


Fig. 2(a)

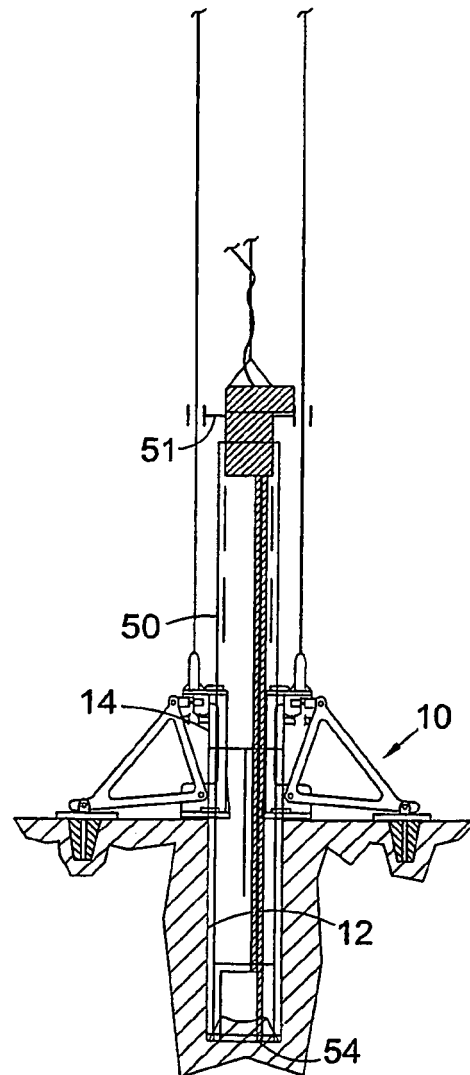


Fig. 2(b)

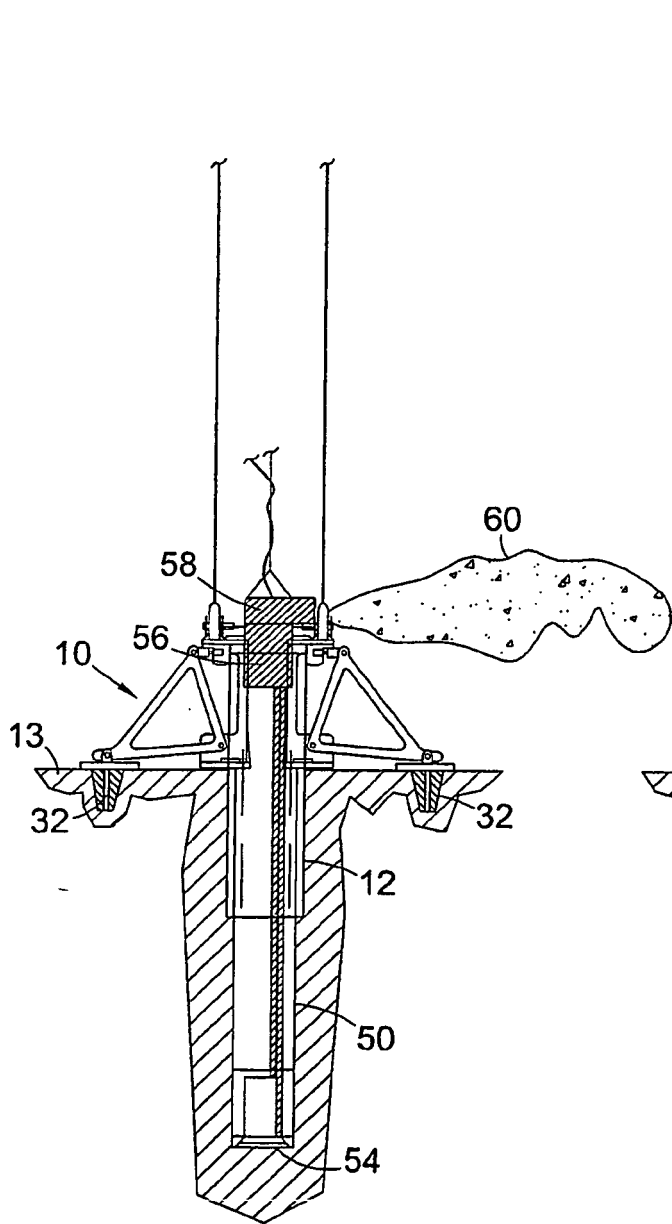


Fig. 2(c)

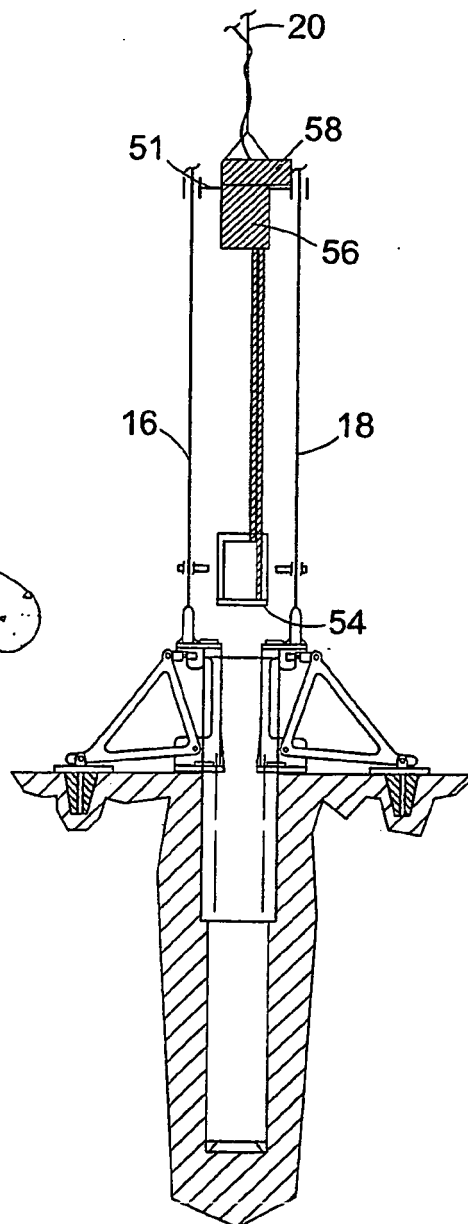


Fig. 2(d)

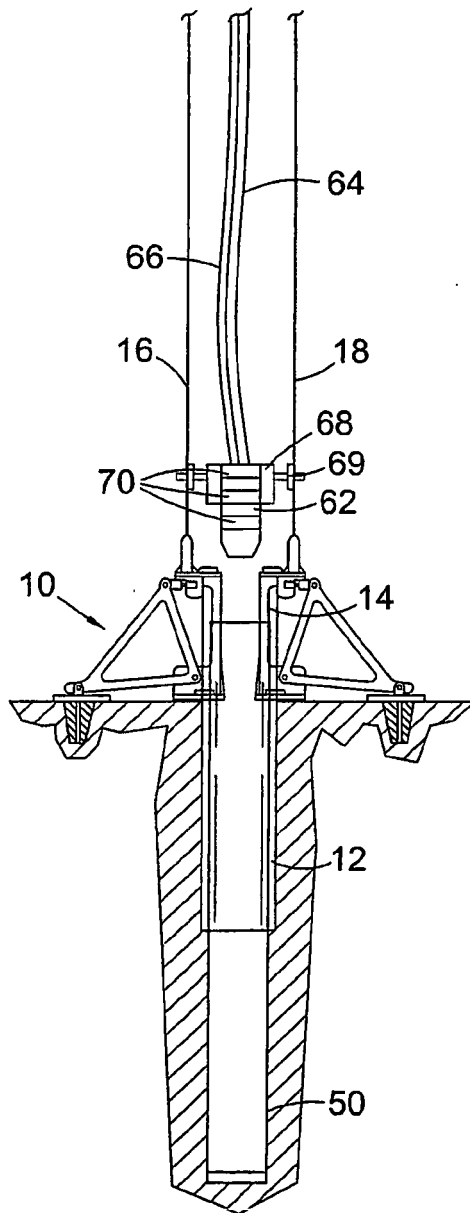


Fig. 3(a)

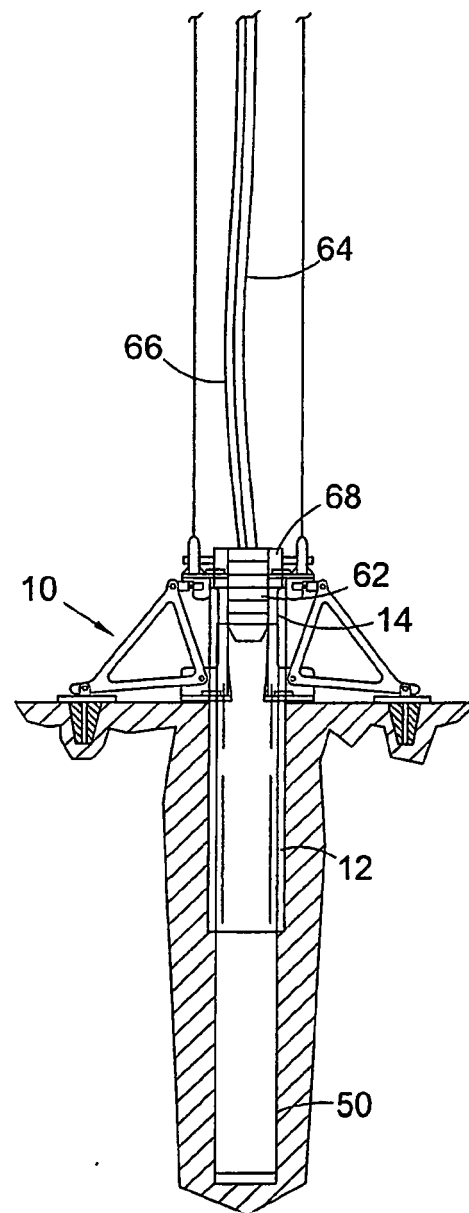


Fig. 3(b)

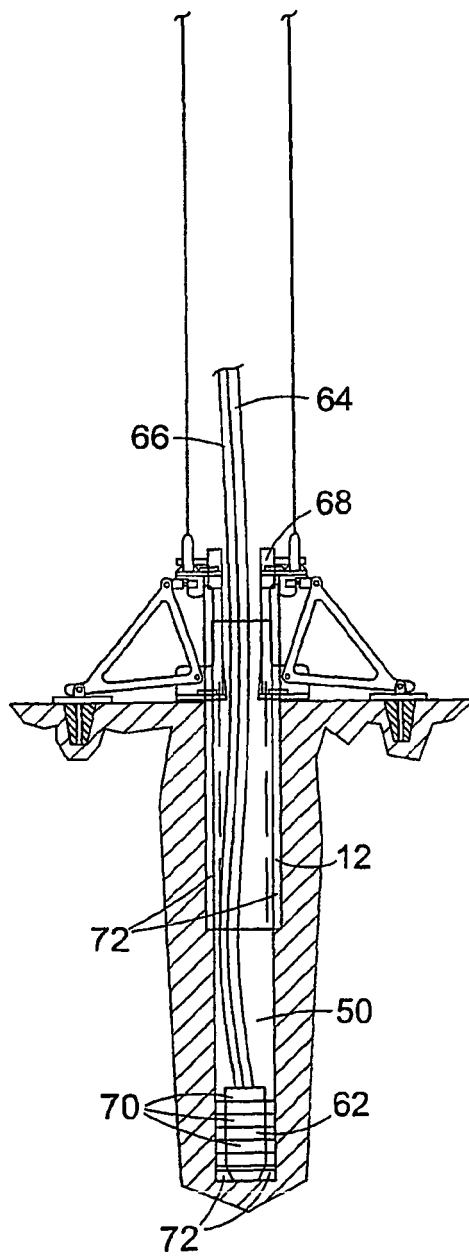


Fig. 3(c)

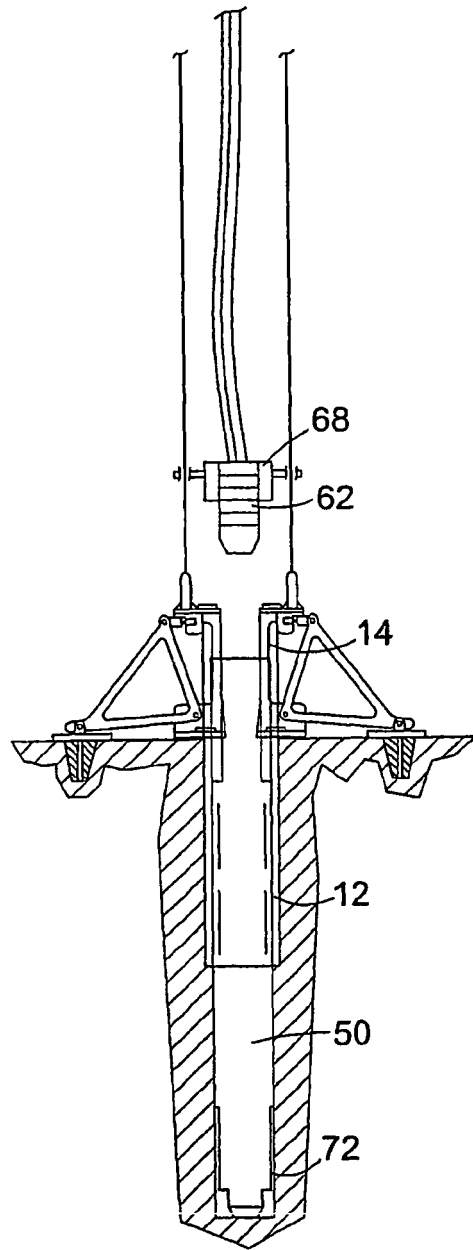


Fig. 3(d)

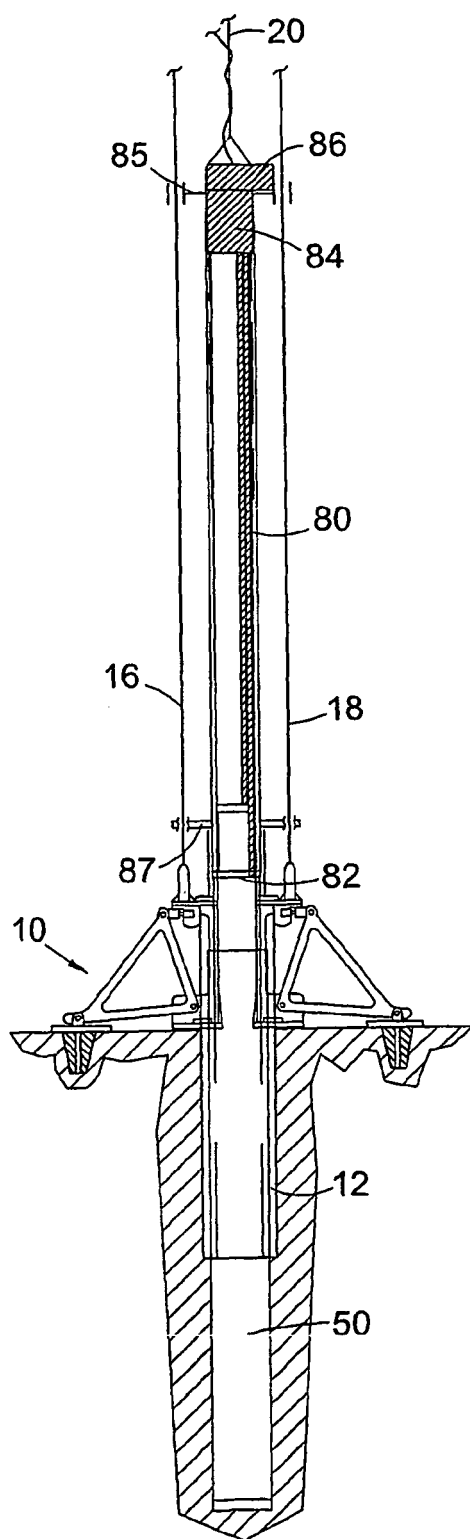


Fig. 4(a)

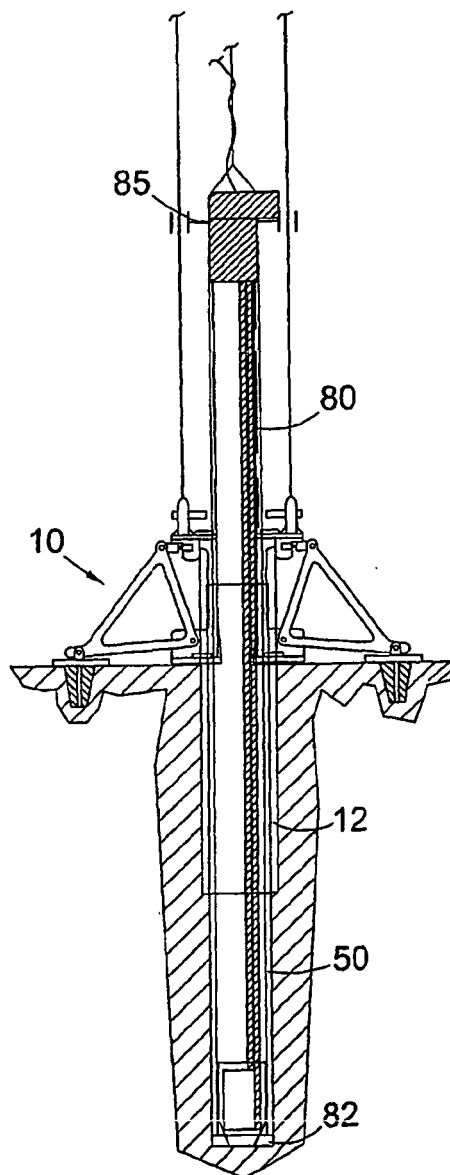


Fig. 4(b)

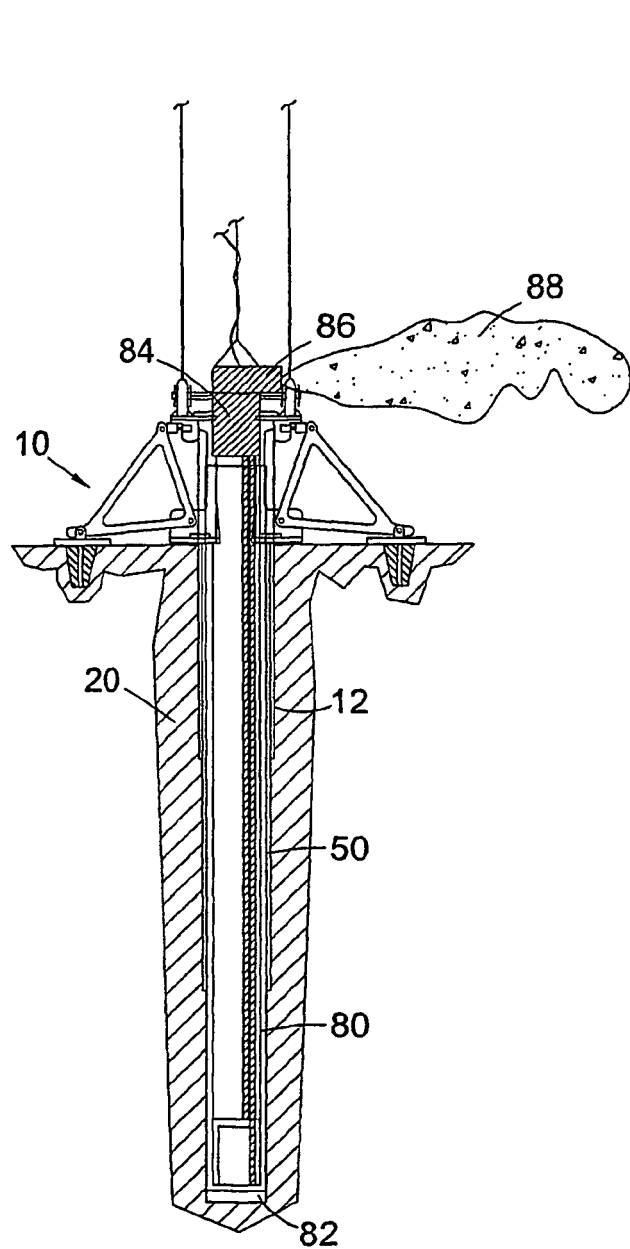


Fig. 4(c)

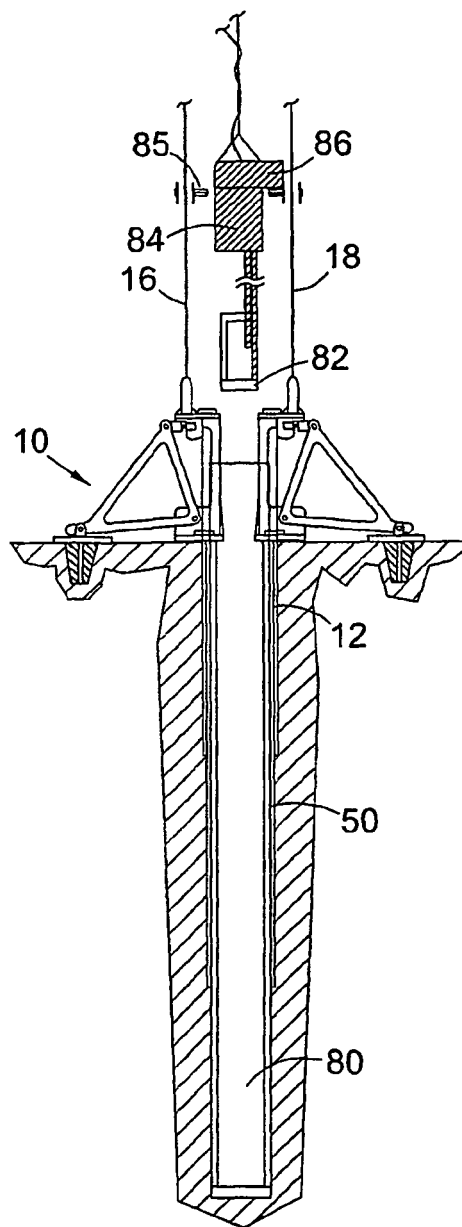


Fig. 4(d)

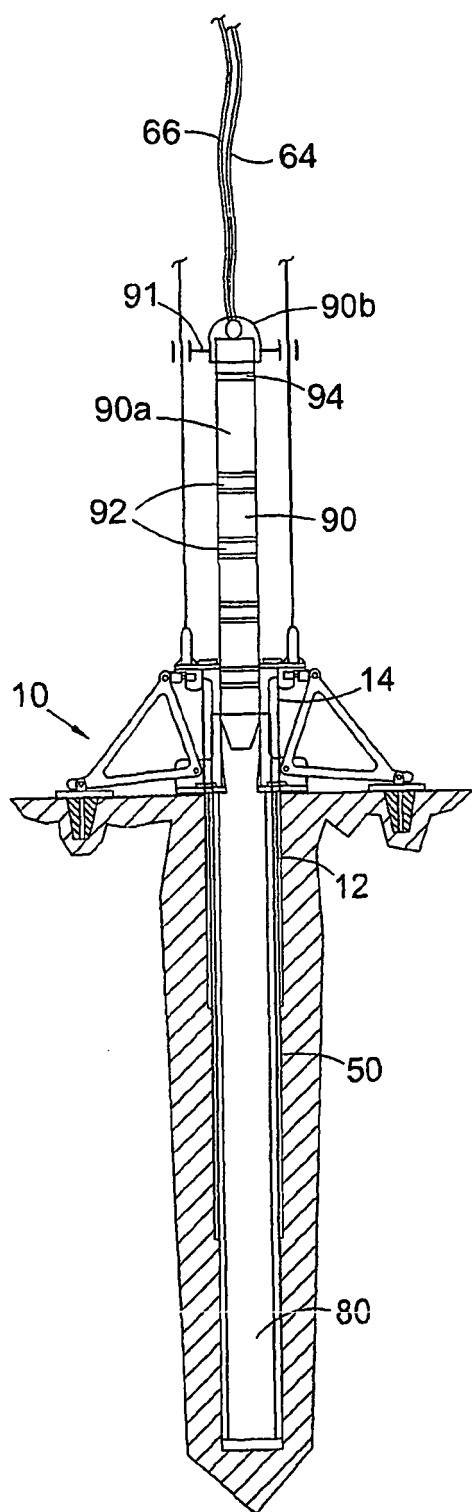


Fig. 5(a)

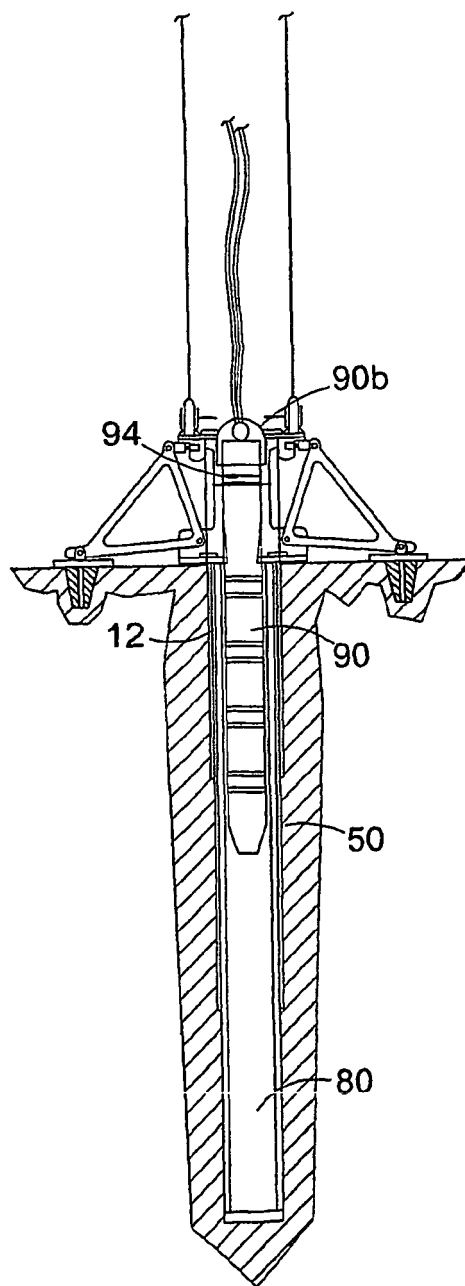


Fig. 5(b)

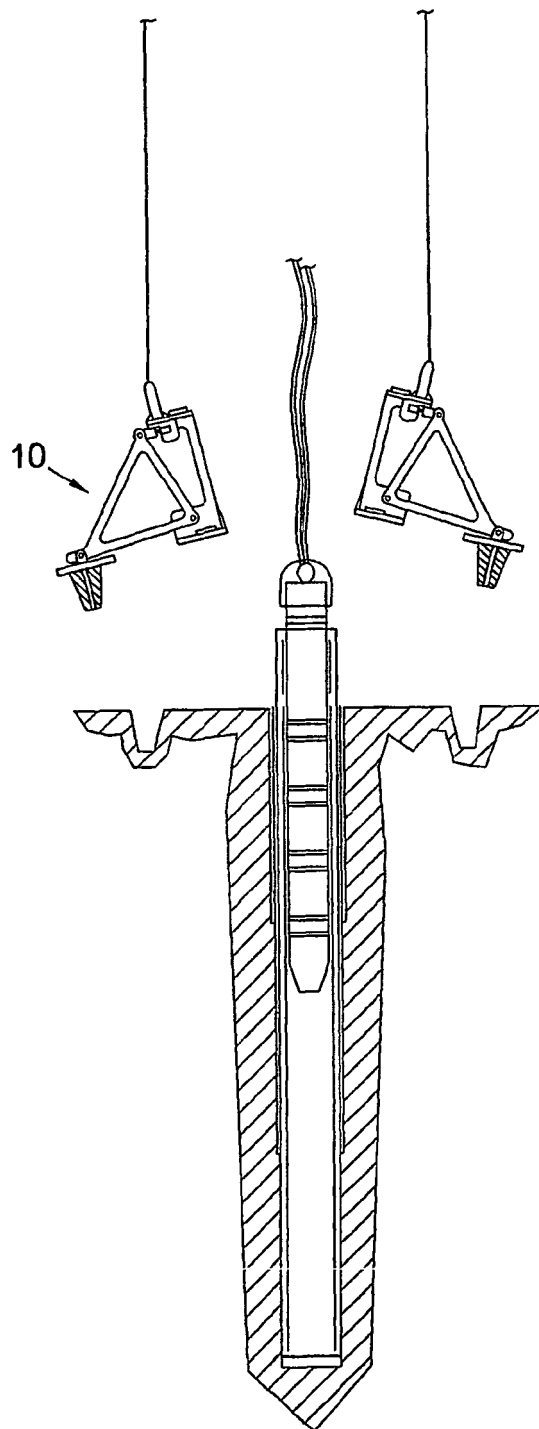


Fig. 5(c)

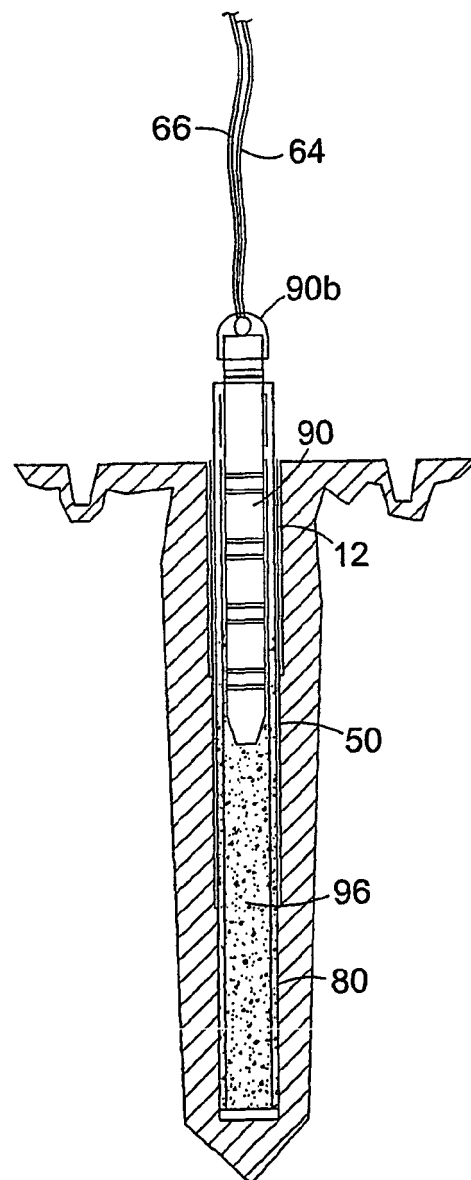


Fig. 5(d)

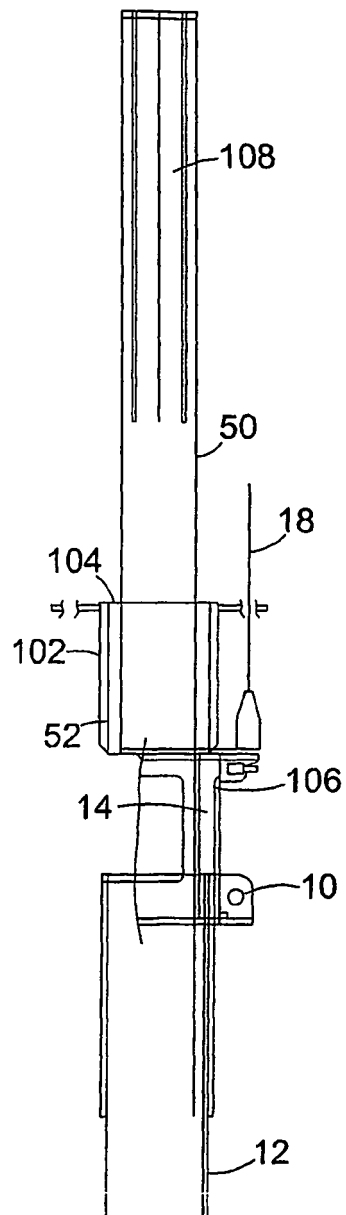


Fig. 6(a)

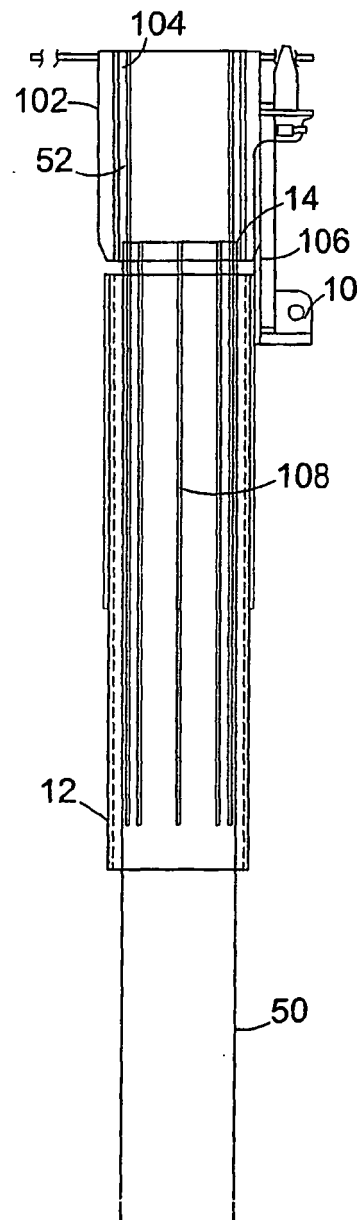


Fig. 6(b)

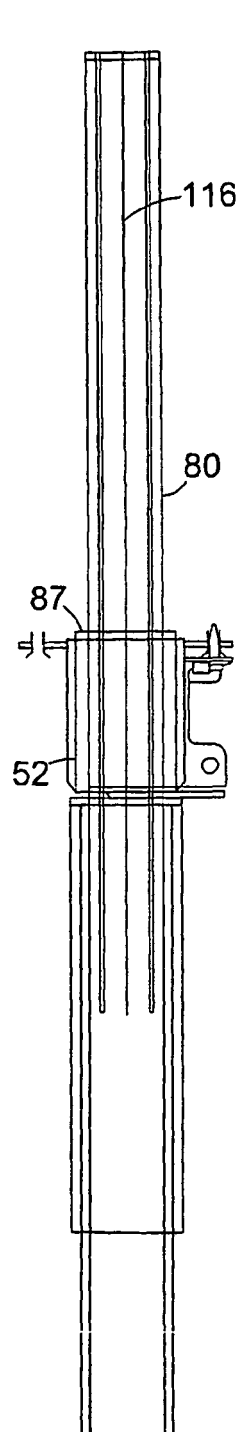


Fig. 6(c)

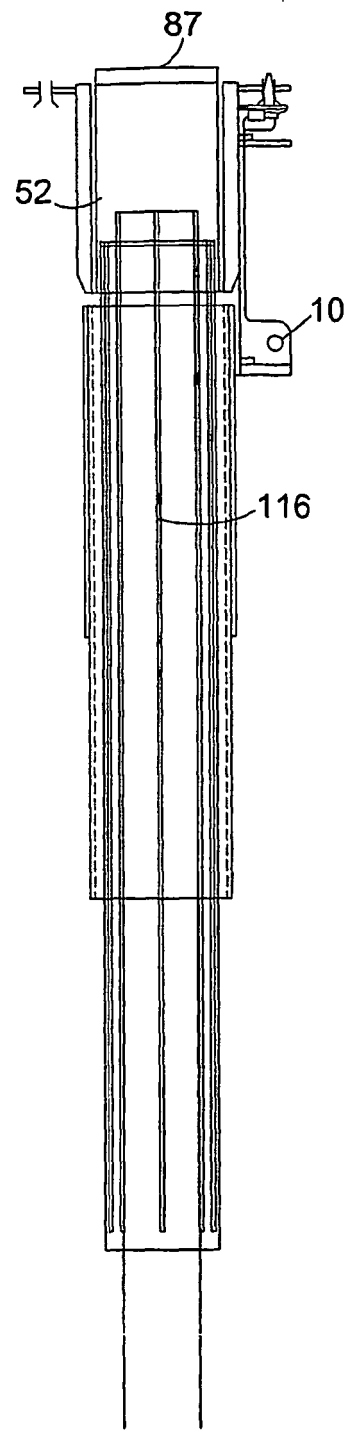


Fig. 6(d)

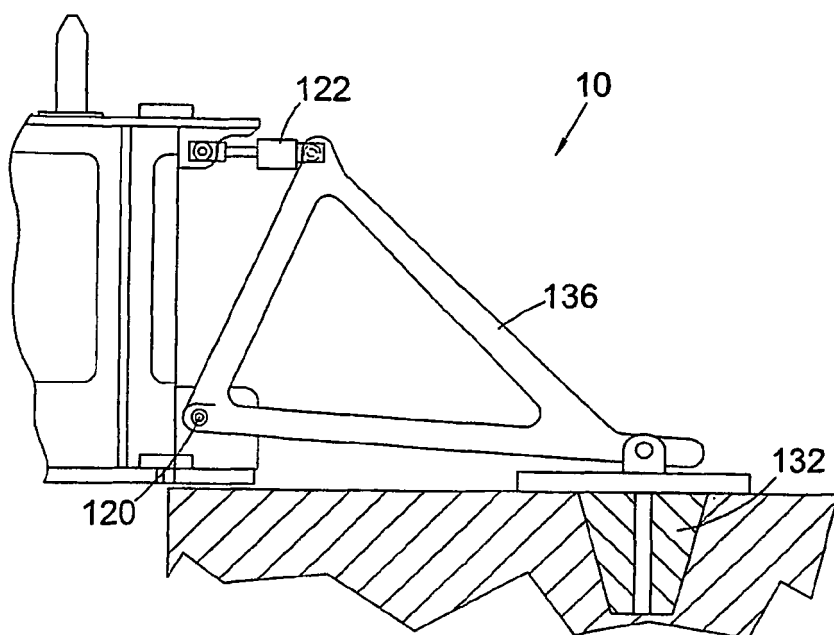


Fig. 7(a)

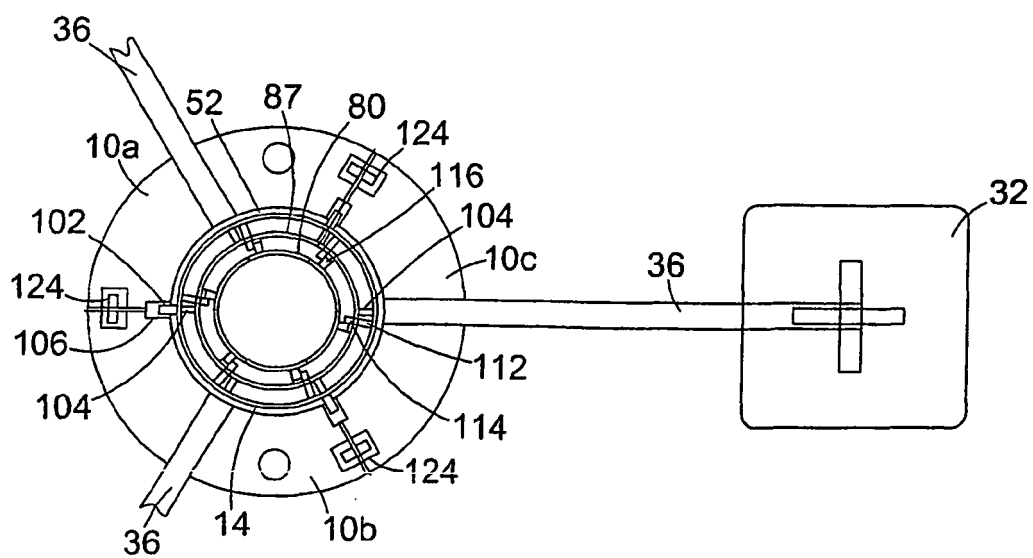


Fig. 7(b)

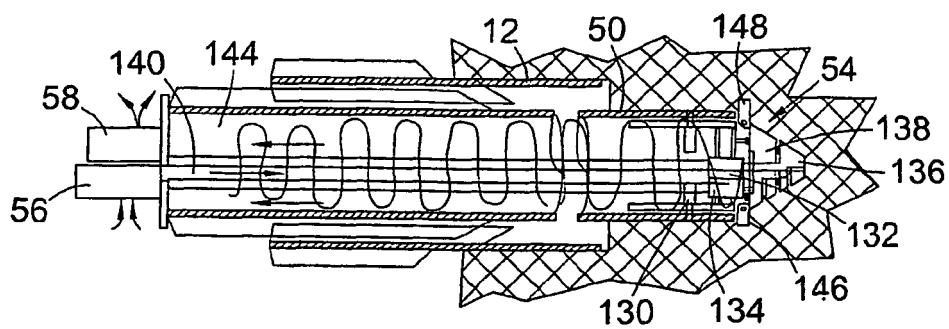


Fig. 8

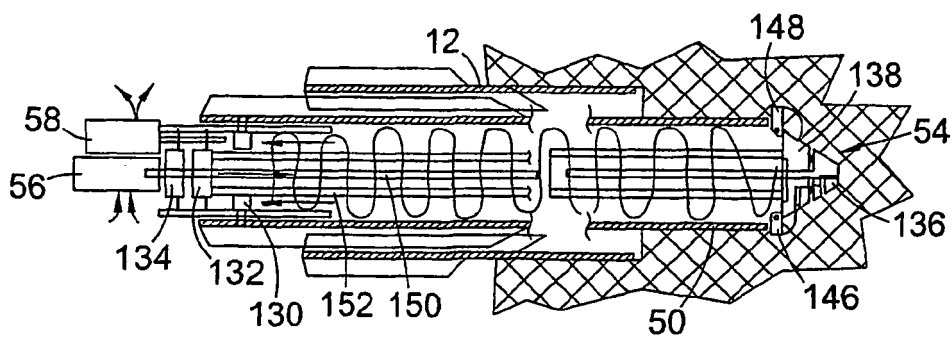


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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