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(56) Documents Cited:
GB 2462435 A GB 2446142 A
GB 1466487 A EP 1167636 A
WO 1999/054556 A NL 009201058 A

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(54) Title of the Invention: **Steerable underwater trenching apparatus**
Abstract Title: **Steerbale underwater trenching apparatus**

(57) An underwater trenching apparatus 10 comprises at least one trenching tool (14, fig 2); an lif attachment point 48 configured for lifting & lowering the trenching apparatus to, or from, its location of operation; at least two steerable, by actuators 44a (& 44b, fig 2), endless track units 16a-d for transmitting tractive effort to move the underwater trenching apparatus in use; and for each steerable endless track unit, a first mounting arrangement 28 permitting rotation of the track unit about a vertical axis, and a first actuator configured to move the track unit about the vertical axis 36, and control means configured to control the action of the actuator. In alternative forms, in addition to, or alternative to the steerable endless track units, the apparatus includes height adjustment means 26 for adjusting the vertical spacing between the main body portion and the respective endless tracks; and control means configured to control the action of the height adjustment means.

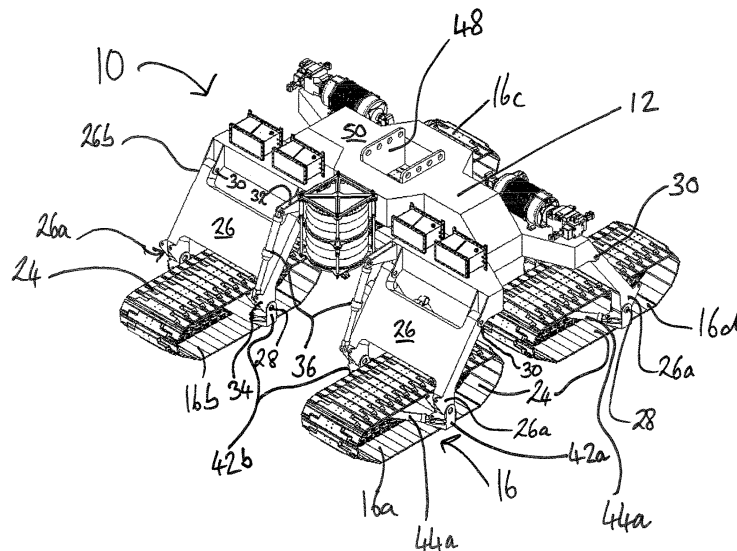


Fig 1

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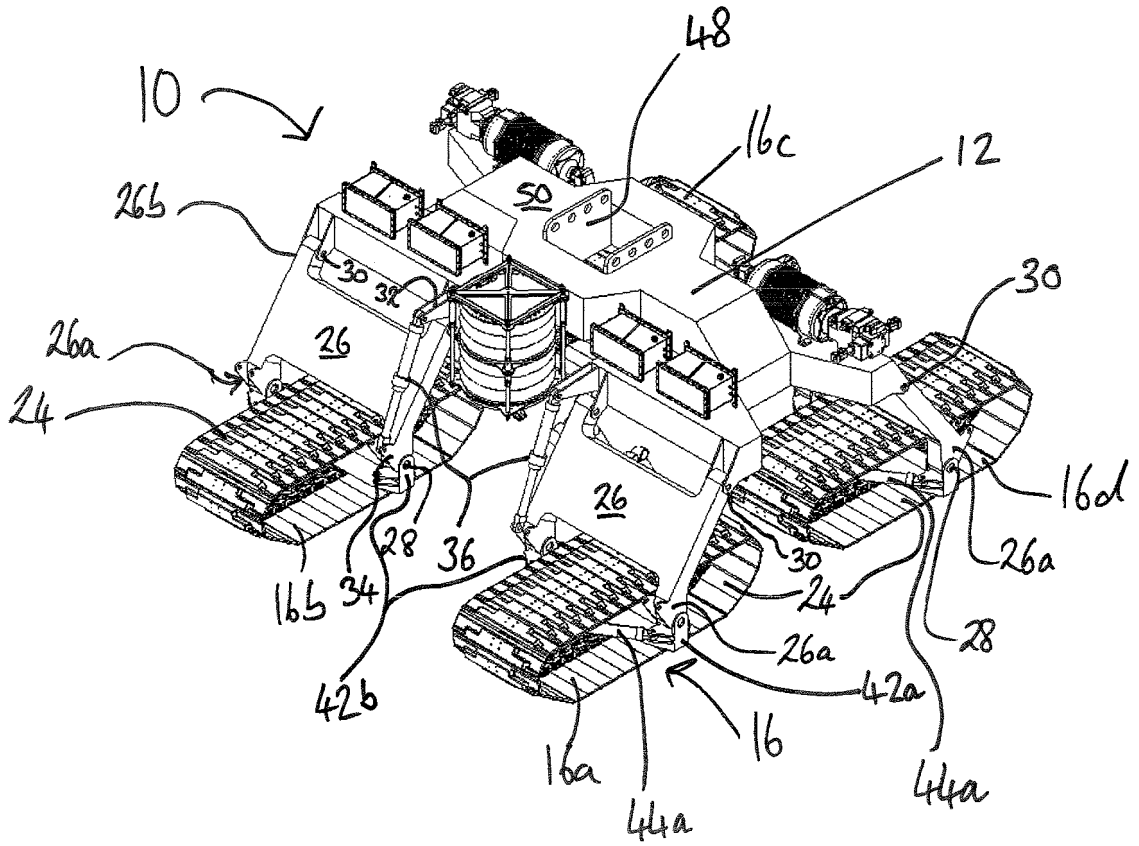


Fig 1

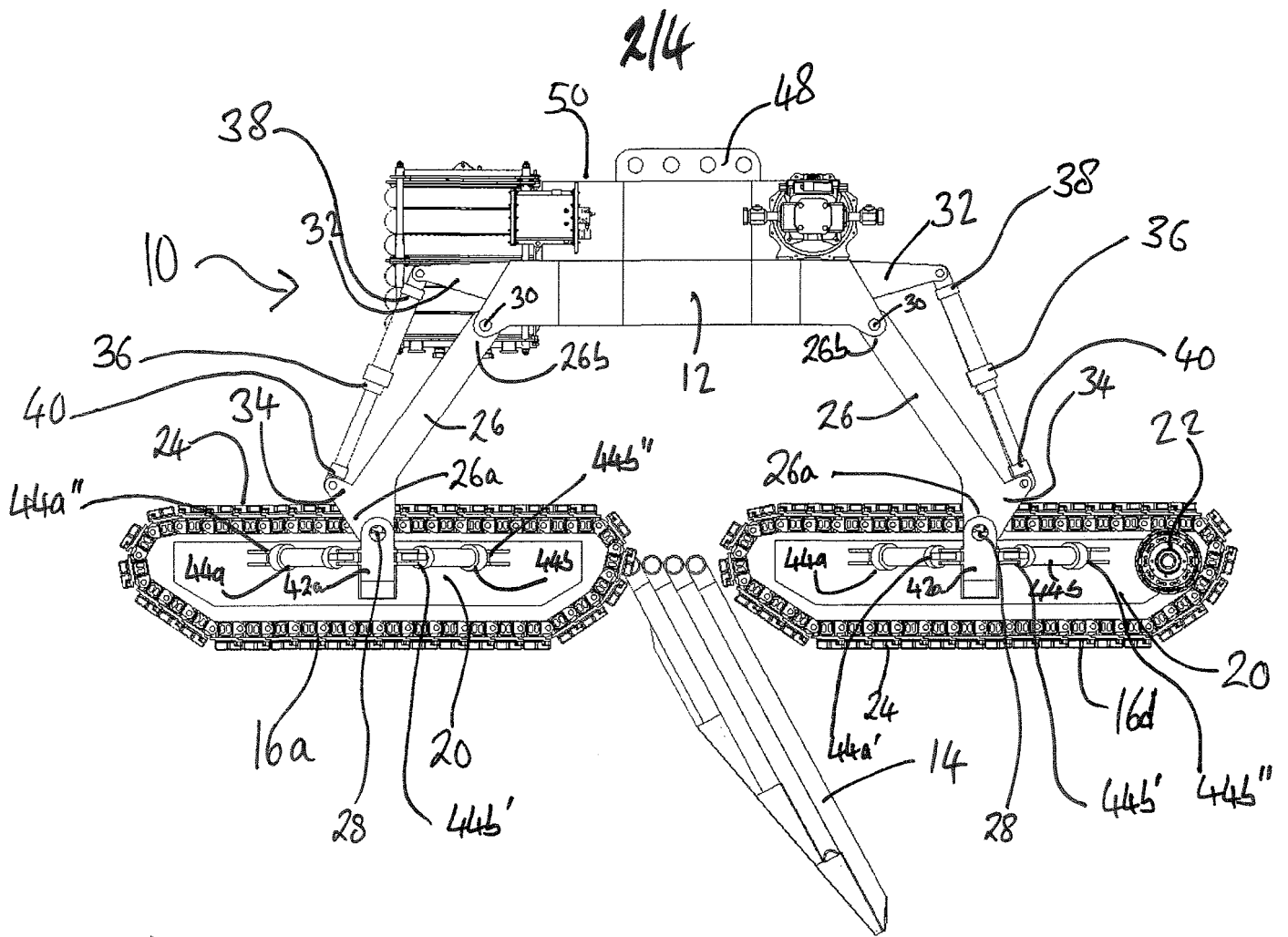


Fig 2

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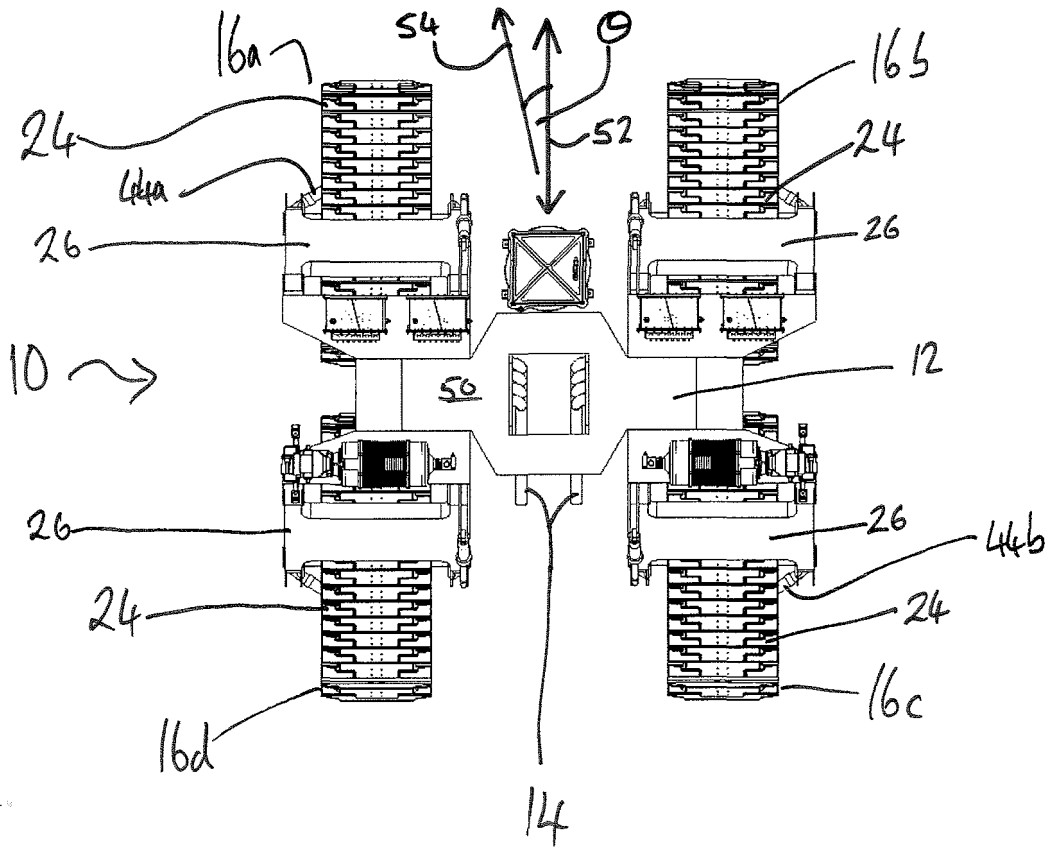


Fig 3

H/H

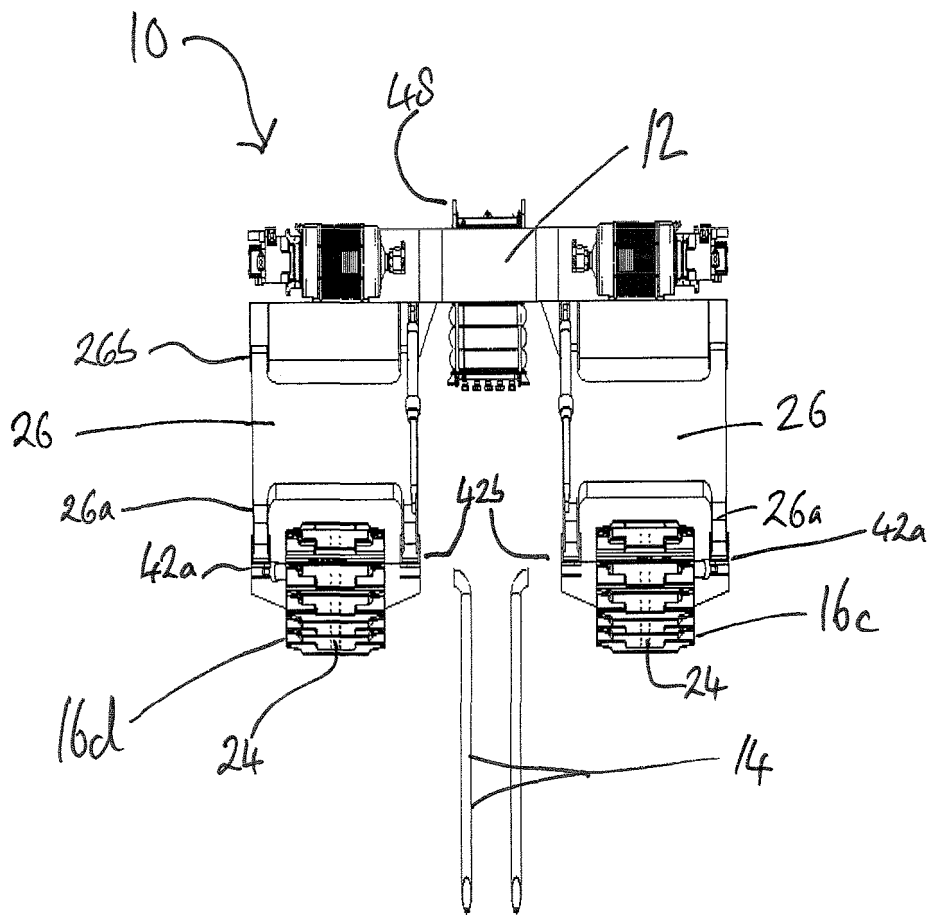


Fig 4



STEERABLE UNDERWATER TRENCHING APPARATUS

INTRODUCTION

[0001] The present invention relates to an apparatus for forming a trench in the bed of a body of water, such as the bed of a lake or the seabed. Such trenches are commonly
5 required for burying underwater pipelines or cables, in order to protect the pipeline or cable from damage. A variety of trenching apparatus suitable for use in an underwater environment is known. Hereinafter "subsea" is used to refer to environments beneath the sea or beneath a lake, and "seabed" is used to refer to the bed of a lake or the seabed.

[0002] The present invention relates in particular to the formation of a trench in hard
10 seabed soils. More especially the present invention relates to forming a seabed trench using a tracked vehicle, and to such tracked vehicles.

BACKGROUND

[0003] Tracked vehicles are known for use on land and for use in the subsea environment. Such vehicles are usually carried on endless articulated tracks which may, for example, be
15 driven by sprocket wheels engaging internal parts of the endless track. Articulated vehicle tracks have the advantage of spreading the weight of the vehicle over a large contact area.

[0004] In the subsea environment, especially in connection with laying of pipes or cables in a trench vehicles with endless articulated tracks have some disadvantages. For example, when, during trenching operations, it is necessary to correct the course of the
20 trenching vehicle (i.e. to change its direction) conventional skid steering reduces the tractive effort of the vehicle, and can cause sinkage of the tracks into the seabed, and loss of trench cutting performance. Conventional skid steering changes the relative speed of the articulated tracks at opposed sides of the vehicle in order to effect the change in direction.

[0005] Skid steering often causes pitching of the vehicle which can result in
25 disadvantageously high loading of the trench forming tool carried by the vehicle and also problems in the grading of the trench (i.e. the inclination of the trench base). These problems can also occur as the tracked vehicle passes over objects (for example rocks or debris) on the seabed which may similarly cause pitching of the vehicle.

[0006] A further problem can occur when a subsea trench cutting apparatus is lowered
30 from a service vessel (for example) to the seabed. If the approach speed of the apparatus is too great, the apparatus can be damaged on contact with the seabed.

[0007] The present invention seeks to overcome or alleviate some or all of the above problems.

BRIEF SUMMARY OF THE INVENTION

[0008] According to a first aspect of the present invention there is provided an underwater trenching apparatus comprising:

at least one trenching tool;

5 a lifting attachment point configured for attachment of a lifting means for lowering the trenching apparatus to, or raising the trenching apparatus from, its location of operation;
at least two steerable endless track units for transmitting tractive effort to move the underwater trenching apparatus in use; and
for each steerable endless track unit,

10 a first mounting arrangement permitting rotation of the track unit about a vertical axis, and
a first actuator configured to move the track unit about the vertical axis, and
control means configured to control the action of the actuator.

[0009] According to a second aspect of the invention there is provided an underwater trenching apparatus comprising

15 at least one trenching tool;

a lifting attachment point configured for attachment of lifting means for lowering the trenching apparatus to, or raising the apparatus from, its location of operation.

at least two endless track units for transmitting tractive effort to move the underwater trenching apparatus in use;

20 a main body portion to which the lifting attachment portion is attached and to which the endless tracks are mounted;

height adjustment means for adjusting the vertical spacing between the main body portion and the respective endless tracks; and

control means configured to control the action of the height adjustment means.

25 **[0010]** Preferably in the first aspect of the invention the apparatus further comprises

a main body portion to which the lifting attachment portion is attached and to which the endless track units are mounted,

height adjustment means for adjusting the vertical spacing between the main body portion and the respective endless track units; and

30 control means configured to control the action of the height adjustment means.

[0011] Preferably in the second aspect of the invention the apparatus further comprises:

at least two steerable endless track units for transmitting tractive effort to move the underwater trenching apparatus in use; and

for each steerable endless track unit,

35 a first mounting arrangement permitting rotation of the track unit about a vertical axis, and

a first actuator configured to move the track unit about the vertical axis, and control means configured to control the action of the actuator.

[0012]

5 **[0013]** Preferably the apparatus of the first or second aspect further comprises, for each endless track unit

a second mounting arrangement permitting rotation of the endless track unit about a horizontal axis arranged substantially perpendicularly to the direction of movement of the track unit, and a second actuator configured to move the endless track unit about the horizontal axis

10 and

control means adapted to control the action of the second actuator.

[0014] In preferred embodiments the lifting attachment point is centrally located with respect to the endless track units.

15 **[0015]** Preferably the height adjustment means includes one or more dampers configured to reduce contact loads on the endless track units when the endless track units contact the seabed on lowering of the trenching apparatus to the seabed.

[0016] In preferred embodiments the trenching tool is mounted centrally with respect to the endless track units.

20 **[0017]** In further embodiments the control means is operable to control the respective first actuators of the endless track units independently of the other endless track unit(s).

[0018] In some preferred embodiments the underwater trenching apparatus comprises two steerable endless track units.

[0019] In other preferred embodiments the underwater trenching apparatus comprises two steerable endless track units and two non-steerable endless track units.

25 **[0020]** In other preferred embodiments the underwater trenching apparatus comprises four steerable endless track units.

30 **[0021]** Preferably the height adjustment means and control means of a given endless track unit are operable to adjust the vertical spacing between the main body portion and a given endless track unit independently of the spacing between the main body portion and a different endless track unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] For a better understanding of the invention and to show how the same may be carried into effect, reference will be made, by way of example only, to the following drawings, in which:

5 Figure 1 is a perspective view of a subsea trench cutting apparatus according to the present invention;

Figure 2 is a side view of the apparatus of Figure 1;

Figure 3 is a plan view of the apparatus of Figure 1; and

Figure 4 is a front view of the apparatus of Figure 1.

10 **DETAILED DESCRIPTION**

[0023] Referring now to the drawings, there is shown a trenching apparatus 10 comprising a main body portion 12 and a trenching tool 14. The trenching tool 14 may, in principle, be any suitable tool for cutting a subsea trench as known in the art, the most suitable tool being selected by the person of skill in accordance with, for example, the subsea ground
15 conditions. Suitable trenching tools (14) include (but are not limited to) jetting tools, chain cutters, augers, rockwheels and the like.

[0024] The trenching apparatus 10 as illustrated in Figures 1 to 4 includes four endless track units 16, indicated at 16a, 16b, 16c and 16d. In variations of the invention, other numbers of endless track units may be provided, for example, 2, 6 or 8 endless track units.
20 Each endless track unit 16 comprises an endless track 18 mounted on a subframe 20 and usually connected to a drive arrangement 22 which moves the endless track 18 around the subframe 20 and so – with the endless tracks in contact with the ground – propels the apparatus 10 over the ground. In some cases, separate propulsion means may be provided, such as a subsea tractor or a tow line from a surface vessel, but these are less
25 preferred.

[0025] Each endless track 18 consists of a number of individual track elements 24, each of which elements 24 is articulatedly joined to its neighbour so to form an endless loop. Articulated tracks 18 and their drive means 22 are known per se in the art and any suitable design configured for subsea use may be employed with the apparatus 10 of the present
30 invention.

[0026] Each endless track until 16 is attached to the respective frame or leg 26 which is, in turn attached to the main body portion 12. In particular, each endless track unit 16 is attached to a first end 26a of a respective leg 26, an opposed second end 26b of which is attached to the main body portion 12.

[0027] Each endless track unit 16 is attached to its respective a first end 26a of leg 26 in such a manner that the endless track unit 16 can rotate with respect to the leg 26 about an axis 28. Axis 28 is nominally horizontal with respect to the orientation of the apparatus 10 shown in the Figures.

5 **[0028]** Leg 26 and endless track unit subframe 20 are most preferably configured such that nominally horizontal axis 28 is located centrally with respect to the endless track unit 16. That is, the axis 28 crosses the endless track unit 16 at a point at, or about, half way along the length of the endless track unit 16 (the length being the maximum horizontal front-to-back dimension of the endless track unit.

10 **[0029]** Because of the articulation of the endless track unit 16 with respect to its leg 26, the apparatus 10 of the present invention is better able to accommodate uneven-ness in the ground (seabed) traversed by the apparatus 10.

[0030] In particular embodiments, an actuator (e.g. a hydraulic actuator) with an associated control means may be disposed between the leg 26 and the subframe 20 of the
15 endless track unit 16, thereby to control the rotation of the endless track unit 16 about its respective nominally horizontal axis 28.

[0031] As noted above, second end 26b, which is the upper end as illustrated, of each leg 26 is connected to the main body portion 12. The connection or joint between each leg 26 and the main body portion 12 is such that the leg 26 can rotate with respect to the
20 main body portion 12. In particular, the leg 16 can rotate about an axis 30 with respect to the main body portion. Axis 30 is configured to be nominally horizontal (with respect to the orientation of the apparatus as illustrated and perpendicular to the normal direction of travel of the apparatus 10). By rotation of the leg 26 about axis 30, the height of the endless track unit 16 with respect to the main body portion 12 varies. That is, rotation of
25 leg 26 about axis 30 results in an increase or decrease (in accordance with the direction of rotation) in the vertical spacing of the endless track unit 16 from the main body portion 12. Here, "vertical" is with respect to the orientation of the apparatus 10 as shown in the Figures.

[0032] Adjacent an upper part of each leg 26, an arm or shoulder 34 extends outwardly
30 from leg 26. Shoulder 34 and arm 32 are preferably arranged in substantially the same vertical plane. An actuator 36 extends between the arm 32 and the shoulder 34. The actuator 36 is pivotally connected at its first (upper) end 38 to a distal portion (with respect to the main body portion 12) of the arm 32 and is pivotally connected at its second (lower) end 40 to shoulder 34. Actuator 36 may be of any suitable type for underwater use. A
35 hydraulic actuator (as illustrated) is preferred.

[0033] As will be readily apparent from the Figures, extension of actuator 36 will cause movement of leg 26 about pivot axis 30 such that the vertical spacing of the endless track unit 16 with respect to the main body portion 12 is increased. Correspondingly, retraction of the actuator 36 causes movement of leg 26 about pivot axis 30 in the opposite sense, so that the vertical spacing of the endless track unit 16 with respect to the main body portion 12 is decreased. A control means (typically an electronic control means) is provided, by means of which an operator can control the action or operation of actuator 36.

[0034] In further preferred embodiments of the invention, at least some of the endless track units 16 are steerable. That is, at least some of the endless track units are moveable about a nominally vertical axis whereby their alignment with respect to the main body portion 12 is changed or adjusted. Preferably two of the endless track units 16 are steerable, the steerable units being those arranged side-by-side with respect to the direction of travel of the apparatus 10.

[0035] Where the apparatus 10 has more than two endless track units 16, in particular where the apparatus 10 has four endless track units 16, preferably at least two of the endless track units 16 are steerable. More preferably, all of the endless track units 16 are steerable. Thus, in a preferred form of the apparatus 10, the apparatus 10 has four endless track units 16 all of which are steerable.

[0036] Each endless track unit 16 is attached to leg 26 through a pair of connection brackets 42a, 42b. Each connection bracket 42a, 42b is attached to leg 26 such that connection bracket 42a, 42b pivots about nominally horizontal axis 28. Connection bracket 42a is connected to a lower end portion 26a at an outside edge thereof. Connection bracket 42b is connected to a lower end portion 26a at an inside edge thereof. The terms "inside" and "outside" are used in relation to the apparatus 10 as a whole (and not in respect of an individual leg 26 taken in isolation). Rotation or pivoting of the endless track unit 16 about nominally horizontal axis 28 as described above is thereby achieved.

[0037] Extending between the connection brackets 42a, 42b and intersecting the endless track unit 16 is a carrying member 46. Endless track unit 16 is mounted on the carrying member 46. At its respective ends the carrying member 46 is fixedly connected to the connection brackets 42a, 42b. The carrying member 46 may be formed integrally with the respective connection brackets 42a, 42b.

[0038] Endless track units 16 which are steerable are mounted on the carrying member 46 such that the endless track unit 16 is rotatable with respect to the carrying member 46 about a nominally vertical axis (with respect to the orientation of the apparatus 10 as shown in the Figures). Typically, the subframe 20 of the endless track unit 16 is pivotally

attached to the carrying member 46 to allow said rotation of the endless track unit 16 about the vertical axis.

[0039] Steerable endless track units 16 further comprise a pair of actuators 44a, 44b which extend between the connection bracket 42a and the subframe 20 of the endless track unit 16. Each actuator 44a, 44b is pivotally connected at a first end 44a', 44b' to the connection bracket 42a and at a second end 44a'', 44b'' is pivotally connected to the subframe 20 of the endless track unit 16. Actuators 44a, 44b associated with a given endless track unit 16 operate as a pair to effect steering of the endless track unit 16. Thus, extension of actuator 44a is accompanied by a corresponding retraction of actuator 44b so that the endless track unit 16 is turned in an anti-clockwise (counter-clockwise) sense, as observed from above (Figure 3). Likewise, extension of actuator 44b is accompanied by a corresponding retraction of actuator 44a, so that the endless track unit 16 is turned in a clockwise sense.

[0040] Actuators 44a, 44b may be of any type suitable for underwater use, but are preferably hydraulic actuators.

[0041] Control means are provided to control the motion or operation of the actuators 44a, 44b whereby an operator can adjust the angular position (about the vertical axis) of the steerable endless track unit 16 with respect to the main body 12. The apparatus 10 can thus be steered by an operator. In other words, the direction of travel of the apparatus 10 can be adjusted by an operator, for example in the light of operational circumstances such as ground conditions.

[0042] In some advantageous embodiments of the invention, each steerable endless track unit 16 is independently steerable. That is, the control means provides for extension/retraction of the actuators 44a, 44b associated with an endless track unit 16 independently of the state of operation of the actuators 44a, 44b associated with a different endless track unit 16.

[0043] In other advantageous embodiments, endless track units 16 may be steerable in pairs. That is, for a given pair of track units, substantially the same steering operation is applied to each endless track unit 16 of the pair, so that the angular position of the each of the said endless track units 16 in the pair is substantially the same at any given time. Endless track units arranged side-by-side (such as 16a and 16b, or 16c and 16d) conveniently form steering pairs.

[0044] In other advantageous embodiments, all of the steerable endless track units are steered in unison by the control means, so that each adopts substantially the same angular position, and the control means is configured to operate accordingly.

[0045] The control means may further be configured to allow an operator to select any of the above steering configurations, that is, fully independent steering of the endless track units 16, paired steering of endless track units 16, or steering in unison of all the steerable endless track units 16.

5 **[0046]** Independent steering ability for each of the endless track units 16 further allows the apparatus 10 to adopt a so-called “crab-steering” configuration. In this configuration the control means (typically via an operator input) sets the respective actuators 44a, 44b such that each of the endless track units 16 is arranged in a substantially parallel configuration with respect to the other endless track units 16. The apparatus 10 thus moves “sideways”
10 along an essentially straight path. For example, if the normal “straight ahead” direction of travel of the apparatus 10 is indicated in Figure 3 by arrow 52 which is aligned with the longitudinal axis of the apparatus 10, then a “crab steering” setting of the endless track units 16 results in movement of the apparatus along a path such as that indicated by arrow 54 at an angle θ to the straight ahead direction of arrow 52. The longitudinal axis of the
15 main body portion 12 remains aligned with arrow 52.

[0047] Main body portion 12 of apparatus 10 is provided with a lifting attachment point or formation 48. The lifting attachment formation 48 is used for the attachment of lifting cables by means of which the trenching apparatus 10 is lowered to the seabed (from a service vessel at the surface) and is raised from the seabed for return to the surface.
20 Lifting attachment formation 48 is most preferably secured directly to the main body portion 12 of apparatus 10 and is provided with suitable components or fittings to which lifting cables may conveniently be attached.

[0048] Lifting attachment formation 48 is preferably arranged substantially centrally with respect to the main body portion, and preferably at or adjacent a top surface 50 of the
25 main body portion 12.

[0049] Substantially central arrangement of the lifting attachment formation 48 with respect to the main body portion 12 is most preferably such that – at least as so far as is practical – the lifting attachment formation 48 is spaced substantially equidistantly from the extremities of the main body portion 12 and/or is arranged substantially equidistantly from
30 each endless track unit 16 (or, where more than four endless track units are provided, the lifting attachment formation 48 is arranged substantially equidistantly from those endless track units 16 disposed at or near outer corners of the apparatus 10, when viewed in plan).

[0050] The above substantially central arrangement of the lifting attachment formation is achievable in the present invention because of the provision of the steerable endless track
35 units 16.

[0051] The provision of steerable endless track units 16 as described herein is also advantageous in allowing a central location of the trenching tool 14 with respect to main body portion 12 (“central” having the same meaning as in respect of the lifting attachment formation defined above). Such central location of the trenching tool 14 is advantageous
5 in ensuring that cutting loads (derived from the trenching operation with the trenching tool 14) are evenly distributed through the apparatus 10 whereby even pressures of each endless track on the ground (seabed) are achieved. That is, the pressure exerted by each track on the seabed is substantially the same at any time during trenching operations.

[0052] In further advantageous embodiments, the apparatus 10 of the present invention
10 provides a damping action or effect on landing of the apparatus 10 on the seabed. That is, a damping effect is provided at the point when the apparatus 10 contacts the seabed as the apparatus 10 is lowered. As noted, the apparatus 10 is attached to lifting cables at lifting attachment formation 48 during lifting and lowering operations. The damping action achieved with the apparatus 10 significantly reduces the loading on the apparatus 10
15 during the landing operation thereby avoiding damage to the apparatus 10.

[0053] The damping effect or action is achieved by adjustment of the “ride height” of the apparatus 10, that is, by suitably adjusting the angular position of legs 26 about pivot axes 30 using actuators 36. The adjustment of the legs 26 takes into account the known, or expected, ground conditions of the seabed at the landing point.

[0054] Each of the legs 26 is most preferably individually adjustable, that is, without
20 reference to the angular position of the other legs 26. An advantage of this arrangement is that the vertical spacing of each endless track unit 16 with respect to the main body portion 12 can be independently adjusted – for example in the light of particular ground conditions encountered during trenching operations – so that an even track pressure is achieved.

[0055] Furthermore, individual adjustment of the “ride height” (that is, the vertical spacing
25 of each endless track unit 16 from the main body portion 12) can be advantageous in ensuring that the trenching tool 14 is at, or is maintained at, a desired angle. Typically the desired angle is vertical, or such angle of the tool 14 as is required to obtain a trench with the vertical sides. Deflection from the desired tool angle may occur due to ground
30 conditions, such as unevenness of the seabed, and the independent adjustment of the legs 26 compensates accordingly.

[0056] As noted, legs 26 are operated under the control of a control means. The control
35 means may operate automatically, or may be under the control of an operator, or may have automatic functions and operator functions, and may have a manual override of automatic functions. The same applies to each or any of the control means for the actuators 44a, 44b and actuators controlling the angular position of endless track units 16

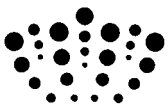
about horizontal axis 28. Of course, a single control means may be provided to control all of, or any group or combination of, actuators provided on the apparatus 10.

[0057] The, or each, control means is preferably an electronic control means. Elements of such control means for use by an operator are desirably located at the surface (in a service vessel) or, in conjunction with suitable remote control equipment, may be located
5 on land. Such elements can, for example, include an electronic control panel or the like.

CLAIMS

1. An underwater trenching apparatus comprising:
at least one trenching tool;
- 5 a lifting attachment point configured for attachment of a lifting means for lowering the trenching apparatus to, or raising the trenching apparatus from, its location of operation;
at least two steerable endless track units for transmitting tractive effort to move the underwater trenching apparatus in use; and
for each steerable endless track unit,
- 10 a first mounting arrangement permitting rotation of the track unit about a vertical axis, and
a first actuator configured to move the track unit about the vertical axis, and
control means configured to control the action of the actuator.
2. An underwater trenching apparatus comprising
at least one trenching tool;
- 15 a lifting attachment point configured for attachment of lifting means for lowering the trenching apparatus to, or raising the apparatus from, its location of operation.
at least two endless track units for transmitting tractive effort to move the underwater trenching apparatus in use;
- 20 a main body portion to which the lifting attachment portion is attached and to which the
endless tracks are mounted;
- height adjustment means for adjusting the vertical spacing between the main body portion
and the respective endless tracks; and
control means configured to control the action of the height adjustment means.
3. An underwater trenching apparatus as claimed in claim 1 further comprising
- 25 a main body portion to which the lifting attachment portion is attached and to which the
endless track units are mounted,
- height adjustment means for adjusting the vertical spacing between the main body portion
and the respective endless track units; and
control means configured to control the action of the height adjustment means.
- 30 4. An underwater trenching apparatus as claimed in claim 2 further comprising:
at least two steerable endless track units for transmitting tractive effort to move the
underwater trenching apparatus in use; and
for each steerable endless track unit,
- 35 a first mounting arrangement permitting rotation of the track unit about a vertical axis, and
a first actuator configured to move the track unit about the vertical axis, and
control means configured to control the action of the actuator.

5. An underwater trenching apparatus as claimed in any preceding claim further comprising, for each endless track unit
5 a second mounting arrangement permitting rotation of the endless track unit about a horizontal axis arranged substantially perpendicularly to the direction of movement of the track unit, and a second actuator configured to move the endless track unit about the horizontal axis
and
control means adapted to control the action of the second actuator.
- 10 6. An underwater trenching apparatus as claimed in any preceding claim wherein the lifting attachment point is centrally located with respect to the endless track units.
7. An underwater trenching apparatus as claimed in claim 2 or 4 or claim 5 or 6 when dependent on claim 2 or 4 wherein the height adjustment means includes one or more dampers configured to reduce contact loads on the endless track units when the
15 endless track units contact the seabed on lowering of the trenching apparatus to the seabed.
8. An underwater trenching apparatus as claimed in any preceding claim wherein the trenching tool is mounted centrally with respect to the endless track units.
9. An underwater trenching apparatus as claimed in claim 1 or 4 or any of claims 5
20 to 8 when dependent of claim 4 wherein the control means is operable to control the respective first actuators of the endless track units independently of the other endless track unit (s).
10. An underwater trenching apparatus as claimed in claim 1, 4 or 9 or any of claims 5 to 8 when dependent on claim 1 or 4 comprising two steerable endless track units.
- 25 11. An underwater trenching apparatus as claimed in claim 10 comprising two steerable endless track units and two non-steerable endless track units.
12. An underwater trenching apparatus as claimed in claim 1, 4 or 9 or any of claims 5 to 8 when dependent on claim 1 or 4 comprising four steerable endless track units.
13. An underwater apparatus as claimed in claim 2, 3 or 4 or any claim when
30 dependent thereon wherein the height adjustment means and control means are operable to adjust the vertical spacing between the main body portion and a given endless track unit independently of the spacing between the main body portion and a different endless track unit.



Application No: GB1118503.0
Claims searched: 1-13

Examiner: Mr D. P. Harness
Date of search: 23 February 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-13	NL9201058 A (KONIJN) Steerable underwater trenching and cable laying apparatus; Figs 1-2; Abstract translation; steerable track units 16 on pivoted legs 17.
A	1 & 2	EP1167636 A (FOECKERSPERGER) mobile assembly to dig a trench to lay a buried water pipe with support (16,17) and angular adjustment units (20,21). Figures 1, 2, 5 & 6.
A	1 & 2	GB2446142 A (ENGINEERING BUSINESS LTD) Tracked trenching machine with storable cutters. Figs 1-5.
A	1 & 2	GB2462435 A (ENGINEERING BUSINESS LTD) A trench excavating apparatus 10. Figure 1
A	1 & 2	WO99/54556 A (REECE ET AL) A submarine trenching vehicle (1) for laying pipe (2). Figs 1 & 2.
A	1 & 2	GB1466487 A (PETROLES CIE FRANCAISE) A submersible trencher. Figs 1-4.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

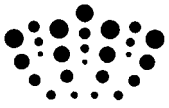
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

E21B; F16L; H02G

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC



International Classification:

Subclass	Subgroup	Valid From
E02F	0005/10	01/01/2006
F16L	0001/16	01/01/2006