(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 067 580 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.10.2022 Bulletin 2022/40

(21) Application number: **21166704.3**

(22) Date of filing: **01.04.2021**

(51) International Patent Classification (IPC):
E02F 5/10 *(2006.01)* ***E02F 3/92*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E02F 5/107; E02F 3/925

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicants:
- **Soil Machine Dynamics Limited**
  Tyne and Wear NE28 6UZ (GB)
- **Offshore Projects Alliance Ltd.**
  Aberdeen Scotland AB11 6DB (GB)

(72) Inventors:
- **NAYLOR, Ross**
  Tyne & Wear NE28 6UZ (GB)
- **WHITE, Roger Paul**
  Tyne & Wear NE28 6UZ (GB)

(74) Representative: **Vinsome, Rex Martin**
Murgitroyd & Company Newcastle
3 Collingwood Street
Newcastle NE1 1JW (GB)

(54) **APPARATUS FOR INSERTING ELONGATE OBJECT INTO A TRENCH**

(57) An apparatus (2) for inserting a cable (4) into a trench (12) in the seabed (6) in shallow water is disclosed. The apparatus (2) comprises a body (8) for supporting the cable (4) and a chain cutter (10) for forming a trench (12) in the seabed (6) for receiving the cable (4). Tracks (14) enable the apparatus (2) to move relative to the seabed (6) to enable the chain cutter (14) to form the trench (12), and an air eduction system (20) directs air into water in the trench (12).

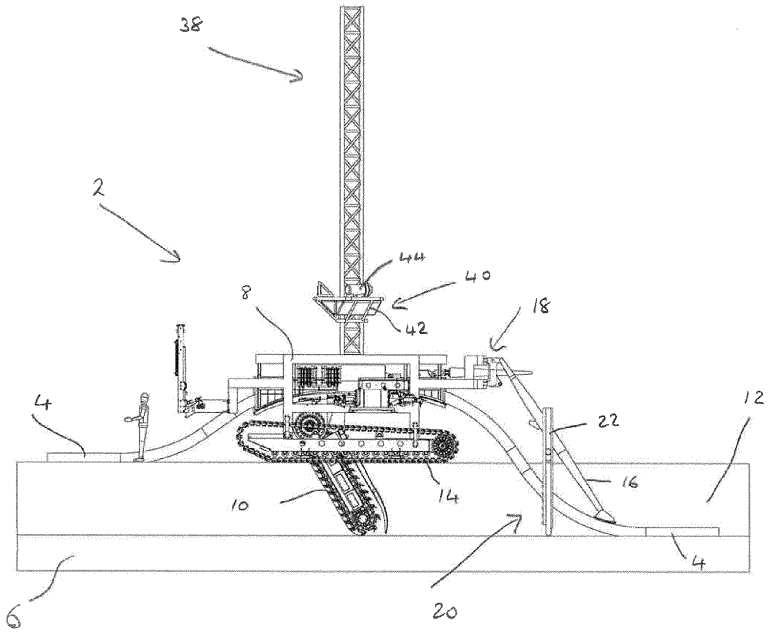


FIG 1

EP 4 067 580 A1

Description

[0001] The present invention relates to an apparatus for inserting an elongate object into a trench in floor of a body of water, and relates particularly, but not exclusively, to an apparatus for burying power cables in the seabed in shallow water.

[0002] Apparatus for burying power cables in the seabed in shallow water close to beaches are known in which location of the cable at the bottom of a trench formed by the apparatus is assisted by water pumps which displace water into the trench, to fluidise debris or slurry in the trench to facilitate movement of the cable to the bottom of the trench. However, such known apparatus suffers from the drawback that the water pumps use considerable amounts of energy, and it is not possible to operate the water pumps when the water has depth insufficient depth to fully submerge the pumps.

[0003] Preferred embodiments of the present disclosure seek to overcome one or more of the above disadvantages.

[0004] According to an aspect of the disclosure, there is provided an apparatus for inserting an elongate object into a trench in a floor of a body of water, the apparatus comprising:-

a body for supporting an elongate object;

trench forming means for forming a trench in the floor of the body of water for receiving the elongate object;

moving means for moving the apparatus relative to the floor of the body of water to enable the trench forming means to form the trench; and

gas directing means for directing at least one gas into the trench.

[0005] By providing gas directing means for directing at least one gas into the trench, this provides the advantage that debris can be displaced from the trench in shallower water than is the case with known apparatus, and less energy is consumed than in the case of known apparatus.

[0006] The gas directing means may be adapted to introduce at least one gas into water in a lower portion of the trench.

[0007] This provides the advantage of maximising the effect of lift generated by the gas on debris or slurry in the trench.

[0008] The gas directing means may comprise at least one first conduit having at least one aperture for directing gas therethrough into water in the trench.

[0009] At least one said first conduit may have a plurality of apertures for directing gas therethrough into water in the trench.

[0010] This provides the advantage of assisting in fluidisation of debris or slurry in the trench.

The gas directing means may comprise at least one second conduit having at least one inlet and at least one outlet, and at least one said first conduit may be adapted to introduce at least one gas into water in said second conduit.

[0011] This provides the advantage of enabling the gas introduced into water in the second conduit to reduce the density of water in the second conduit, thereby causing more dense water in the trench surrounding the second conduit, together with debris, to enter at least one inlet and to displace water and debris out of at least one said outlet.

[0012] At least one said outlet may be adapted to output material out of the trench.

[0013] The gas directing means may be movable between a storage condition and a working condition.

[0014] This provides the advantage of making the apparatus more compact for transport purposes.

[0015] The apparatus may further comprise gas supply means for supplying at least one gas to the gas directing means.

[0016] The gas supply means may comprise air compressor means.

[0017] This provides the advantage of enabling ambient air to be used to displace the debris or slurry in the trench.

[0018] The gas supply means may comprise at least one container of compressed gas.

[0019] This provides the advantage of increasing the range of depth over which the apparatus can operate.

[0020] The apparatus may further comprise object engaging means for engaging an object for urging the object into the trench.

[0021] The gas directing means may be mounted to the object engaging means.

[0022] This provides the advantage of enabling more compact construction of the apparatus when the gas directing means is in its stowed condition.

[0023] According to another aspect of the disclosure, there is provided an apparatus for inserting an elongate object into a trench in a floor of a body of water, the apparatus comprising:-

a body for supporting an elongate object;

trench forming means for forming a trench in the floor of the body of water for receiving the elongate object;

moving means for moving the apparatus relative to the floor of the body of water to enable the trench forming means to form the trench;

at least one first support member extending from the body; and

at least one second support member adapted to be moveably mounted to a respective said first support member to enable the second support member to

float on the surface of the body of water.

[0024] By providing at least one first support member extending from the body and at least one second support member adapted to be moveably mounted to a respective first support member to enable the second support member to float on the surface of the body of water, this provides the advantage of enabling the apparatus to be operated from the surface.

[0025] The apparatus may further comprise gas supply means adapted to be mounted to at least one said second support member.

[0026] The gas supply means may comprise air compressor means.

[0027] The apparatus may further comprise control means for controlling the apparatus, wherein the control means is adapted to be mounted to at least one said second support member.

[0028] This provides the advantage of enabling operation of the apparatus from the surface, especially in the case of failure of the apparatus.

[0029] The control means may be adapted to operate hydraulically.

[0030] The trench forming means may comprise at least one chain cutter.

[0031] The trench forming means may be pivotable relative to the body.

[0032] This provides the advantage of enabling the depth of the trench to be adjusted.

[0033] The moving means may comprise at least one track.

[0034] A preferred embodiment will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:-

Figure 1 is a side view of an apparatus embodying the disclosure operating in water of a first depth;

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

Figure 3 is a side view of the apparatus of Figure 1 operating in water of a second depth;

Figure 4 is a front view of the apparatus of Figure 3;

Figure 5 is a side view of the apparatus of Figure 1 operating in water of a third depth;

Figure 6 is a front view of the apparatus of Figure 5;

Figure 7 is a perspective view of an eductor unit of the apparatus of Figures 1 to 6;

Figure 8 is a side view of the eductor unit of Figure 7; and

Figure 9 is a sectional view along the line A-A in Figure 8.

[0035] Referring to Figures 1 to 6, an apparatus 2 for burying a power cable 4 in the seabed 6 in shallow water, for example near to a beach, has a body 8 for supporting the cable 4 and trench cutting means in the form of a chain cutter 10 pivotably mounted to the body 8 for forming a trench 12 in the seabed 6. Moving means in the form of a pair of tracks 14 enables the apparatus 2 to move relative to the seabed 6 to enable the chain cutter 10 to form the trench 12 in the seabed 6. A cable engaging means in the form of a depressor arm 16 is pivotably mounted to a rear part 18 of the body 8 and is adapted to engage the cable 4 to urge the cable 4 to the bottom of the trench 12.

[0036] Gas directing means in the form of an air eduction system 20 is mounted to the depressor arm 16 and comprises a pair of eductor units 22, shown in greater detail in Figures 7 to 9. Each eductor unit 22 is pivotably mounted to a respective side of the depressor arm 16, so that the depressor arm 16 and eductor units 22 can be pivoted between a storage condition and a working condition.

[0037] As shown in greater detail in Figures 7 to 9, each eductor unit 22 has a pair of elongate first conduits 24 which extend from an air inlet 26 at the upper part of the eductor unit 22 to apertures 28 at a lower part of the eductor unit 22, and a second conduit 30 having an inlet 32 at its lower end and an outlet 34 at its upper end. The outlet 34 is arranged to direct material out of the trench 12. Each first conduit 24 also has apertures 36 arranged along its length which act as air jet nozzles to enable fluidisation of debris or slurry in the trench 12 to assist in location of the cable 4 at the bottom of the trench 12 by the depressor arm 16. By introducing compressed air through apertures 28 into the lower end of the second conduit 30, the density of water in the second conduit 30 is reduced, as a result of which more dense water surrounding the second conduit 30 enters the second conduit 30 via inlet 32 to draw debris in the trench 12 into the inlet 32 of the second conduit 30 and displace it out of the trench 12 via the outlet 34 of the second conduit 30.

[0038] A first support member in the form of a lightweight tower 38 extends upwards from the body 8, and a second support member in the form of a floating pontoon 40 is slidably mounted to the tower 38. The floating pontoon 40 is provided with buoyancy blocks 42 to ensure that it floats on the surface of the water and slides along the tower 38 as the position of the surface of the water changes relative to the tower 38. Gas supply means in the form of one or more electrically or hydraulically operable air compressors 44 is mounted to the floating pontoon 40 and receives and compresses ambient air above the surface of the water, and feeds the compressed air via a conduit (not shown) to the air eduction system 20. The floating pontoon 40 can freely move up and down the tower 38 so that it floats on the surface of the water. A remote hydraulic intervention panel is also supported on the floating pontoon 40 to allow functions of the apparatus 2 to be performed from the surface, for example

in the event of a failure of the apparatus 2. A tank of compressed air (not shown) can also be mounted directly on the apparatus 2, to enable operation of the apparatus 2 in deeper water.

[0039] It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the disclosure as defined by the appended claims.

Claims

1. An apparatus for inserting an elongate object into a trench in a floor of a body of water, the apparatus comprising:-

a body for supporting an elongate object;
trench forming means for forming a trench in the floor of the body of water for receiving the elongate object;
moving means for moving the apparatus relative to the floor of the body of water to enable the trench forming means to form the trench; and
gas directing means for directing at least one gas into water in the trench.

2. An apparatus according to claim 1, wherein the gas directing means is adapted to introduce at least one gas into water in a lower portion of the trench.

3. An apparatus according to claim 1 or 2, wherein the gas directing means comprises at least one first conduit having at least one aperture for directing gas therethrough into water in the trench.

4. An apparatus according to claim 3, wherein at least one said first conduit has a plurality of apertures for directing gas therethrough into water in the trench.

5. An apparatus according to claim 3 or 4, wherein the gas directing means comprises at least one second conduit having at least one inlet and at least one outlet, and at least one said first conduit is adapted to introduce at least one gas into water in said second conduit.

6. An apparatus according to claim 5, wherein at least one said outlet is adapted to output material out of the trench.

7. An apparatus according to any one of the preceding claims, wherein the gas directing means is movable between a storage condition and a working condition.

8. An apparatus according to any one of the preceding claims, further comprising gas supply means for supplying at least one gas to the gas directing means.

9. An apparatus according to claim 8, wherein the gas supply means comprises air compressor means.

10. An apparatus according to claim 8 or 9, wherein the gas supply means comprises at least one container of compressed gas.

11. An apparatus according to any one of the preceding claims, further comprising object engaging means for engaging an object for urging the object into the trench.

12. An apparatus according to claim 11, wherein the gas directing means is mounted to the object engaging means.

13. An apparatus for inserting an elongate object into a trench in a floor of a body of water, the apparatus comprising:-

a body for supporting an elongate object;
trench forming means for forming a trench in the floor of the body of water for receiving the elongate object; moving means for moving the apparatus relative to the floor of the body of water to enable the trench forming means to form the trench;
at least one first support member extending from the body; and
at least one second support member adapted to be moveably mounted to a respective said first support member to enable the second support member to float on the surface of the body of water.

14. An apparatus according to claim 13, including one or more of the following features:

(i) further comprising gas supply means adapted to be mounted to at least one said second support member;
(ii) further comprising control means for controlling the apparatus, wherein the control means is adapted to be mounted to at least one said second support member;
(iii) wherein the trench forming means comprises at least one chain cutter;
(iv) wherein the trench forming means is pivotable relative to the body; or
(v) wherein the moving means comprises at least one track.

15. An apparatus according to claim 14, including one or more of the following features:

(i) wherein the gas supply means comprises air compressor means; or
(ii) wherein the control means is adapted to operate hydraulically.

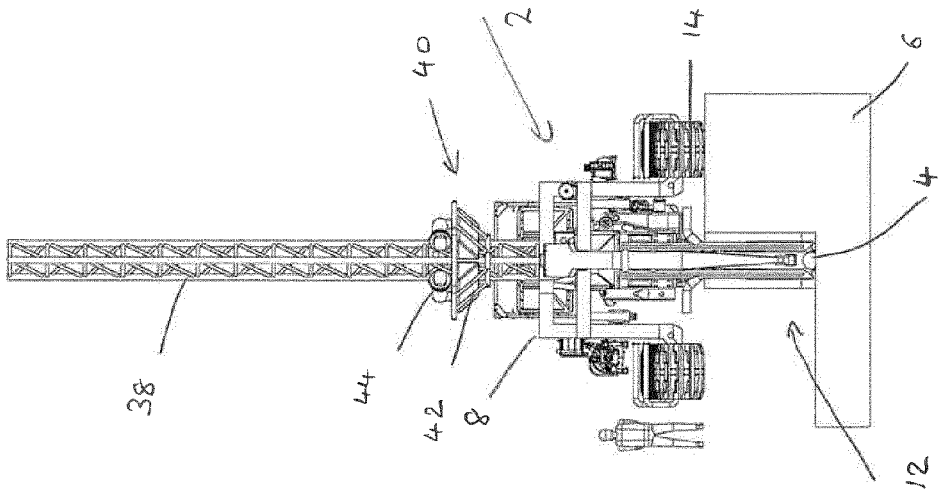


FIG 2

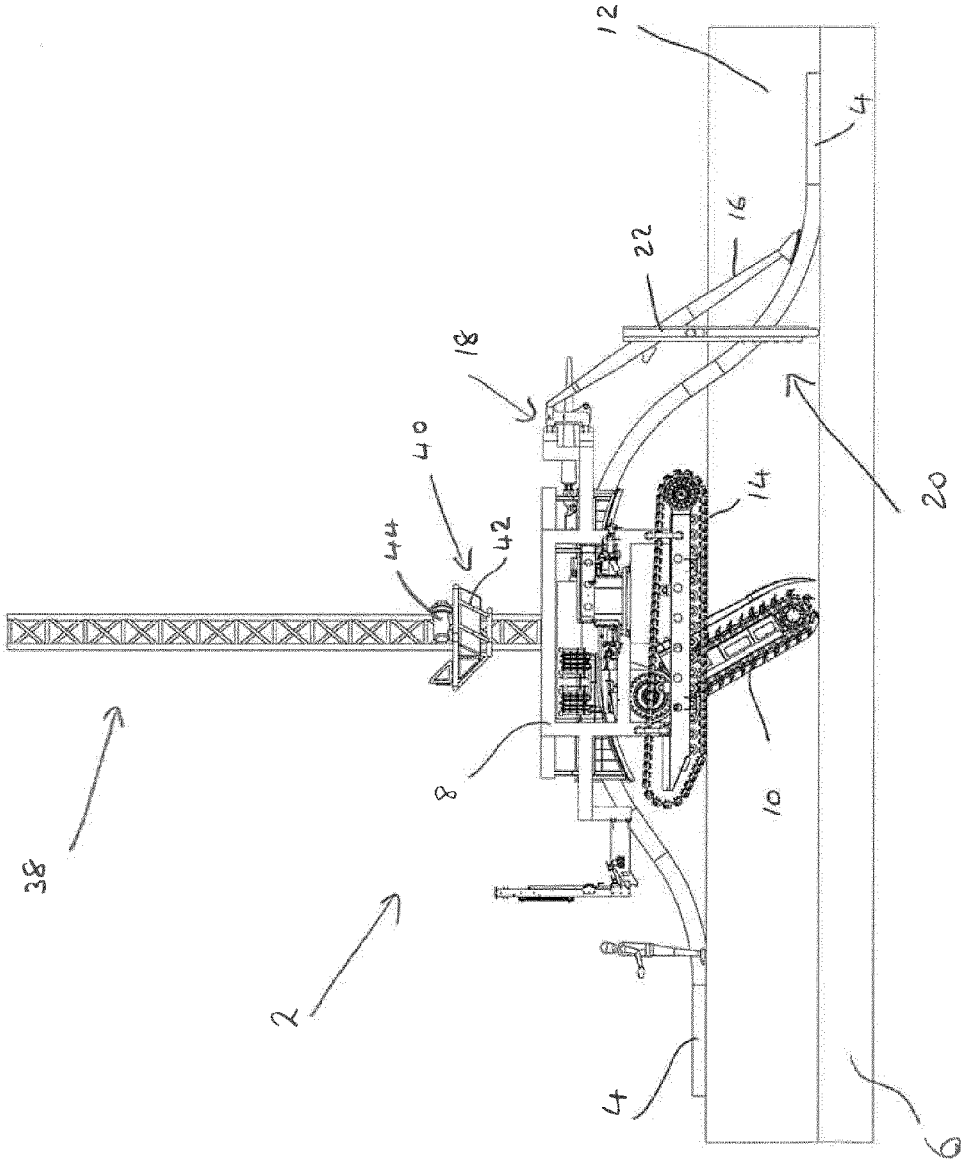


FIG 1

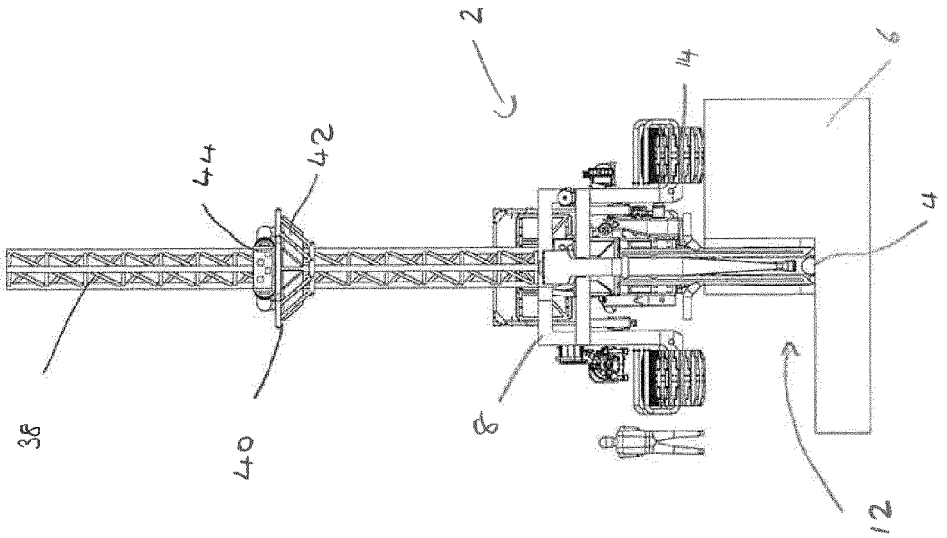


FIG 4

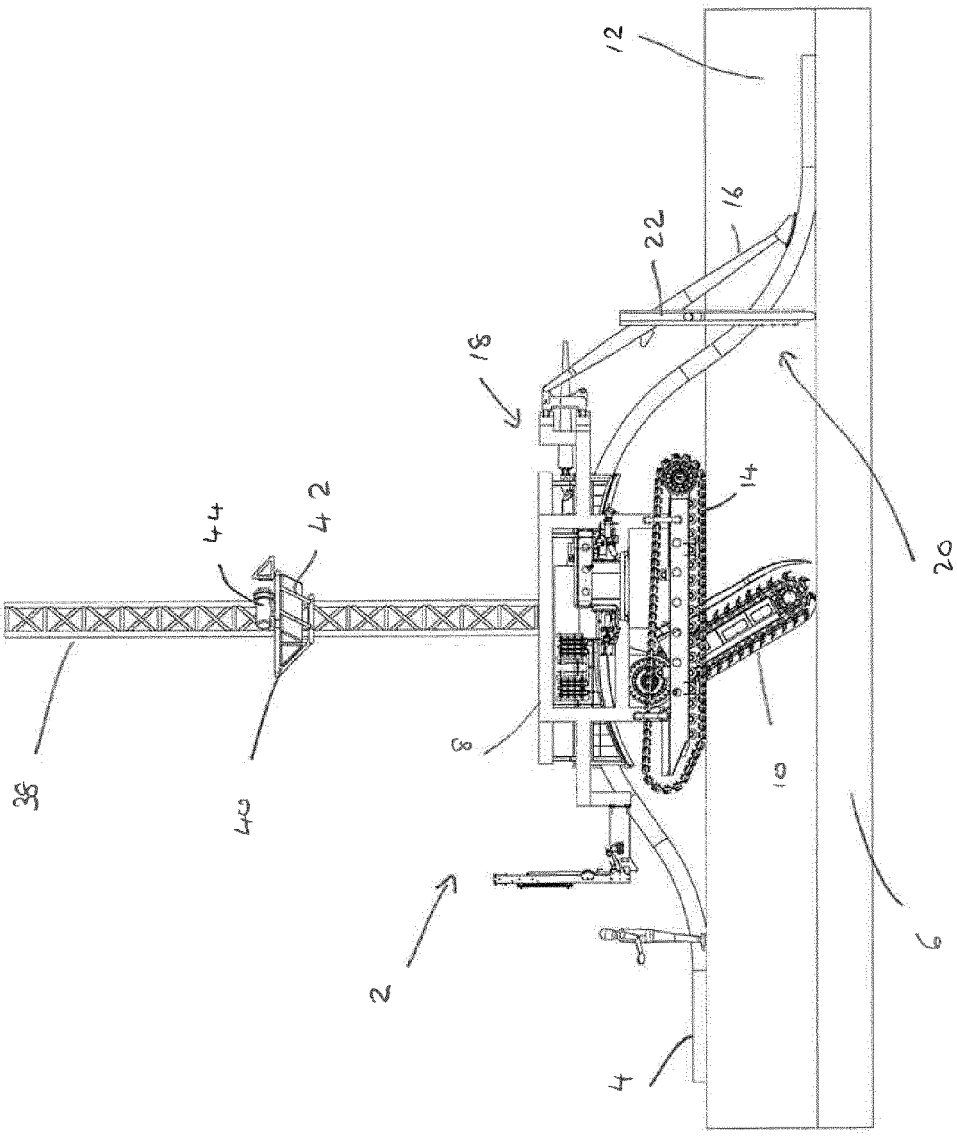


FIG 3

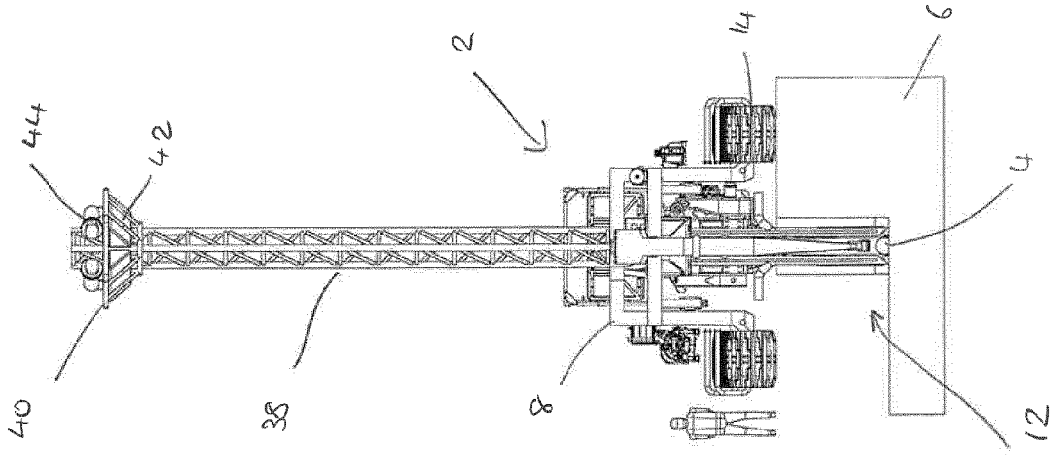


FIG 6

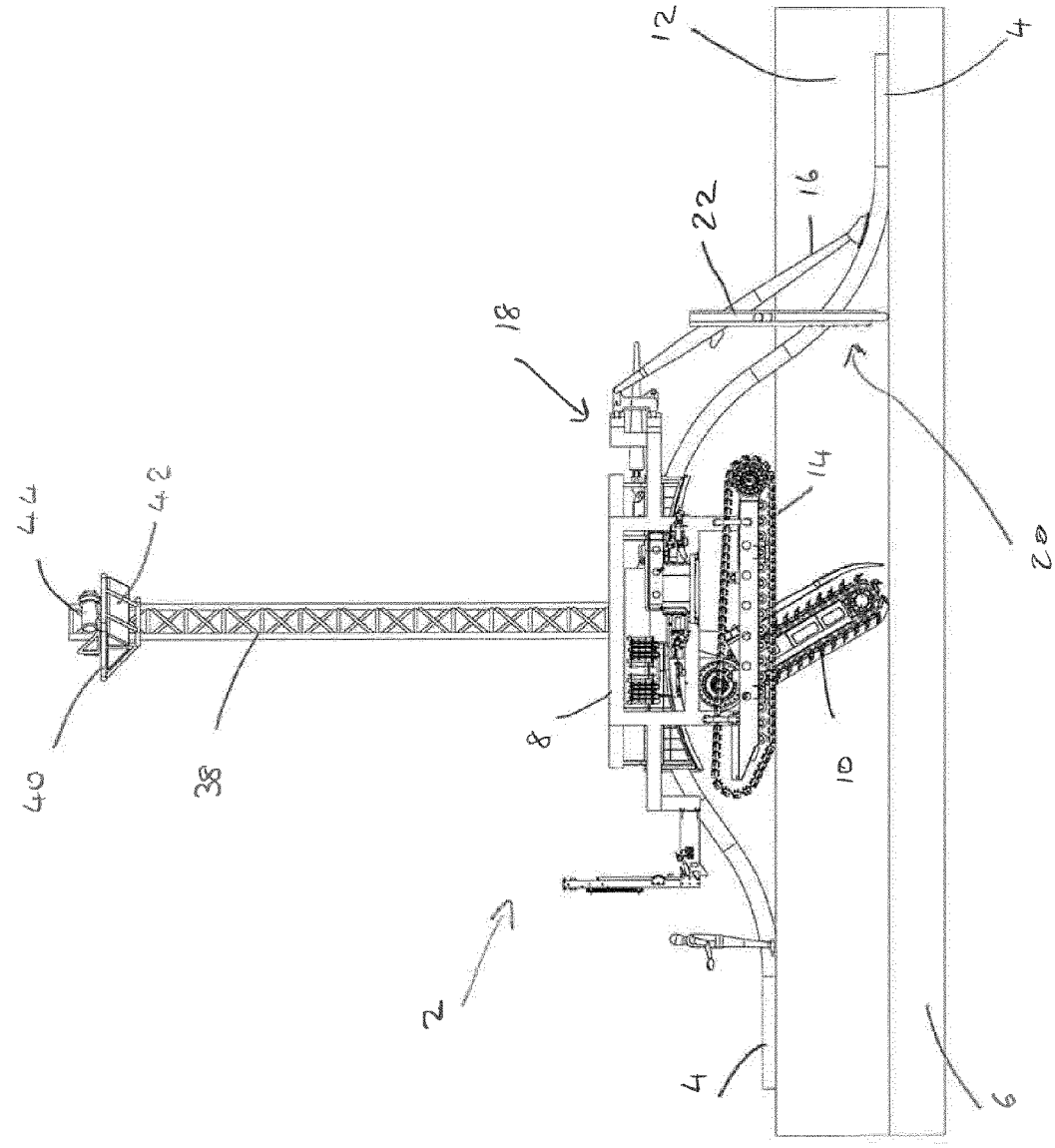


FIG 5

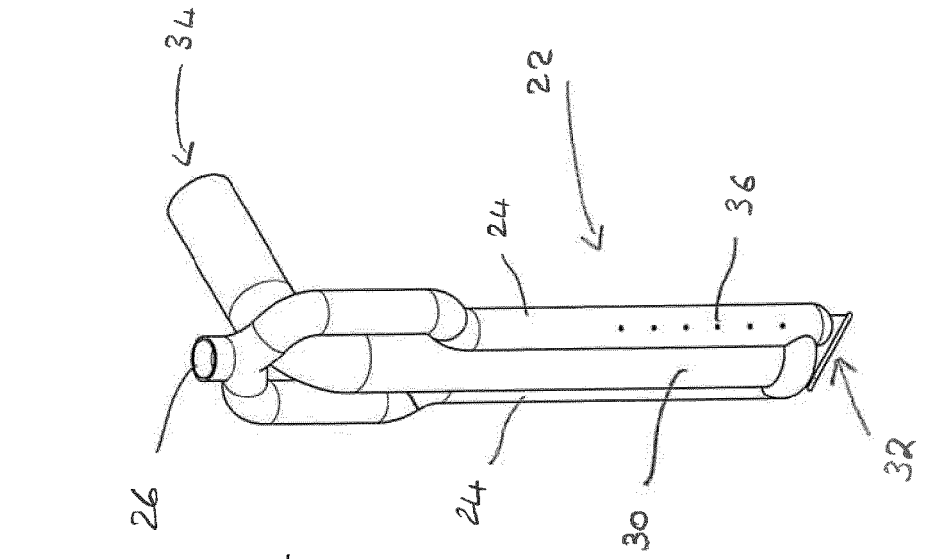


FIG 9

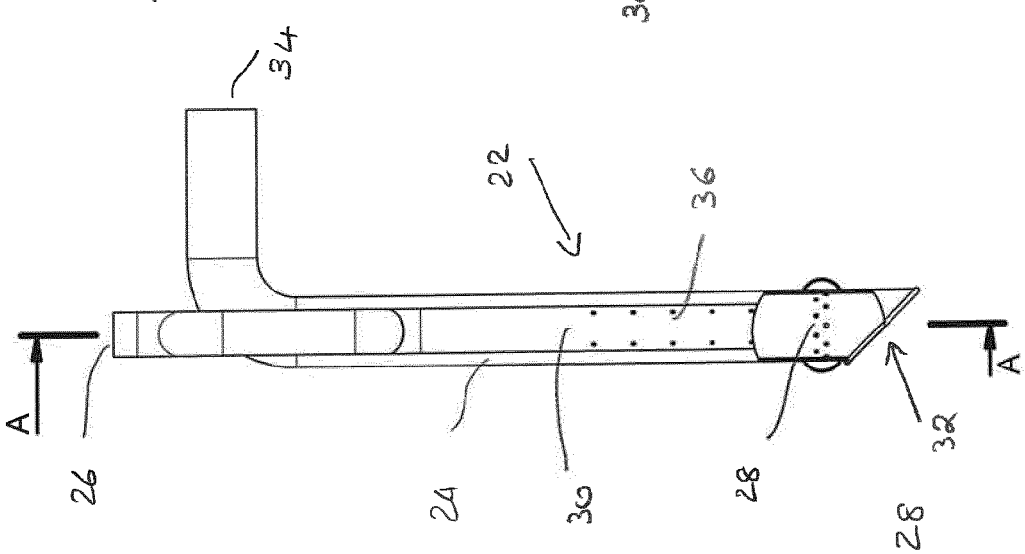
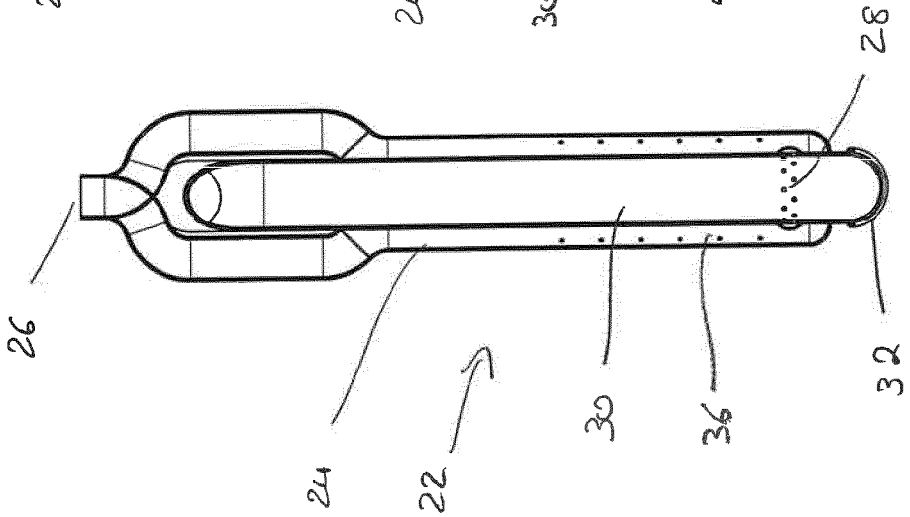


FIG 8



SECTION A - A

FIG 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 16 6704

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	US 4 787 777 A (HARMSTORF RUDOLF [DE]) 29 November 1988 (1988-11-29) * the whole document *	1-4, 7-11, 13-15 1-10 12	INV. E02F5/10 E02F3/92
Y	US 4 037 422 A (DEBOER NICO ET AL) 26 July 1977 (1977-07-26) * column 3, line 67 - column 4, line 36; figures 1,3,7,9 * * column 10, line 5 - line 34 *	5,6	
Y A	WO 99/54556 A1 (SOIL MACHINE DYNAMICS LTD [GB]; REECE ALAN RICHARD [GB]) 28 October 1999 (1999-10-28) * page 10, line 16 - page 11, line 6; figure 1 *	1-10 11,12	
A	US 5 639 185 A (SAXON SAINT ELMO [US]) 17 June 1997 (1997-06-17) * column 4, line 48 - column 5, line 23; figures 1,2,3 * * column 6, line 60 - column 7, line 3 *	13-15	TECHNICAL FIELDS SEARCHED (IPC) E02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 January 2022	Clarke, Alister

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 21 16 6704

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

Europäisches Patentamt
European Patent Office
Office européen des brevets

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 21 16 6704

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-12

   Apparatus for inserting an elongate object into an underwater trench comprising gas directing means

   ---

2. claims: 13-15

   Apparatus for inserting an elongate object into an underwater trench comprising first and second support members

   ---

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 16 6704

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-01-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4787777 A	29-11-1988	NONE	
US 4037422 A	26-07-1977	CA 1029566 A	18-04-1978
		DE 2639535 A1	17-03-1977
		DK 400576 A	05-03-1977
		GB 1505038 A	22-03-1978
		NL 7609094 A	08-03-1977
		NO 144679 B	06-07-1981
		US 4037422 A	26-07-1977
WO 9954556 A1	28-10-1999	AU 3431499 A	08-11-1999
		EP 1073800 A1	07-02-2001
		JP 2002512323 A	23-04-2002
		WO 9954556 A1	28-10-1999
US 5639185 A	17-06-1997	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82