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(71) Applicant: **JAN DE NUL N.V.**
9308 Hofstade-Aalst (BE)

(72) Inventors:
- **Pille, Noel**
  8210 Zedelgem(Loppem) (BE)
- **De Backer, Robert**
  9031 GENT (Drongen) (BE)

(74) Representative:
Carpmael, John William Maurice
CARPMAELS & RANSFORD
43 Bloomsbury Square
London, WC1A 2RA (GB)

(54) Apparatus for burying pipes or cables in the sea bed

(57) A trenching machine (1) is provided for digging a trench on a seabed (5) after a pipeline (2) is positioned. The trenching machine (1) has a trenching body (3) and a connecting pipe (9) by which the trenching body (3) is attached to a vessel. Jet water nozzles (22, 24) and suction ducts (20) are provided on two legs of the trenching body (3) for liquidising the seabed (5) and removing the liquidised material to form the trench. The jet water power and the suction power are provided by the vessel via the connecting pipe (9). Skids (8) are provided at both sides of the trenching machine (1) in order to provide horizontal stability. A steering mechanism is provided in a coupling (10) between the trenching body (3) and the connecting pipe (9) in order to provide additional fine steering capacity. The legs (4) can be lowered independently along an axis perpendicular to the pipeline in order to allow safe deployment of the trenching machine (1) over the pipeline (2) at the start of the works.

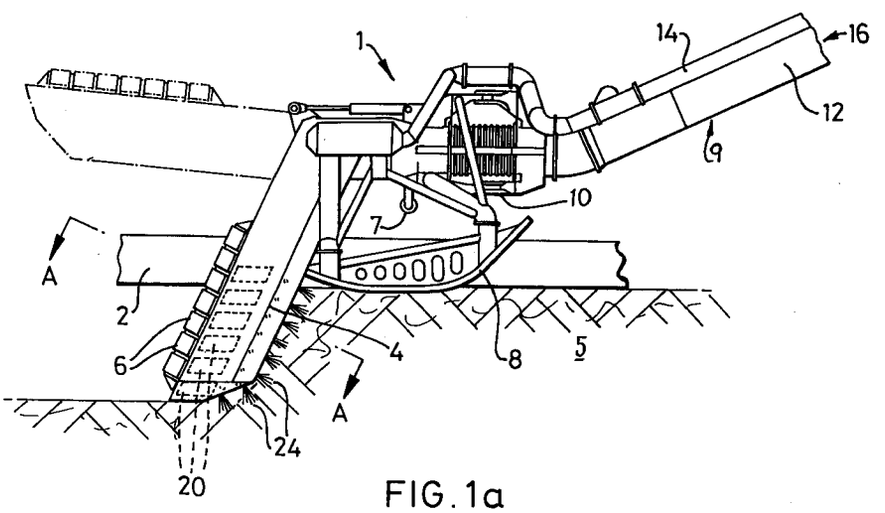


FIG.1a

EP 0 816 574 A1

Description

This invention relates to a trenching machine for lowering a pipeline into the seabed after pipeline installation.

A pipeline can be lowered into the seabed by removing the material of the seabed from below the pipeline by breaking up the material and removing the material thereby providing a trench under the pipeline. The pipeline can then sink into the trench.

Known trenching machines use jetting nozzles to break up the seabed with the jetting power being supplied via a flexible hose from an operating platform such as a pipelay barge. Such known trenching machines have the disadvantage of having a limited travelling speed within the limits of the operating barge.

International patent application WO95/28529 discloses an apparatus which is attached to a suction device on the surface of the water. This apparatus has two hinged legs which are placeable over the pipeline. This apparatus has the disadvantage of being horizontally unstable, does not provide fine steering capability in order to reduce pipeline induced stresses, and has limited safety for deployment over a pipeline without causing damage to the pipeline. This apparatus is only suitable for partial burial of pipelines and could exercise unacceptable forces on the pipeline.

According to a first aspect of the present invention there is provided a trenching machine for lowering a pipeline into the seabed after pipeline installation on the seabed, the trenching machine comprising a trenching body and a connecting pipe wherein, in use, the trenching machine is attached by the connecting pipe to a dredging vessel which propels the trenching machine and wherein the connecting pipe provides suction and jet power to the trenching body from the dredging vessel the trenching machine also comprising a pair of skids to provide horizontal stability to the trenching machine.

The skids provide the advantage of increasing the clearance between the pipeline and the trenching body due to the span crossing ability of the skids.

Preferably, a steering means for fine steering is provided at a coupling point of the connecting pipe and the trenching body.

Preferably, at least part of the connecting pipe is sufficiently rigid to act as a towing mechanism attached to the vessel for towing the trenching machine along the seabed.

Preferably, the trenching body is in the form of a pair of legs which, in use, are placeable either side of the pipeline. Preferably, the legs deliver jets of water and suction power to the seabed material.

The legs may be attached to the trenching body such that the legs can be raised or lowered independently along an axis perpendicular to the pipeline in order to allow safe deployment over the pipeline.

Preferably, the legs can be raised and lowered hydraulically to adjust the trench depth. The legs may be provided with forward and side facing jets and inward facing ducts through which material is pumped out of the trench.

The skids may be adjustable in height to compensate for variations in the clearance between the pipeline and the trenching body.

Preferably, the trenching body is attached to the connecting pipe via a universal and rotating coupling which gives three axes of freedom namely, pitch, roll and yaw.

Rollers may be provided adjacent the pipeline to monitor pipeline contact forces.

The trenching machine may preferably include a surveillance system to allow operators of the trenching machine to observe the machine. The trenching machine may also optimally include an instrumentation system to monitor the trenching machine and the interaction with the pipeline.

Preferably, the connecting pipe includes a suction pipe and a water jet pipe.

According to a second aspect of the present invention there is provided a trenching system for providing a trench for a pipeline in a seabed, the trenching system comprising a trenching body, a self-propelled dredging vessel and a connecting pipe, the connecting pipe connecting the trenching body to the dredging vessel and providing suction and jet power to the trenching body from the dredging vessel, wherein the vessel propels the trenching body along the seabed, the trenching system also including a pair of skids disposed on either side of the trenching body to provide horizontal stability to the trenching body.

Preferably, the vessel is a trailer suction hopper dredger working on dynamic tracking.

According to a third aspect of the present invention there is provided a method of providing a trench in a seabed for a pipeline comprising dragging a trenching body along the seabed by a self-propelled vessel, wherein the trenching body is attached to the vessel by a connecting pipe which supplies suction and jet power to the trenching body, the trenching body being horizontally stabilised by the provision of a pair of skids on either side of the trenching body.

Optimally, the trenching body is steered by a fine steering means provided at a coupling point of the connecting pipe and the trenching body.

According to a fourth aspect of the present invention there is provided a trenching machine for lowering a pipeline into the seabed after pipeline installation on the seabed, the trenching machine comprising a trenching body and a connecting pipe wherein, in use, the trenching machine is attached by the connecting pipe to a dredging vessel which propels the trenching machine and wherein the connecting pipe provides suction and jet power to the trenching body from the dredging vessel the trenching machine also comprising a steering means provided at a coupling point between the connecting pipe and the trenching body.

An embodiment of a trenching machine in accordance with the present invention is now described with reference to the accompanying drawings in which:

Figure 1A is a side elevation of the trenching machine with the pipeline in a first position;

Figure 1B is a side elevation of the trenching machine with the pipeline in a second position;

Figure 2 is a top elevation of the trenching machine;

Figure 3A is a front elevation of the trenching machine with the pipeline in the first position.

Figure 3B is a front elevation of the trenching machine with the pipeline in the second position;

Figure 4 is a cross-section through A-A of Figure 1A; and

Figure 5 is a detail of Figure 4.

Referring to the drawings, a trenching machine 1 is positioned over a pipeline 2 on a seabed 5. The trenching machine 1 is attached via a coupling 10 and steering mechanism to a connecting pipe 9. The trenching machine 1 is controlled and operated from a vessel in the form of a trailer suction hopper dredger (not shown). The trenching machine 1 uses the high jet and dredge pump power of the hopper dredger in order to post lower the pipeline 2. In most cases this can be done in a single pass dependent on the trench depth and soil encountered. The trenching machine 1 is primarily designed for sand although the jet power of the hopper dredger enables it to be used with clay and other materials.

The trenching machine 1 has a pair of parallel legs 4 which extend, in use, on either side of the pipeline 2. The legs 4 each have inwardly projecting rollers 6 on their mutually adjacent sides. A further roller 7 is disposed on the underside of the trenching body 3.

The rollers 6, 7 are of steel construction with a hard rubber coating and plain bearings. The rollers 6, 7 are mounted on roller cradles and are positioned so as to prevent any other contact with the pipeline 2. The rollers 6, 7 are instrumented vertically and laterally to monitor pipe contact forces.

The legs 4 are of steel fabricated construction with jet nozzles 24, 22 pointing sidewards and in the direction of travel of the trenching machine 1. The side facing jet nozzles 22 are positioned on each of the legs 4 such that the side facing jet nozzles 22 are directed towards each other on either side of the pipeline 2 position. The jet nozzles 22, 24 are nylon and replaceable to permit change to suit different soil types. The jet nozzles 22, 24 are supplied with jet powered water from the vessel via a jet water pipe 14. The jet water pipe 14 forms part of the connecting pipe 9.

The legs 4 also have a series of inward facing ducts 20 situated throughout the length of the legs 4. The ducts 20 are connected to a suction pipe 12 acts as part of the connecting pipe 9. The material from the trench is pumped out of the trench by suction through the ducts 20 and through the suction pipe 12.

The legs 4 are attached via a hydraulic system to the trenching body 3. The legs 4 can be raised and lowered hydraulically and independently from each other to allow safe deployment of the trencher above the pipeline 2 and to adjust the desired trench depth. The legs 4 are raised and lowered by pivoting about an axis perpendicular to the pipeline 2.

The hydraulic system is in the form of an electric motor driving a hydraulic pump which provides oil to an oil filled valve tank.

The suction pipe 12 and the jet water pipe 14 are attached via a universal and rotatable coupling 10 to the trenching machine 1 to give three axes of freedom for the trenching machine 1 namely pitch, roll and yaw.

Fine steering means are provided at the coupling 10. The fine steering means is in the form of a hydraulic module which does not rely on contact with the pipeline 2 and which alters the direction of the skids 8 by reference to the coupling 10.

The trenching machine 1 is a seabed referencing device which runs on skids 8. The trenching body 3 has two skids 8 positioned on either sides of the legs 4. The trenching machine 1 has roll freedom so that it can follow the shape of the seabed 5. In this way, the horizontal position of the trenching machine 1 is unaffected by the connecting pipe 9. The skids 8 are sufficiently large to give adequate support on soft soil. The skids 8 are placed sufficiently in advance of the legs 4 in order to reduce the risk of undermining by the excavation. The figures show the skids 8 in two different height positions.

The trenching machine 1 is provided with a surveillance system which includes obstacle avoidance sonar to look ahead and to the side of the trenching machine 1, profiling sonar at the front and back of the trenching machine 1 for locating the pipeline 2 and monitoring the trench created. Cameras are also provided, one forward, one aft and both on pan and tilt. Four lights are also mounted on the trenching machine 1 in optimum positions.

The trenching machine 1 includes an instrumentation system with load cells to measure force, in cylinder transducers to measure position and a number of other transducers. The parameters which the instrumentation system controls are pipe contact forces, jet leg reaction, jet leg position, pipe height, suction pipe angle, pitch and roll, speed of wheel running on pipe, moisture ingress to electronics pod, water depth, suction and jet pressure.

The trenching machine 1 is fitted with a one atmosphere pressure vessel which acts as a junction box for electrical harnesses and contains the data gathering unit. The unit communicates via the connecting pipe 9

with the control cabin on the bridge of the vessel. The unit also controls the hydraulic valves, instrumentation and surveillance. An umbilical system linking the vessel to the junction box is attached to the suction pipe 12 and is an armoured type.

Control equipment for the trenching machine 1 is installed on the bridge of the dredging vessel.

All the power, umbilical and signal cables are glanded into a separate air conditioned area of the vessel to keep the temperature of the components within their operational limits. All high voltage equipment is shielded and the transformers are enclosed in a frame for safety.

There are normally two operators - the operator, who controls and finely steers the trencher hydraulic functions at the left hand side of a console, and the co-operator, who controls ancillary functions on the right. The operators control the trenching machine 1 via joy-sticks and membrane keypads.

A processor system is provided which is designed so that the operator can directly change transducer calibration constants and alarm levels, and can chose the graphics picture layout. The system also has flexibility. If, say, an extra transducer is added, then the required changes to the software can be done quickly and easily using a programmer.

The processor system is initially programmed by a computer. During normal operations the computer and processor system are linked. A data logging packager is provided so the information can be obtained as hard copy from the printer and in addition the data can be logged onto the computer hard disc.

At any time during the operations a "snapshot" of the control system can be taken and printed out. This shows all variables at the time the snapshot was requested together with scaling factors and alarm system settings.

A spare computer is also provided which can be used to monitor data in the processor system running program. It is not possible to both data log and monitor the processor system program from one computer at the same time, so the use of two computers allows continuous data logging, even if processor system monitoring is required for reasons such as fault diagnosis or changes to software.

Since the two computers are networked together, access to the "live" data, as well as previously stored data, is possible for "on-line" trend analysis using a suitable software package.

A chart recorder is used to provide a visual record of chosen variables. The chart recorder generates an independent "real time" record.

A remote display unit is provided, and this is usually mounted on the bridge. The remote display unit contains two black and white monitors and two RGB monitors. The pilot screen, profiling sonar and two TV pictures can be displayed, using outputs from video switches in a control area.

Operation of the Trenching Machine

The trenching machine 1 is designed to suit post trenching of varying diameters of pipeline from 20" to 46" and trench depths from 0.0 to 3.0 m. Prior to deployment from the dredger the trenching machine 1 will be adjusted to alter the length and distance between the trenching machine's legs 4 in accordance with the given pipeline 2 diameter. Also the skids 8 will be set in order to achieve the clearance required with the given trench depth in view of possible freespans of the pipeline 2 between dunes on the seabed 5.

Depth of trenching is controlled by setting the angle of incidence of the legs 4 to the seabed 5 and the length of leg 4 which penetrates the seabed 5. The legs 4 are modular and can therefore be lengthened or shortened prior to deployment.

Deployment of the trenching machine 1 takes place with the vessel moving forwards on dynamic tracking at around 0.3 to 3.0 knots.

The as laid pipeline coordinates (vertical and horizontal) will have been input to the vessel's navigation and dredging computers prior to deployment. The deployment position will be 200 to 300m ahead of the start of the trenching run. Once the dredging hopper has attained and is maintaining the required track, the trenching machine 1 is lowered to 5m above the seabed 5.

At this point in the deployment, the electronic and visual sensor arrays installed on the trenching machine 1 are used for additional reference information. The trenching machine 1 is then positioned laterally over the pipeline 2 by manual joy stick operation from the control position on the bridge of the vessel. Lateral position can be fine tuned by the jet water nozzles 22 exerting sidewards thrust. When the operator is satisfied as to the position of the trenching machine 1 above the pipeline 2 the trenching machine 1 is lowered over the pipeline 2 and supported on its skids 8 on the seabed 5.

Once on the seabed 5 the trenching machine's 1 position is further adjusted by the forward motion provided by the vessel via the suction pipe, and fine steering by a hydraulic module fitted to the coupling 10. This steering module, which does not rely on contact with the pipeline 2, alters the skid 8 direction by reference to the universal coupling joint 10 between the trenching machine 1 and suction pipe 12.

The fine steering mechanism consists of an hydraulic cylinder which acts from the connecting pipe 9 to the rotating part of the universal coupling 10. As such the trencher body can rotate in the horizontal plane around the vertical axis of universal coupling 10, providing fine steering capacity around the theoretical pipeline alignment. The fine steering is operated by joy-stick control from the control console on the vessel bridge.

Based on the electronic and visual sensors displaying the position of the pipeline 2 in between the skids 8, one of the trenching legs 4 is hydraulically lowered into

the seabed 5, which is at the greatest distance from the pipeline 2. Whilst moving forwards, the trenching machine 1 is further aligned and the other trenching leg 4 is lowered from the moment that the sensors display the position of the pipeline 2 in the center of the trenching machine 1.

On completion of deployment and position alignment to the pipeline 2, the trenching operation can start. The trenching from here on is an automated process with a manual overview and over-ride capability.

The complete operation is controlled by the dredging, trenching and navigation computers which monitor and steer the dredger hopper and trenching machine 1.

The trenching machine 1 is designed to operate at forward speeds between 0.3 and 3 knots, the forward movement being provided by pulling loads via the vessel's suction pipe 12. The jet nozzles 22, 24 mounted on the front and inside of the trenching machine's legs 4 cause localised fluidisation of the soil thus reducing resistance to the legs 4 forward motion through the soil.

Generally, one trenching pass will be required to lower the pipeline 2 into sand to a depth of 1.5 m. For greater depths, multipass operation could be required.

Trenching is achieved by the vessel's massive suction power ability to pump the soil liquified by the jets 22, 24 out of the trench. On the inside faces of the trenching machine's legs 4 suction ducts 20 are installed at some distance behind the jets 22, 24. The soil under the pipeline 2 is sucked out of the trench via these ducts 20, and using the suction tube 12 and dredge pump, to which the trenching machine 1 is attached, the trench material can be loaded into the vessel's hopper. The standard procedure however will be to repump the soil down a second suction pipe of the vessel to the seabed at approximately 30-40m parallel to the trench on the other side of the vessel with the mouth of the second suction pipe 10m or more above the seabed 5.

In addition to the vessel track position information and the visual type sensor arrays mounted on the trenching machine 1, warning signals from strain sensitive contact rollers 6 on each of the trenching machine's legs 4 are monitored at the trenching machine's control console on the vessel bridge. A continuous read out of the lateral contact pressure of the rollers 6 on the pipeline 2 will be available for pipe stress analysis purposes. The tracking system continuously checks the horizontal and vertical position of the pipeline 2 in relation to the trenching machine's skids 8.

Similar vertical rollers 7 are also mounted on the trenching machine 1 to monitor any vertical contact forces to the pipeline 2. In order to have sufficient span crossing ability in case of post trenching being executed over sand dunes, a vertical clearance of 2.5m is available between the pipeline 2 and the trenching machine's main body 3 with a given trench depth up to 1.5m.

During transit from one dune to another, the trenching machine's legs 4 will be left in the seabed 5 at approximately 0.5m depth with the jets 22, 24 operating at reduced volume but without pumping the seabed soil out of the trench. As such, the seabed 5 under the pipeline 2 will be fluidised over limited depth and cause a levelled seabed 5 for the pipeline 2 in areas of minor freespans which could have remained after pipelay.

Recovery of the trenching machine 1 is a straightforward and simple operation comparable with the lifting of a draghead. On completion of the trenching run the trenching machine's legs 4 are raised thus providing the maximum lateral clearance between the trenching machine's skids 8 for the purpose of lifting. After completing visual checks of the trenching machine 1 alignment to the pipeline 2, the suction pipe 12 hoist winches will be engaged to lift the trenching machine 1 clear of the pipeline 2 and up onto the vessel's deck.

The vessel can then, if necessary, deploy the trenching machine 1 for any subsequent passes required.

The trenching machine 1 is provided with equipment, to continuously monitor and control the trenching equipment as the pipeline 2 is lowered into the trench. The monitoring and control includes the following aspects:

- Suitability of the trenching spread for the local soil conditions (soil bearing capacity versus track pressure, etc.);
- Bumpers/ tubular protection structures, etc. to avoid any possible direct contact during trenching between the trenching machine's steel components with the pipeline;
- A load recording device, with permanent print out and an audible alarm shall be installed on the pulling suction pipe to enable pulling load monitoring;
- Permanent readout/ recording of the power consumption on pumps and jets.

Improvements and modifications can be made to the above without departing from the scope of the present invention.

Claims

1. A trenching machine (1) for lowering a pipeline (2) into the seabed (5) after pipeline (2) installation on the seabed (5) the trenching machine (1) comprising a trenching body (3) and a connecting pipe (9) wherein, in use, the trenching machine (1) is attached by the connecting pipe (9) to a dredging vessel which propels the trenching machine (1) and wherein the connecting pipe (9) provides suction and jet power to the trenching body (3) from the dredging vessel, the trenching machine (1) also comprises a pair of skids (8) disposed on either side of the trenching body (3) to provide horizontal stability to the trenching machine (1).

2. A trenching machine (1) as claimed in claim 1,

wherein a steering mechanism for fine steering is provided at a coupling (10) between the connecting pipe (9) and the trenching body (3).

3. A trenching machine (1) as claimed in claim 1 or claim 2, wherein at least part of the connecting pipe (9) is sufficiently rigid to act as a towing mechanism attached to the vessel for towing the trenching machine (1) along the seabed (5).

4. A trenching machine (1) as claimed in claim 1, 2 or 3, wherein the trenching body (3) is in the form of a pair of legs (4) which, in use, are placeable either side of the pipeline (2).

5. A trenching machine (1) as claimed in claim 4, wherein the legs (4) deliver jets of water and suction power to the seabed (5) material.

6. A trenching machine (1) as claimed in claim 4 or claim 5, wherein the legs (4) are attached to the trenching body (3) such that the legs (4) can be raised or lowered independently along an axis perpendicular to the pipeline in order to allow safe deployment over the pipeline.

7. A trenching machine (1) as claimed in any claims 4 to 6, wherein the legs (4) can be raised and lowered hydraulically to adjust the trench depth.

8. A trenching machine (1) as claimed in any of claims 4 to 7, wherein the legs (4) are provided with forward and side facing jets (22, 24) and inward facing ducts (20) through which material is pumped out of the trench.

9. A trenching machine (1) as claimed in any of the preceding claims, wherein the pair of skids (8) are disposed (3) on either side of the pair of legs (4).

10. A trenching machine (1) as claimed in claim 9, wherein the skids (8) are adjustable in height to compensate for variations in the clearance between the pipeline (2) and the trenching body (3).

11. A trenching machine (1) as claimed in any of the preceding claims, wherein the trenching body (3) is attached to the connecting pipe (9) via a universal and rotating coupling (10) which give three axes of freedom namely, pitch, roll and yaw.

12. A trenching machine (1) as claimed in any of the preceding claims, wherein rollers (6, 7) are provided adjacent the pipeline (2), in use, to monitor pipeline (2) contact forces.

13. A trenching machine (1) as claimed in any of the preceding claims, wherein the trenching machine (1) includes a surveillance system to allow operators of the trenching machine (1) to observe the machine (1).

14. A trenching machine (1) as claimed in any of the preceding claims, wherein the trenching machine (1) includes an instrumentation system to monitor the trenching machine (1) and the interaction with the pipeline (2).

15. A trenching machine (1) as claimed in any of the preceding claims, wherein the connecting pipe (9) includes a suction pipe (12) and a water jet pipe (14).

16. A trenching system for providing a trench for a pipeline (2) in a seabed (5), the trenching system comprising a trenching body (3), a self-propelled dredging vessel and a connecting pipe (9), the connecting pipe (9) connecting the trenching body (3) to the dredging vessel and providing suction and jet power to the trenching body (3) from the dredging vessel, wherein the dredging vessel propels the trenching body (3) along the seabed (5), the trenching system also included a pair of skids (8) disposed on either side of the trenching body (3) to provide horizontal stability to the trenching body (3).

17. A trenching system as claimed in claim 16, wherein the vessel is a trailer suction hopper dredger working on dynamic tracking.

18. A method of providing a trench in a seabed (5) for a pipeline (2) comprising dragging a trenching body (3) along the seabed (5) by a self propelled vessel, wherein the trenching body (3) is attached to the vessel by a connecting pipe (9) which supplies suction and jet power to the trenching body (3), the trenching body (3) being horizontally stabilised by the provision of skids (8) on either side of the trenching body (3).

19. A method as claimed in claim 18, wherein the trenching body (3) is steered by a fine steering means provided at a coupling (10) point of the connecting pipe (9) and the trenching body (3).

20. A trenching machine (1) for lowering a pipeline (2) into the seabed (5) after pipeline (2) installation on the seabed (5) the trenching machine (1) comprising a trenching body (3) and a connecting pipe (9) wherein, in use, the trenching machine (1) is attached by the connecting pipe (9) to a dredging vessel which propels the trenching machine (1) and wherein the connecting pipe (9) provides suction and jet power to the trenching body (3) from the dredging vessel, the trenching machine (1) also comprises a steering means provided at a coupling

point (10) between the connecting pipe (9) and the trenching body (3).

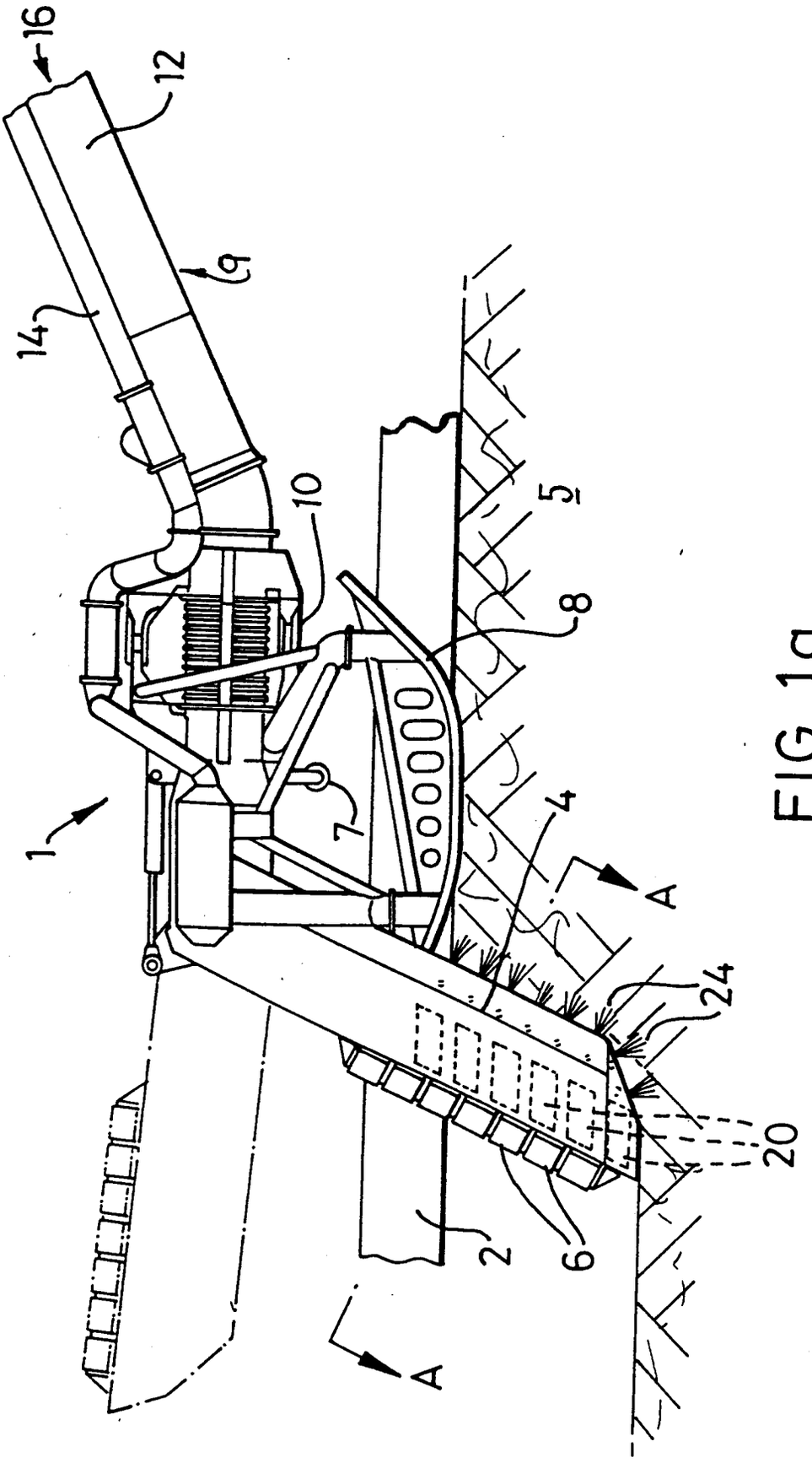


FIG.1a

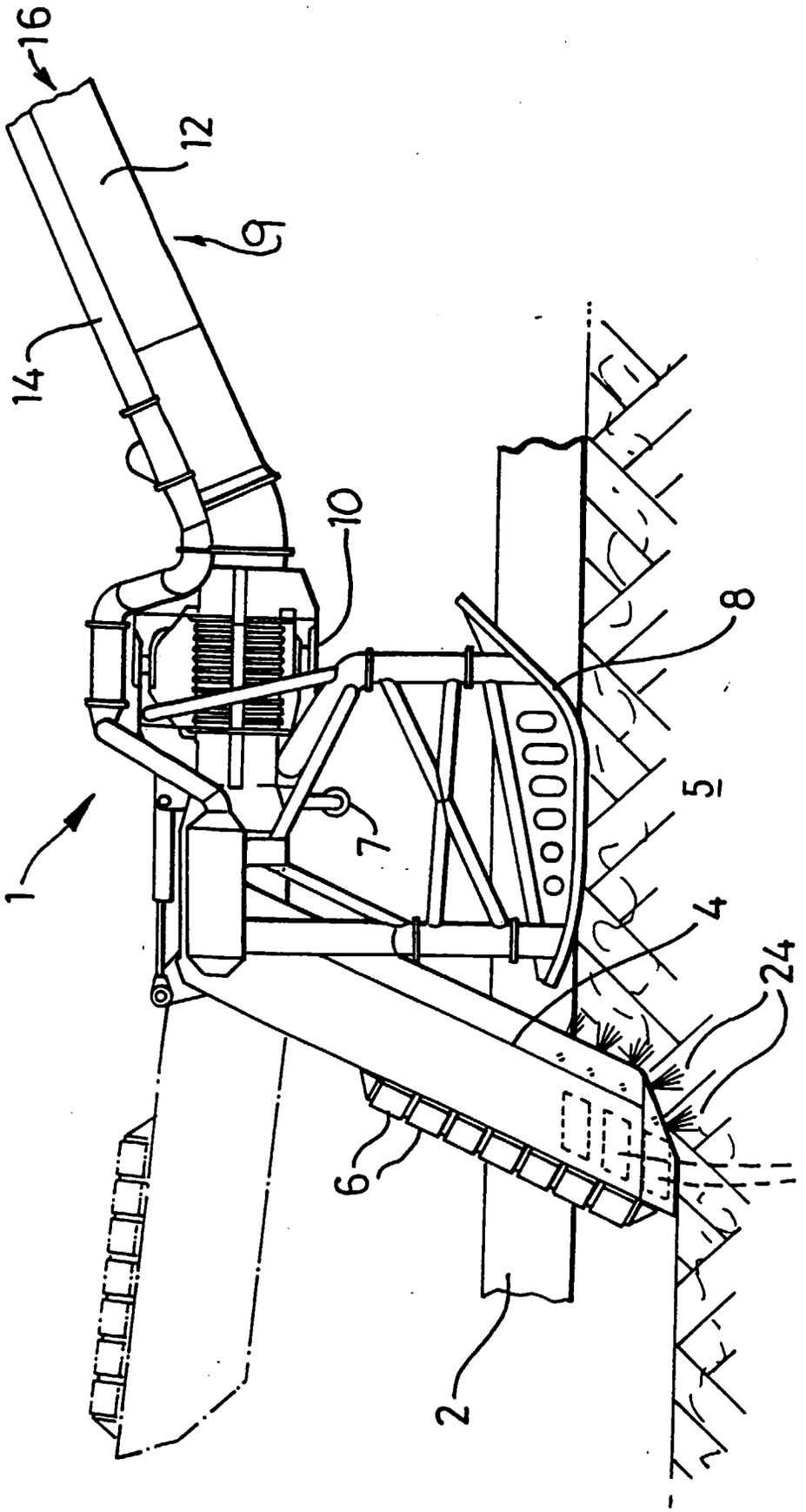


FIG. 1b

FIG. 2

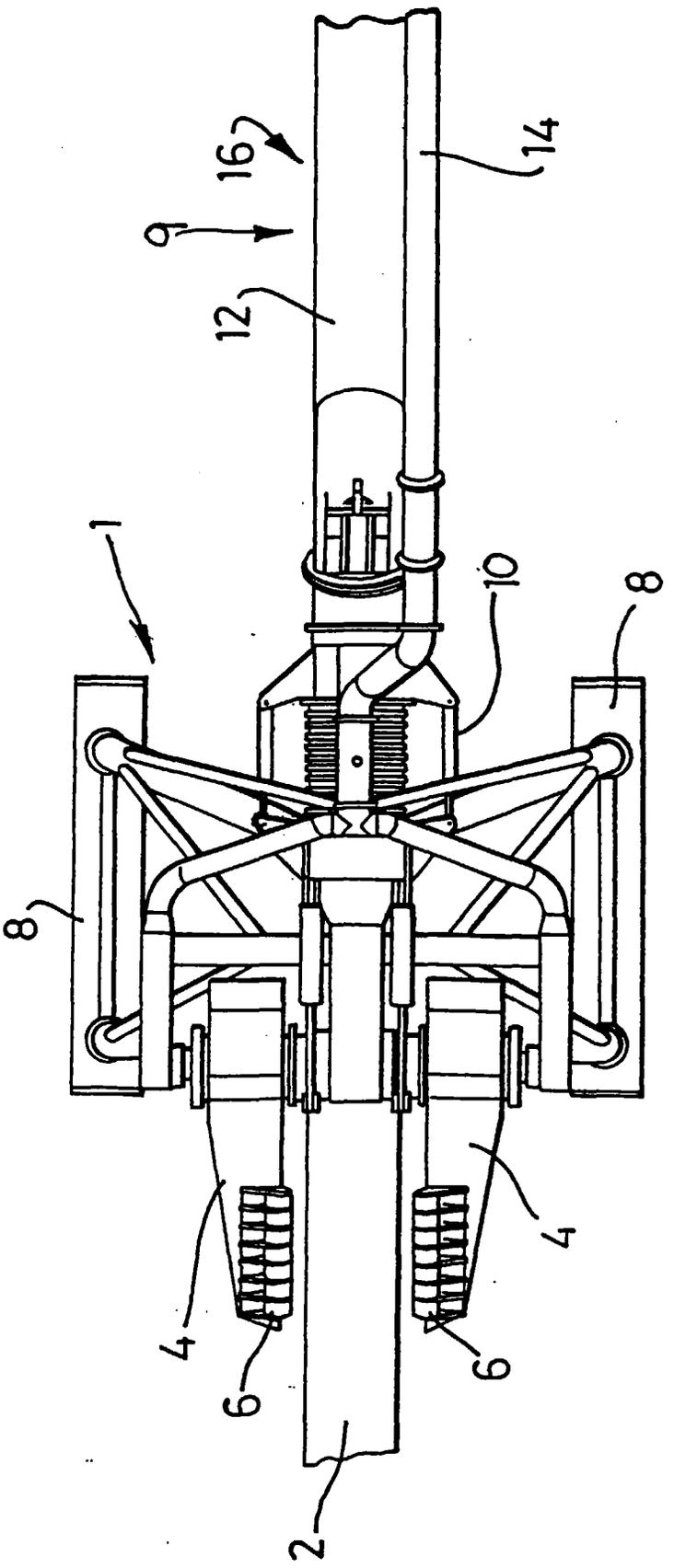


FIG. 3a

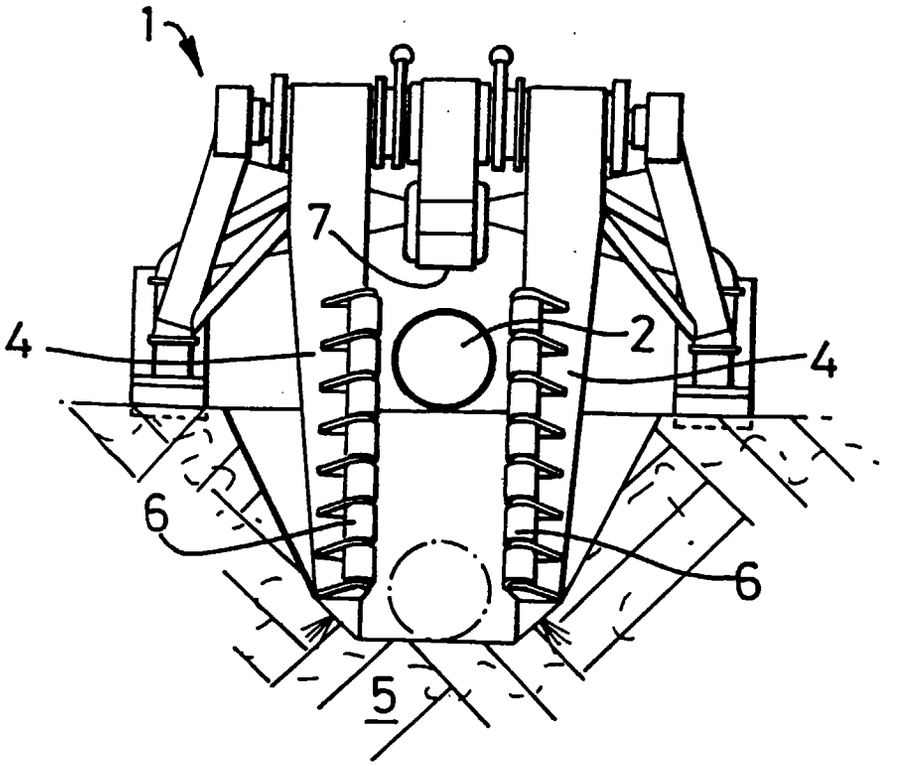


FIG. 3b

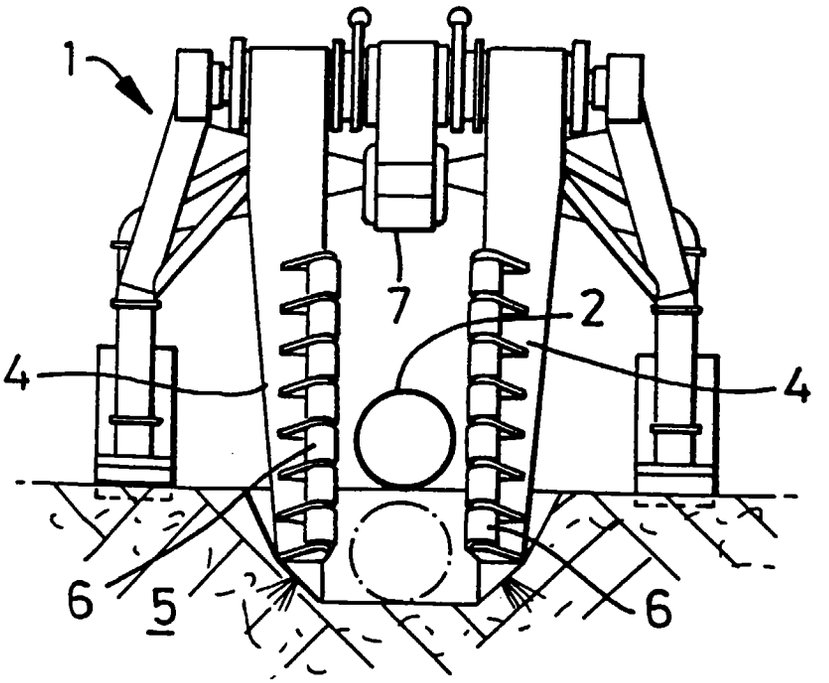


FIG. 4

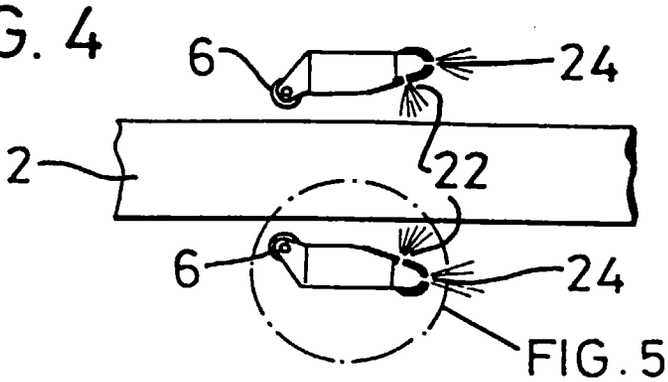
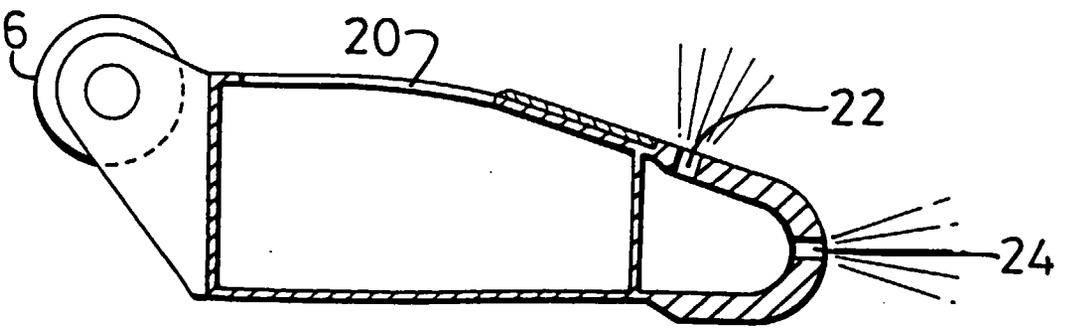


FIG. 5

FIG. 5



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 4922

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y,D A	WO-A-95 28529 (OORD ACZ B V VAN ;STEEN ANTON RUDOLF FRITS V D (NL)) 26 October 1995 * page 1, line 38 - page 6, line 17 * * figures * ---	1-20 6	E02F5/10
Y	US-A-4 190 382 (LOCHRIDGE JOE C ET AL) 26 February 1980 * column 2, line 51 - line 61 * * column 3, line 5 - line 10 * * column 3, line 34 - line 37 * * column 4, line 15 - line 23 * * column 6, line 17 - line 28 * * column 7, line 14 - line 47 * * column 9, line 1 - line 10 * * column 9, line 19 - line 29 * * figures 3,4,6-8 * ---	1-20	
Y	EP-A-0 322 935 (HOLLANDSCHE BETONGROEP NV) 5 July 1989 * column 2, line 14 - line 43 * * column 4, line 17 - line 27 * * figures 1,2 * ---	2,11,19	TECHNICAL FIELDS SEARCHED (Int.Cl.6) E02F
Y	GB-A-2 015 618 (LAND & MARINE ENG LTD) 12 September 1979 * page 1, line 39 - line 51 * * page 1, line 128 - page 2, line 7 * * figures 1-3 * ---	6	
Y A	EP-A-0 581 357 (PARAGON INTERNATIONAL B V) 2 February 1994 * column 3, line 48 - line 54 * * figure 1 * --- -/--	10 1,9,16, 18,20	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 December 1996	Estrela y Calpe, J

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
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EUROPEAN SEARCH REPORT

Application Number
EP 96 30 4922

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-3 751 927 (PEROT J) 14 August 1973 * column 3, line 27 - line 43 * * column 4, line 50 - column 5, line 14 * * column 5, line 55 - column 6, line 20 * * column 7, line 66 - column 8, line 2 * * column 11, line 11 - line 37 * * figures * ---	1,4-9, 12-18,20	
A	US-A-4 165 571 (CHANG NUKE M ET AL) 28 August 1979 * abstract * * column 5, line 21 - line 25; figures 1,2,4 * -----	1,4,5,8, 9,12, 16-18,20	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 December 1996	Estrela y Calpe, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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