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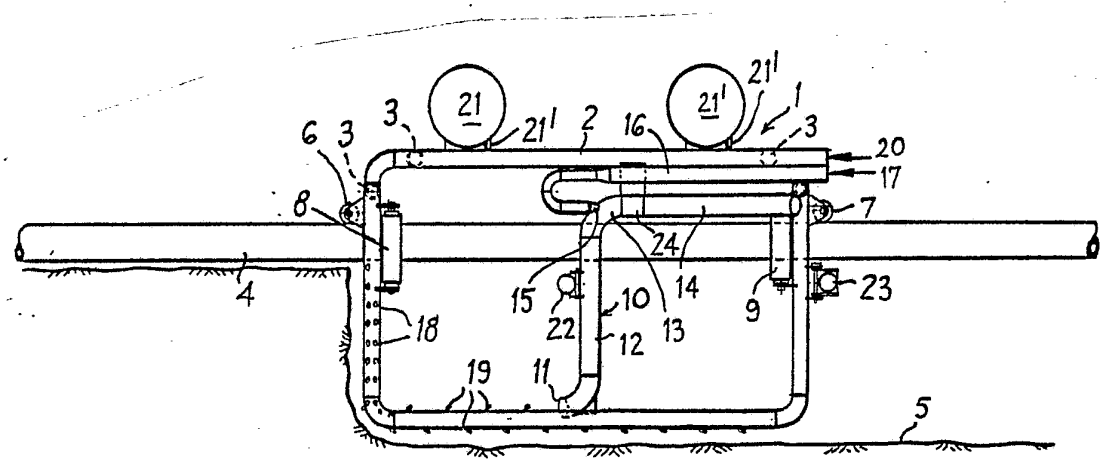
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(54) Title: UNDERWATER TRENCHING MACHINE



(57) Abstract

A machine for underwater trenching for pipelines in which a sled (1) comprising two pipe loops (2) arranged in vertical planes at opposite sides of the pipeline (4) and interconnected by transverse pipes (3) is supported on and guided for movement along the pipeline by rubber-faced rollers (6, 7, 8, 9). High pressure water is supplied to the loops through connection (20). Nozzles (18) in the front vertical runs of the loops (2) break up the soil in the face of the trench (5). Nozzles (15) of water jet pumps suck soil from the trench through the forwardly facing inlets (11), adjacent the bottom of the sled, of two eductor tubes (10) carried by the loops (2) at opposite sides of the pipeline, and discharge it through discharge outlets (14) directed respectively outwardly sideways and mainly rearwardly of the sled. The water and soil discharge produces a reaction which propels the sled forwards.

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UNDERWATER TRENCHING MACHINE

This invention relates to an underwater trenching machine which will cut a trench under a pipeline and also remove the spoil from the trench to allow the pipeline to fall into the trench under its own weight.

Some underwater trenching machines comprise a sled which is tethered by a cable to a barge which, as it moves forwards on the surface of the sea, pulls the sled along the seabed. With such machines problems arise due to an increase or decrease in the cable tension as the barge rides on the sea. It is therefore desirable to produce the forward propulsion from the sled itself and independent of barge motion. To this end, tractor type machines are known, having hydraulic or electric drive, which are propelled by wheels or endless tracks in engagement with the pipeline itself or the seabed. A problem is to get enough friction between the wheels and the pipe without damaging the latter or its anti-corrosive coating, or, where the tractor drives on the seabed, for the soil to be firm enough to prevent the track sinking into the mud. Another known machine comprises a sled which uses high pressure water jets aimed in the direction opposite to that in which the sled is to move. These jets propel the sled forward. Some jets are aimed forward to cut the trench and others generally upwards to help push the spoil out of the trench, which is assisted by discharging air at the bottom of the sled. The main disadvantage of this system is that in order to get a net forward thrust on the sled more water must be discharged to the rear of the sled than to the front. Also a separate air lift system is required for spoil removal. The efficiency of this type of machine is very low, and decreases with depth of operation.

An object of this invention is to provide an

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underwater trenching machine which overcomes the above disadvantages. To this end, the invention consists in an underwater trenching machine comprising a sled having means for supporting it on and for guiding it for movement along a pipeline, means, e.g. nozzles directing water jets at the face of the trench, to break up soil in the forward path of the sled, and at least one water jet pump of which the water stream discharges into an eductor tube having its inlet adjacent the bottom of the sled and facing in the forward direction of sled movement and its discharge outlet aimed in a sideways outward and mainly rearward direction of the sled.

The high pressure pump jet produces suction in the eductor that lifts the mud out of the trench being cut and discharges it to the side and rear of the trench, the water jet and spoil discharge producing a reaction on the sled in the forward direction which is used to propel the sled forwards. Preferably, the sled is equipped with two water jet pumps of which the eductor tubes discharge to opposite sides respectively of the sled, and mainly rearwardly.

In order that the invention may be more clearly understood, reference will now be made to the accompanying drawing, in which:-

Fig. 1 is a side view of one embodiment of a sled according to the invention, and

Fig. 2 is a plan of Fig. 1.

Referring to the drawing, the sled 1 comprises a frame formed of two loops of pipe 2,2' spaced apart in parallel upright planes by interconnecting pipes 3 to form a kind of saddle which straddles a pipeline 4 to be laid in a trench 5 cut by the sled. The sled rests on the pipeline 4 by transverse rollers 6,7, faced with rubber or other resilient material, mounted between the pairs of front and rear vertical runs of

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the two pipe loops respectively. The sled is further transversely guided on the pipeline 4 by pairs of rollers 8,8', 9,9', also resiliently faced, mounted for rotation about vertical axes at the front and rear of the sled respectively on the pipe loops at opposite sides of the pipeline 4.

The sled also comprises two eductor tubes 10,10' carried from the respective pipe loops 2 and 2'. The inlet ends 11 of the eductor tubes, located adjacent the bottom of the sled, face forwardly and inwardly. Each inlet connects with a vertical section 12 which leads to an elbow 13 connecting with a horizontal discharge section 14,14' which is directed outwardly sideways and mainly rearwardly of the sled, the discharge sections 14,14' extending symmetrically to opposite sides of the sled. In each elbow 13 is a nozzle 15 aimed along the respective discharge section. Water is fed to the nozzles 15 by feed pipes 16,16' which may be interconnected so that only a single hose connection 17 is required. Between each elbow 13 and its discharge section there is preferably a venturi pipe reducer 24, for example from 30 cms diameter to 25 cms diameter, corresponding to the diameters of the tube sections 12 and 14 respectively.

Each front vertical run of a pipe loop 2,2' is provided with nozzles 18 to provide small jets of water aimed at the front of the trench 5. These break up the soil in front of the trenching machine. Further nozzles 19 may be provided along the bottom run of each pipe loop. High pressure water from a pump unit on a barge is supplied to the pipe loops through a hose connection 20 at the top rear end or front end of one of the pipe loops.

The soil loosened by the nozzles 18,19 is removed from the trench through the eductor tubes. The high pressure water streams of the water jet pumps, aimed

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rearwardly along the discharge sections 14,14', create suction in the eductors which lifts the spoil out of the trench 5 via their inlet ends 11 and discharges it to the side and rear of the sled through the discharge sections 14,14'. The reaction of the water jet pump and the spoil propels the sled forwards and keeps it in contact with the trench face, being guided along the pipeline 4.

Minimum negative buoyancy of the machine, for easy diver handling, is achieved by buoyancy tanks 21 at the top of the pipe loops. They also provide an uprighting force to keep the sled upright as it rides along the pipeline 4. Transverse rubber faced rollers 22,23 may also be fitted to the machine, after it has been positioned on the pipeline, to prevent it from lifting. Each tank 21 is provided with a valve in its upper part to allow air to escape, and an open pipe 21' to allow a diver to fill the tank with air after the sled is positioned on the pipeline 4 and the rollers 22,23 locked under the pipeline. The pipes 21' being open prevent the buoyancy tanks from becoming pressurised vessels.

The machine according to the invention has the advantage that the same power that is used for soil removal is also used for propulsion, only one power source being necessary. The spoil removal pressure source does not have to be as high as that needed to cut the trench. This lowers the cost of the pumps required on the barge. Further, the water jet pump efficiency does not decrease noticeably, if at all, with increasing depth of operation. The spoil is also discharged well to the side of the trench being cut.

While a particular embodiment has been described, it will be understood that various modifications may be made without departing from the scope of the invention. For example the machine may be equipped with more than

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one pair of eductors. If desired the spoil removal, propulsion and jetting water can be supplied through a common hose from a single pump source. The hose or hoses may be connected to the front end of one or both of the pipe loops. In another embodiment the soil at the face of the trench may be broken up by a mechanical cutter, or, by a combination of mechanical cutting means and water jets, the loosened soil being removed by the eductors and discharged outwardly and rearwardly to propel the machine forwardly and against the face of the trench being cut. Further the rollers may be moved into or out of their operative positions by hydraulic or other power means and may be replaced by other means which permit the sled to be advanced.

The machine may also be used for laying cables.

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CLAIMS

1. Underwater trenching machine comprising a sled (1) having means for supporting it on and guiding it for movement along a pipeline (4) or the like, and including means for breaking up soil in the forward path of the sled, and means for removal of spoil from the trench, characterised by at least one water jet pump of which the water stream discharges into an eductor tube having its inlet adjacent the bottom of the sled and facing in the forward direction of sled movement and its discharge outlet aimed in a sideways outward and mainly rearward direction of the sled.

2. Machine according to claim 1, characterised by two said water jet pumps and associated eductor tubes of which the outlets discharge to opposite sides respectively of the sled, and mainly rearwardly.

3. Machine according to claim 2, characterised by the inlets of the two eductor tubes being arranged side by side and directed inwardly respectively, as well as forwardly.

4. Machine according to any preceding claim characterised in that the means for breaking up soil in the forward path of the sled comprises nozzles disposed for directing water jets at the face of the trench.

5. Machine according to claim 4, characterised in that the sled comprises a frame formed of two loops of pipe spaced apart in parallel upright planes by interconnecting pipes to straddle a pipeline or the like and provided with rollers to support the sled on and to guide its movement along a pipeline or the like, the loops of pipe having at least one inlet for connection to a source of water

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under pressure, the front runs of the loops being provided with said nozzles for directing water jets at the face of the trench, and further water jet nozzles being provided along the bottom runs of the pipe loops.

6. Machine according to claim 5, characterised in that each pipe loop carries an eductor tube comprising a vertical section having a forwardly and inwardly facing inlet at its lower end adjacent the bottom of the sled and an elbow at its upper end, above the trench to be cut, connected to a horizontal discharge section which is directed outwardly sideways and mainly rearwardly of the sled, the respective discharge sections extending symmetrically to opposite sides of the sled, a water jet nozzle being disposed in each elbow and aimed along its associated discharge section.

7. Machine according to claim 5 or 6, characterised in that the sled is provided with bouyancy tanks at the top of the pipe loops, each tank being provided with a valve in its upper part to allow air to escape and an open pipe in its lower part through which the tank may be charged with air, the sled also being provided with rollers which can be fitted to extend below the pipeline after the sled has been positioned thereon.

8. Underwater trenching machine substantially as described with reference to the drawing.

9. Method of underwater trenching by advancing a sled along a pipeline or the like to be laid in the trench, breaking up soil in the forward path of the sled, and removing spoil from the trench as the sled advances, characterised by removing the spoil from the trench by

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a water jet pump which produces suction at the inlet of an eductor adjacent the bottom of the trench and discharges the spoil to the side and rear of the trench, and propelling the sled forwards by the reaction of the water jet and spoil discharge.

10. Method according to claim 9, characterised by breaking up soil in the forward path of the sled by directing water jets at the face of the trench.

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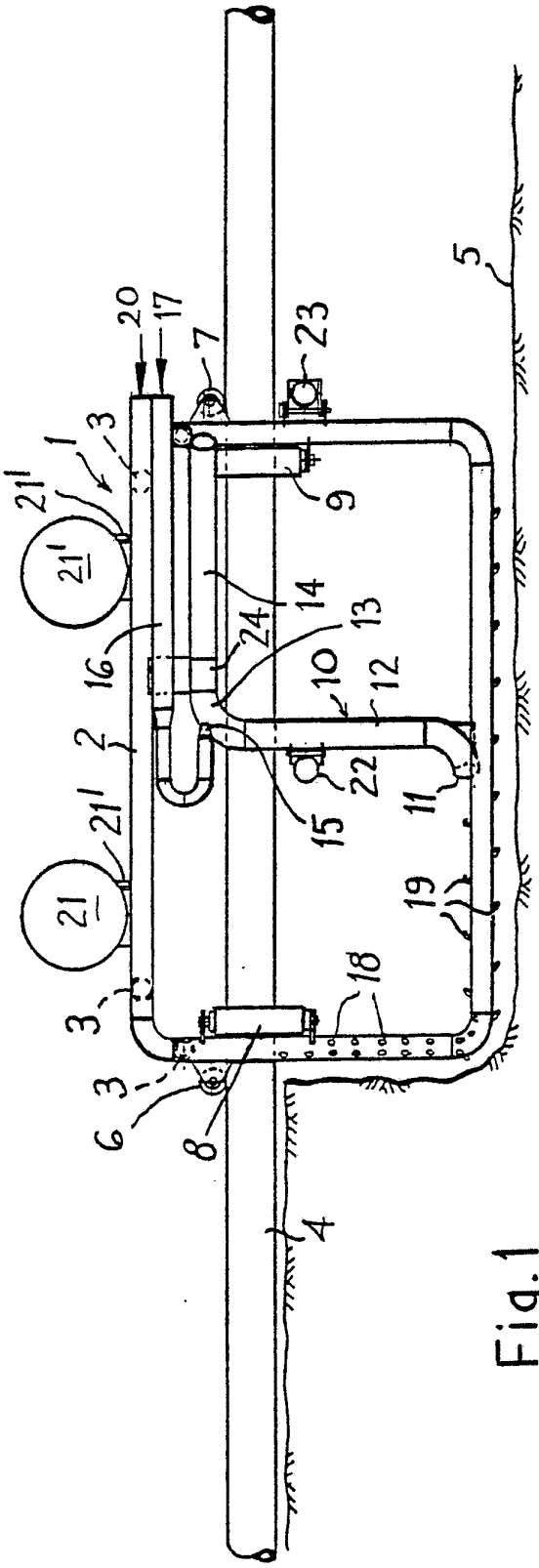


Fig.1

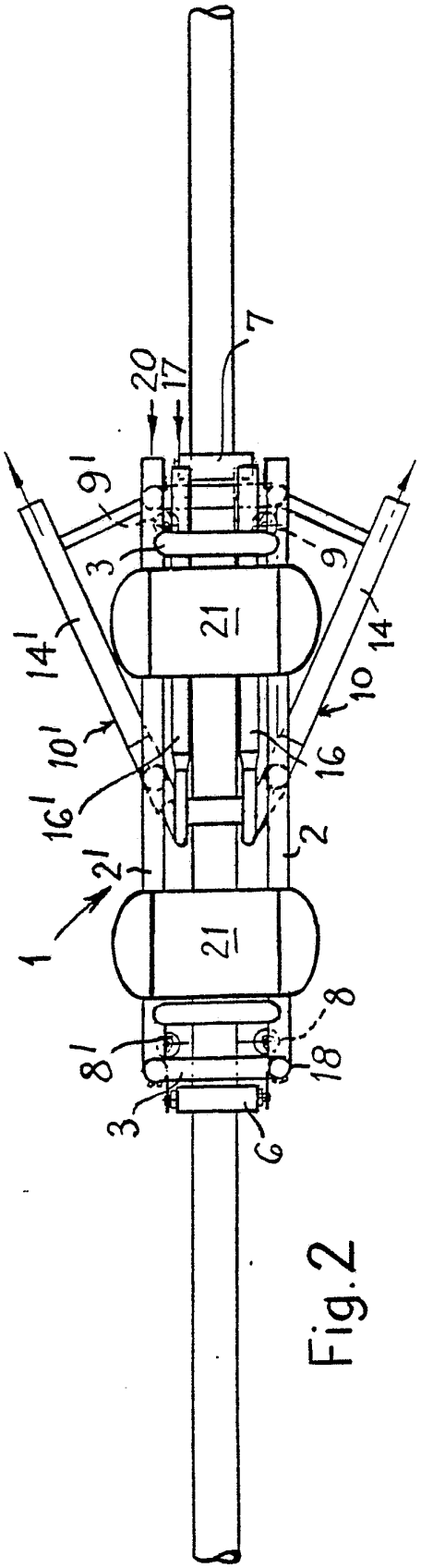


Fig.2

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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 83/00162

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[3]: E 02 F 5/10

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC[3]	E 02 F -

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X,Y	US, A, 4087981 (NORMAN) 9 May 1978 see column 4, line 4 - column 7, line 5	1-10
Y	US, A, 3576111 (HENRY) 27 April 1971 see the entire document	5,9,10
X	GB, A, 1479459 (MOBELL) 13 July 1977 see the entire document	1-10
A	US, A, 4114390 (SHELL) 19 September 1978 see the entire document	5

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
25th August 1983	15 SEP. 1983
International Searching Authority [1]	**Signature of Authorized Officer** [20]
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 83/00162 (SA 5451)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 08/09/83

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 4087981	09/05/78	US-A-	3877237	15/04/75
		US-A-	3926003	16/12/75
US-A- 3576111	27/04/71	None		
GB-A- 1479459	13/07/77	None		
US-A- 4114390	19/09/78	None		