Nov. 9, 1971 J. D. PIPKIN 3,618,236

APPARATUS FOR DIGGING AN UNDERWATER TRENCH

Filed May 19, 1969 2 Sheets-Sheet 1

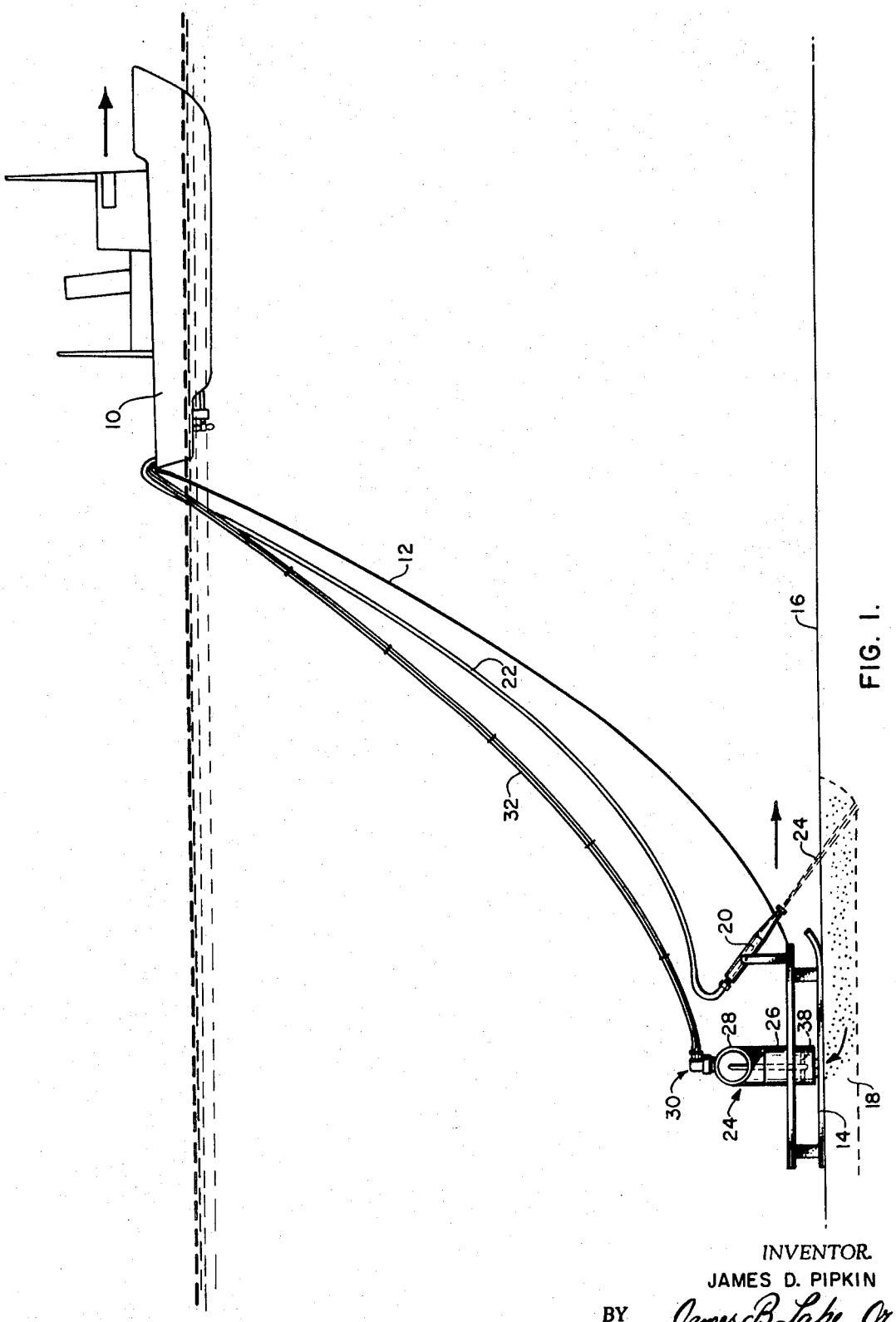


FIG. 1.

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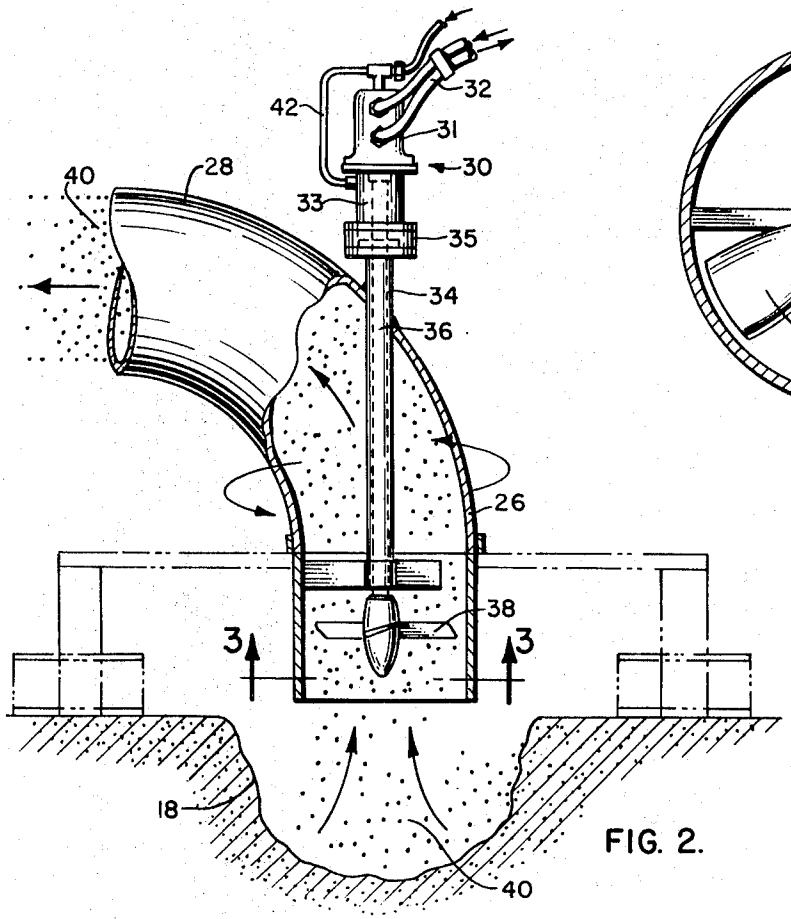


FIG. 2.

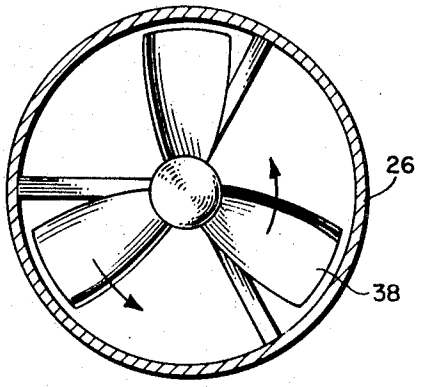


FIG. 3.

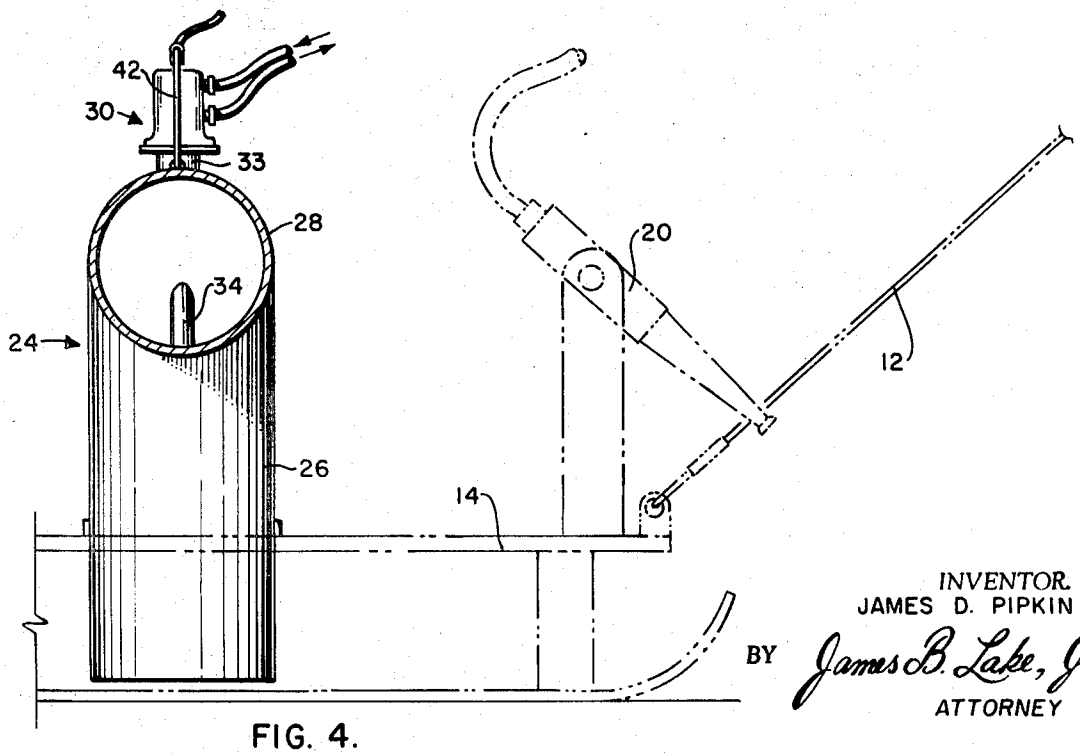


FIG. 4.

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United States Patent Office 3,618,236
Patented Nov. 9, 1971

3,618,236

APPARATUS FOR DIGGING AN UNDERWATER TRENCH

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Filed May 19, 1969, Ser. No. 827,481
Int. Cl. E02f 3/88
U.S. Cl. 37—63 5 Claims

ABSTRACT OF THE DISCLOSURE

The combination of a towing ship and a towed underwater trench digging apparatus, and a suction and discharge mechanism mounted on said towed digging apparatus for sucking up and discharging the debris of digging to one side of a trench as it is dug, and the method of removal of digging debris in underwater trench digging with approximately little or no discharge conduit for any depth of water.

The invention relates generally to burying underwater pipelines and more particularly to the apparatus for and method of digging an underwater trench to accommodate a pipeline.

It is old in the art to dig underwater trenches by mounting high pressure nozzles on a form of underwater conveyance, usually in the form of a sled, and towing it along the bottom along the line of the prospective trench by means of a surface vessel. The towing vessel provides the pressure to the high pressure nozzles and mounts suction pumps for sucking up the bottom debris dislodged by the high pressure nozzles. The pumps are connected to the sled by a large conduit, sometimes as much as thirty inches in diameter, and as long at least as the water is deep to keep the dislodged material from settling back in large part into the trench.

It is an object of the invention to dig trenches in water of any desirable depth in the sea bottom with the use of little or no discharge conduit for the removal of bottom debris and thereby substantially reducing the size and drag of the debris-removal conduit and the size and power of the towing vessel.

Another object of the invention is to provide a suction and discharge mechanism capable of operating under water.

Other objects and a fuller understanding of the invention can be had by referring to the following description, claims, and drawings in which:

FIG. 1 is a side view of the apparatus in combination constituting the invention;

FIG. 2 is an enlarged view, partially cut-away, in transverse cross-section of the underwater apparatus;

FIG. 3 is an enlarged sectional view taken along section lines 3—3 of FIG. 2; and

FIG. 4 is a side elevation of a part of the underwater apparatus showing the relative position of the high pressure nozzle and the suction and discharge mechanism with angular conduit and motor driven propeller.

The apparatus of the invention comprises a towing vessel **10** connected to towing cable **12** to an underwater conveyance or sled **14** which is towed by said vessel **10** along the sea bottom **16** in the line of the prospective trench **18**. A high pressure nozzle **20** is mounted on the forward part of the sled **14** and connected to a source of high pressure on the towing vessel **10** by high pressure line **22**. The jet **24** from nozzle **20** is directed downward against the sea bottom **16** and blasts debris for the depth of the trench loose from the sea bottom. An L shaped debris conduit **24** having a vertical leg **26** and a horizontal leg **28** is mounted on the sled **14** aft of the high pressure nozzle **20** by its vertical leg **26** for rotation

through 180 degrees aft from one side of the sled to the other. A hydraulic motor **30** is vertically mounted on and in conduit **24** and connected by a pair of high pressure hydraulic lines **32** to a source of hydraulic power in the towing vessel **10**. The above arrangement of parts and connections is shown in FIG. 1 and FIG. 4. Any type of water-proofed motor may be used for which power can be provided.

Referring to FIG. 2 the hydraulic motor **30** comprises the motor **31** proper having a depending sleeve **34** and inside the sleeve a drive shaft **36** driven by said motor at its top end and rotating a propeller **38** at its bottom end. The sleeve **34** and the enclosed drive shaft **36** make a closed entrance into the vertical leg **26** at the bend of the conduit **24** and are adapted to create by means of the propeller **38** a strong suction that draws up debris **40** in the trench **18** into said vertical leg **26** and discharges it out of the horizontal leg **28** to one side of the trench. FIG. 3 shows a bottom view of the propeller mounted in the bottom end of the vertical leg **26**. Intermediate the depending sleeve **34** and the motor proper **31** a seal and coupling chamber **33** and a thrust bearing chamber **35** is provided to maintain the water-tight integrity of the motor proper and to absorb the thrust of the propeller **38**. A high-pressure line connects the motor proper with the seal chamber. This high pressure line **42** carries hydraulic fluid at pressures in excess of those due to the depth of water in which the apparatus is operating, and thus keeps salt water out if a leak should occur.

Debris from the trench can be deposited on either side of the trench by the rotational mounting of the vertical leg **26** on the sled. Depositing on the current side would cause the pipe line to be covered quickly, and depositing on the lee side would cause the trench not to fill up as fast.

With sufficient flow velocity, the conduit **24** can be advantageously changed in shape by cutting off the horizontal leg **28** back from approximately 90 degrees at the angle of approximately 60 degrees between said legs **26** and **28**. The advantages are in reducing weight and in directing the debris discharge slightly upward as well as transverse to the trench to create a cloud of dirty water extending to the surface to thereby indicate to surface personnel that the debris removal mechanism is working.

What is claimed is:

1. Apparatus for digging an underwater trench, said apparatus for use in cooperation with a towing ship having a source of high pressure hydraulic fluid and comprising in combination: an unpowered conveyance adapted to being towed by an end on and over a sea bottom by said towing ship; an hydraulic nozzle mounted on the towed end of said conveyance and operably connected to a source of high pressure hydraulic fluid and adapted to direct jet stream of said hydraulic fluid to break up the sea bottom forward of said conveyance for the desired trench depth; an angular conduit having a cylindrical vertical leg defining a bottom intake opening mounted on said conveyance by said vertical leg aft of said hydraulic nozzle and in the line of towing therewith, said intake opening opening on and adjacent to the sea bottom, and said angular conduit having an angular leg defining a discharge opening above said intake opening and transverse said line of towing; an hydraulic motor mounted on said angular conduit and having a drive shaft mounted in and coaxial with said vertical leg, said motor being operably connected with a source of high pressure hydraulic fluid on said towing ship for driving said drive shaft in rotation; a propeller mounted on said drive shaft for rotation therewith in said vertical leg and adjacent the intake opening and adapted to draw sea water in said intake opening and expel it out of said discharge opening, whereby the sea bottom in the line of towing is broken by said

jet stream of hydraulic fluid from the nozzle and is sucked up in the bottom intake opening and discharged transversely thereto through the discharge opening to form an underwater trench.

2. Apparatus for digging an underwater trench as described in claim 1 wherein said angular conduit is mounted for rotation around the vertical leg to position the angular leg at any transverse angle to the line of towing.

3. Apparatus for digging an underwater trench as described in claim 1 wherein said angular leg is normal to said vertical leg.

4. Apparatus for digging an underwater trench as described in claim 1 wherein said angular leg makes an angle of 120 degrees with said vertical leg to throw discharge from the discharge opening upward thereby discoloring surface sea water to indicate the continued operation of the apparatus to the towing ship.

5. Apparatus for digging an underwater trench as described in claim 1 wherein said hydraulic motor comprises: a depending seal and coupling chamber watertightly enclosing its underside; and a hydraulic pressure line carrying higher hydraulic pressures than those due

to depth of water connecting said motor with said chamber whereby said chamber if leaking leaks outwardly to prevent salt sea water from entering.

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U.S. Cl. X.R.

37—65