United States Patent [19]

Faldi

[11] **3,803,856**

[45] **Apr. 16, 1974**

[54] **PROCESS AND APPARATUS FOR ACHIEVING THE MECHANICAL TRENCHING OF A PIPE-LINE IN A SUB-AQUEOUS DEPTH**

[76] Inventor: **Giovanni Faldi,** via Forese Donati, 27, Firenze, Italy

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[21] Appl. No.: **209,649**

[52] **U.S. Cl.** **61/72.4,** 37/63

[51] **Int. Cl.** **F16l 1/00,** E02b 5/02, E02h 3/88

[58] **Field of Search** 61/72.4, 72.3, 72.1, 72.2; 37/54, 55, 58, 61, 62, 63, 193

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Primary Examiner—Dennis L. Taylor

Attorney, Agent, or Firm—Karl W. Flocks

[57] **ABSTRACT**

The invention relates to a process and apparatus for the mechanical entrenching of a pipe-line in a sub-aqueous bed, wherein two or more dredging devices are positioned at the two sides of the pipe-line and a bridging framework is provided connecting said dredging devices, said framework being pulled astride the pipe-line while the dredging devices are in action, so that the pipe-line, aided by its own weight, sinks slowly into the trench as it is being dug.

5 Claims, 4 Drawing Figures

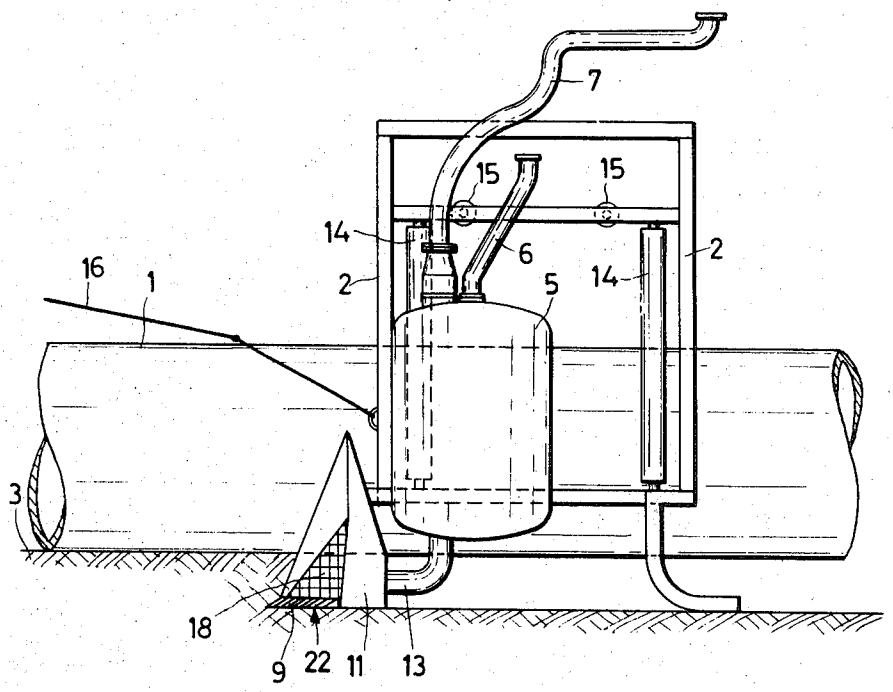


Fig.1

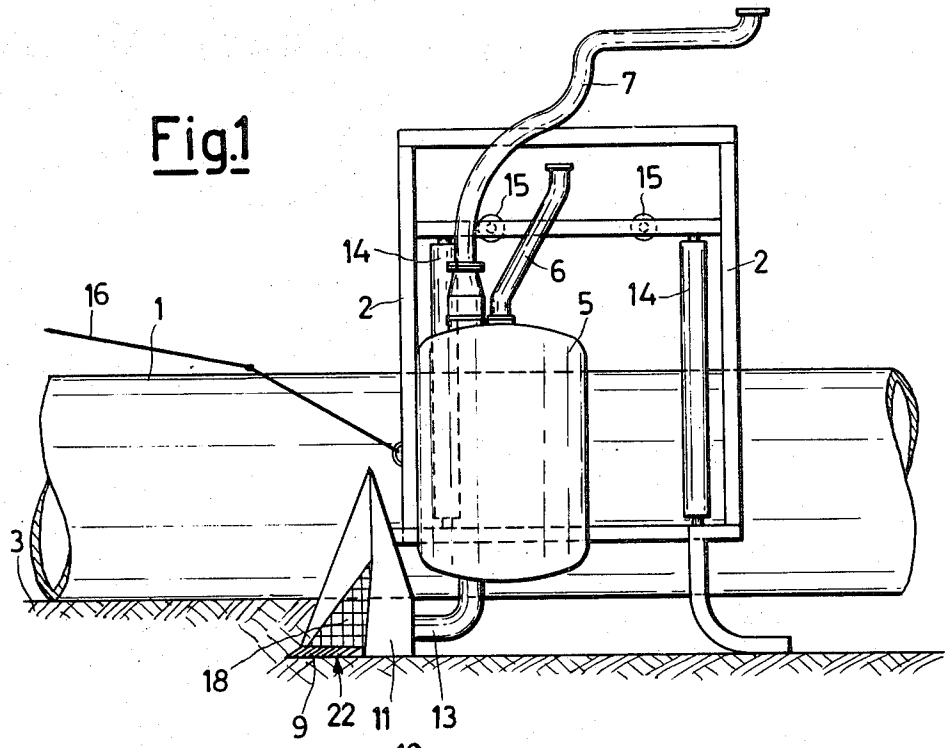
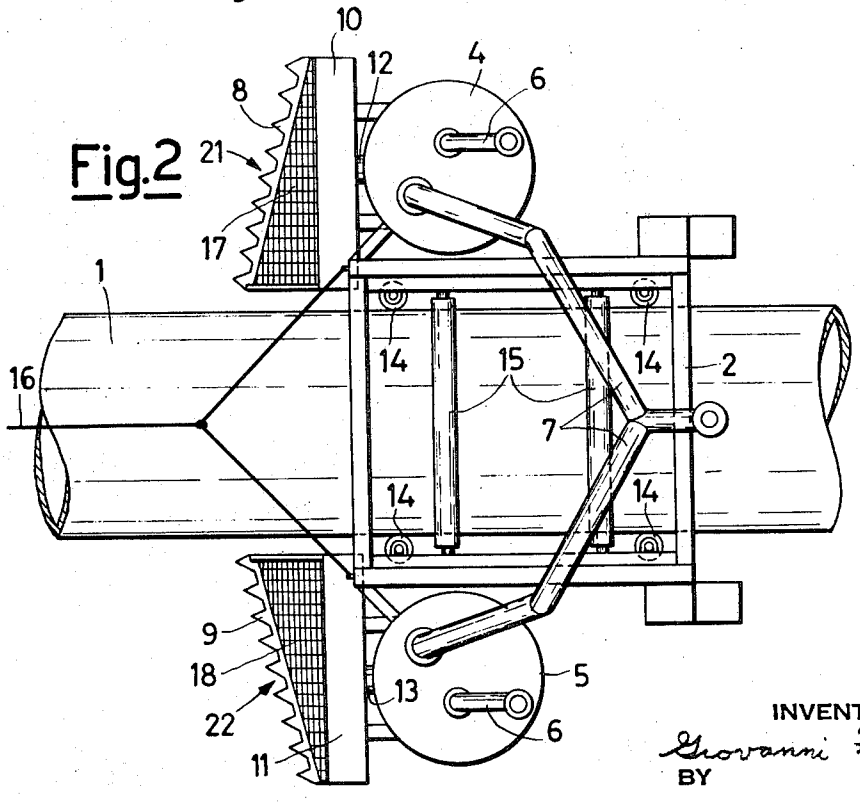


Fig.2



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Fig.3

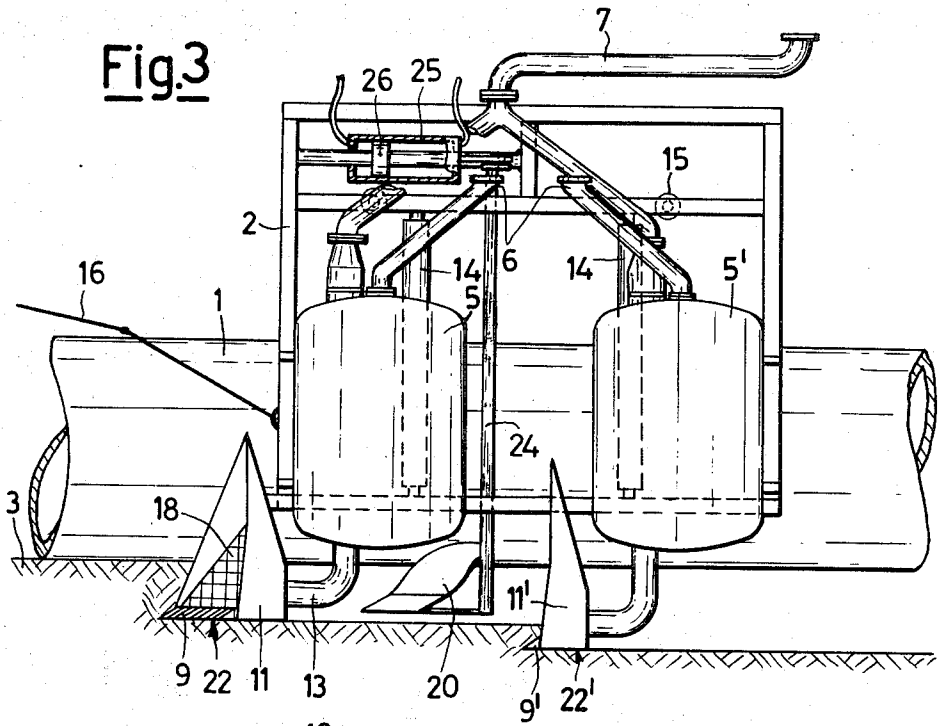
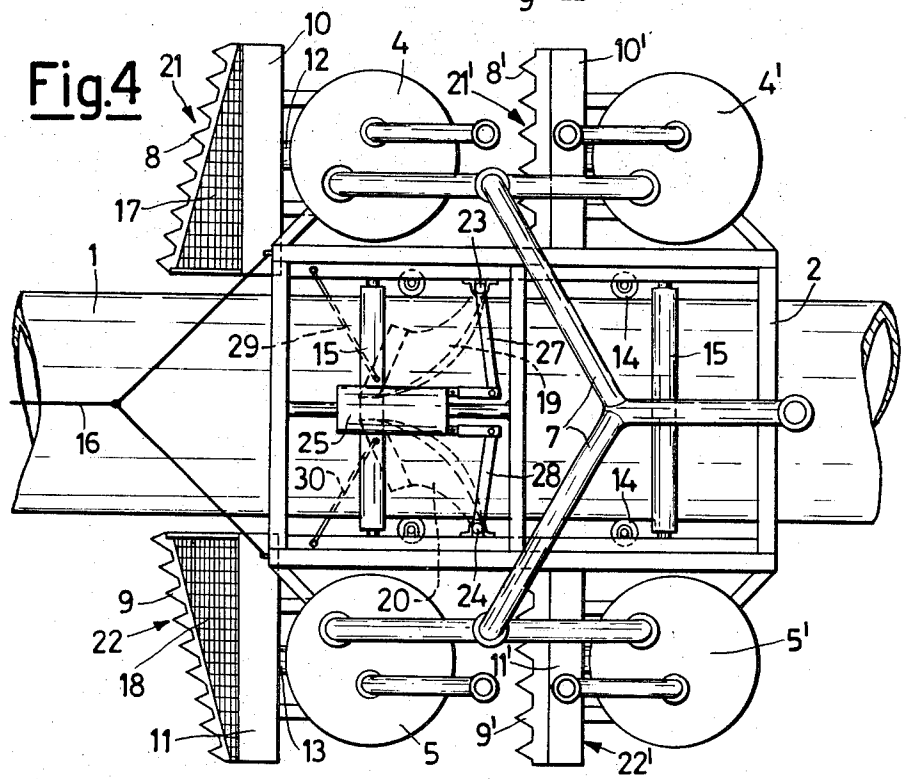

7
26
25
15
2
6
14
14
5'
16
1
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3
18
11'
9
22
11
13
20
9'
22'

Fig.4


10
12
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21'
8'
4'
8
17
23
1
2
29
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27
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22'

PROCESS AND APPARATUS FOR ACHIEVING THE MECHANICAL TRENCHING OF A PIPE-LINE IN A SUB-AQUEOUS DEPTH

It is known that to-date the problem of trenching a pipe-line in the sea, in lakes, in rivers, etc. is generally solved by first excavating a trench of suitable dimensions and depth in the sub-aqueous depth itself and then lowering into said trench the pipe-line in sections that can be prepared ahead of time at the side of the dredging zone and assembled directly in the trench itself.

Evidently this type of work presents many difficulties in that it is performed in two completely separate operations, the second of which (installing the pipe) presupposes perfect performance and difficult maintenance of the trench already excavated.

Because of the movement of the water due to currents, sea-storms or other, very often the trench can be partially or completely filled in before the installation of the pipe can take place.

The work therefore must be repeated a number of times and above all does not guarantee that the pipeline itself will be supported on the bottom of a trench having a uniformly level surface.

The object of the present process is not only that of decreasing the labor time but also of guaranteeing a perfect leveling of the trench on which the pipe-line rests thus obviating all the inconveniences of a poor installation, whose principle consequence might be possible damage to the pipe-line itself or in some instances a bad functioning of the high pressure pipe through the presence of air bubbles or other phenomenon due to a trench not consistently level.

The process which is the subject of the invention, for said purpose, is characterised by the fact that it consists in placing at the two sides of the pipe-line, resting in advance on the sub-aqueous bed, two or more dredging devices (at least one on each side), connecting said devices through means of a bridging framework, pulling astride the pipe-line said framework guided along the pipe-line itself while the devices are in action, in such a manner that the pipe-line, aided by its own weight, sinks slowly into the trench as it is being dug.

The apparatus required to achieve said process, in addition to the bridging framework and the pair(s) of lateral dredging devices, contains rollers or other guiding members both vertical and horizontal, which hold the framework next to the pipe-line during the movement.

According to a preferred embodiment, each of the two or more dredging devices is of the type comprising a compressed-air pump with cylindrical chamber furnished with inlet and outlet valve operated by remote control through means of a suitable distributor from a source of compressed air as described and illustrated in the U.S. Pat. No. 3,624,933 of the Applicant, and toothed showels and casings to break up the trench bottom in the forward direction and suck up the mud, throwing it far away.

A further characteristic of the apparatus consists in fixing to the framework one or more blades or plows or other auxiliary disintegrating members which serve the purpose of breaking up, where necessary, the central core of the trench bottom which develops between the dredging devices, in the event said core has substantial solidity, as in such an instance said core could prevent

the sinking of the pipe-line in spite of the lateral excavations. The auxiliary disintegrator absolutely avoids this danger.

The pulled framework is furnished, as already stated, with idle rollers both vertical and horizontal which serve to guide the framework itself along the pipe-line on which they ride. Such rollers can be rendered movable in the sense of widening their normal distance, either through control from the barge or dragging craft or through other means, either by springs or manually, so that the presence of possible flanges on the pipe-line (incase the sections are not welded) do not offer insurmountable obstacles which might otherwise stop the pull of the framework and therefore the work.

It should be pointed out moreover that the front part of the digging showel is normally equipped with a steel grill in order to avoid the intake of particularly large foreign bodies that could block the inlet opening of the pump.

Such grills could be made particularly robust and inclined toward the outside so that, during the pulling, possible pieces too large to pass through the grill might slide toward the outside without obstructing the passage of material through the grill. Automatically such pieces would be forced to fit themselves into the bank of material forming the external walls of the dredged channel.

For greater clarification two embodiments of the invention have been shown, as examples, in the attached drawings, in which:

FIG. 1 shows a schematic elevation view of an arrangement having two pump casings only;

FIG. 2 shows a plan view of the same;

FIG. 3 shows a schematic elevation view of an arrangement featuring two pairs of pumps in tandem;

FIG. 4 shows a plan view of the same.

The equipment illustrated in FIGS. 1 and 2 is essentially composed of a framework 2 that can descend in the water remaining astride the pipe-line 1 that has been previously brought to rest on the sub-aqueous bed 3. Said framework supports two dredging pump casings 4 - 5, one on each side, the pump casings being provided with suction and delivery valves controlled by compressed air sent through the pipes 6, while the discharge pipes for the wet mud are indicated at 7. However, the complete description of the pumps is omitted, in that they are already the subject of the U.S. Pat. No. 3,624,933 of the same Applicant. The casings 4 - 5 are fitted individually with excavating blades 21 - 22 provided with teeth 8 - 9 and with collecting casings 10 - 11 on whose bottom emerge the suction pipes 12 - 13. On the framework 2 are indicated schematically some idle rolls 14 rotating on vertical axles, and horizontal rolls 15 rotating on horizontal axles, which have the purpose of guiding the framework 2 along the sides of the pipe-line 1 during the pulling which a barge (not shown) effects on the framework through means, for example, of cable 16.

If it is a question or if there is a possibility of encountering a depth containing rather large pebbles and stones that could not pass through the pump casings, every casing is equipped with a front robust grill 17 - 18 inclined toward the outside so as to cause the large pebbles to remove themselves.

An important feature consists of the possible presence of two or more disintegrating knives or plows as

19 - 20 (FIGS. 3 and 4) which are carried by the same framework.

In the event in fact that it is necessary to dredge very compact material such as clay, it might occur that below the tube there remains a certain thickness of clay that does not easily permit the tube to descend.

While this danger does not exist in the case of mud, sludge, or sand, it can in effect happen in the presence of clay, and in this event provision is made for one or two knives or plows more or less in the central part of the steel framework and which, controlled possibly from above by means of tie-bars, compressed-air or hydraulic pistons, or other, cause such plows to move toward the inside, below the tube to be entrenched, so as to draw the compact material into the zone where the pumps can operate easily.

In the case of the pump with two casings it will be necessary to effect a second pass to dredge the material that was present first under the tube and which the plows themselves have moved toward the outside, that is, into the two dredged channels.

In the case that a pump with three casings be mounted on the framework, a single plow placed in such a manner as to convey the material in front of the third pump casing placed in the rear will be sufficient.

FIGS. 3 and 4 show the case in which the framework is used for the sinking of a pump with four pump casings 4 and 5 and 4' and 5', at the head of which are four excavating blades 21 - 22 - 21' - 22' provided with teeth 8 - 9 - 8' - 9' and with collecting casings 10 - 11 - 10' - 11'. In such an event nothing changes in the process in general, outside of the fact that the two rear casings 4' and 5' can very well assure the suction of the material broken up by knives 19 - 20 and thus successive passes can be omitted.

The knives, here shown secured to torsion bars 23 - 24 moved by a cylinder 25 - piston 26 group through means of arms 27 - 28 and further provided with flexible limit stop cables 29 - 30, can also be replaced, if desired, by other disintegrating means, such as revolving helical blades, and the like, according to the consistency of the sub-aqueous bed, and furthermore can be driven or not; or can be replaced with high-pressure jets of water or compressed air.

Also the rollers can be spring-loaded or controlled either from the barge or with other means when the framework is pulled along a pipe-line which contains flanges or other projections which could interfere with the work.

Evidently the framework will be of such a height as to permit the sinking of the pump casing without bearing with its own weight (except possibly in the last part of the sinking itself, when the rollers 15 come to rest on the pipe-line) on the pipe-line so as not to cause damage, for example on the pipe covering. The equipment dredges the bed at the sides of and below the pipe-line previously resting on the bed where it is to be entrenched.

It is evident therefore that, in possibly executing several dredging passes by pulling the apparatus on a stretch of sufficient length, the pump with its dredging action will remove at the sides and beneath the pipe-line a certain quantity of material such that the tube, aided by its own weight, will descend slowly and uniformly into the trench.

The inlet openings of the pump-casing chambers, chambers that may be two or more than two, can be positioned more or less in the vicinity of the pipe according to whether the material is more or less crumbly (sand or sludge more or less compact, etc.).

The attached drawings show a type of pump with two or four chambers, but obviously the installation itself can also be constructed with three chambers, the third of which, placed on the rear and asymmetrically will accomplish a cleaning up job.

In this case, if placed for example to the left along the direction of the dredging, it will produce a greater ditching on the left side, along which automatically the pipe-line will tend to lower without however causing any damage, in that — as stated above — the dragging movements executed by a floating craft will have a length and depth dimensioned in accordance with the coefficient of flexibility of the pipe-line employed.

It is not to be excluded that the same process with suitable equipment can be used for the entrenching of a pipe-line on land that is not sub-aqueous.

What is claimed is:

1. Apparatus to achieve the mechanical entrenching of a pipe-line in a sub-aqueous bed comprising a bridging framework, carrying on its two sides dredging means and guiding elements attached thereto suitable for the pulling with a movement substantially in the direction of the axis of the pipe-line to be entrenched and for the dredging at the sides of the pipe-line that gradually becomes entrenched, each of said dredging means including pumps with at least one chamber submerged and furnished with suction and delivery valves and piping connecting with an air compressor through a suitable distributor, the casing of said pump being rigidly joined to an excavating and dredging shovel with teeth and posterior hopper, and said suction valves being joined to openings which are provided substantially at the bottom of a hollow in said shovel.

2. Apparatus as in claim **1**, characterized by the fact that said framework has said guiding elements including guide rollers rotatable on vertical axes and others rollers rotatable on horizontal axes, whereby said rollers maintain or bring back the framework to its normal dredging position.

3. Apparatus as in claim **1**, characterized by the fact that said guiding elements include means to control said elements to assume a working position and to draw away momentarily when said framework encounters flanges and/or projection.

4. Apparatus as in claim **1**, characterized by the fact that in front of said dredging means are placed grills inclined toward the exterior whose meshes do not let pass toward the suction openings pebbles or stones too big to pass through but cause said pebbles or stones instead to slide toward the exterior.

5. Apparatus as in claim **1**, characterized by the fact that on the lower part of said supporting framework are mounted at least two breaking-up elements which serve to break up, where necessary, the core of the bed immediately beneath the pipe-line in the event of excessive compactness, said breaking-up elements acting at a height below the supporting level of the pipe-line on the bed.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,803,856 Dated April 16, 1974

Inventor(s) GIOVANNI FALDI

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title page, left column, after "Appl.No.: 209,649"

insert the following caption

FOREIGN APPLICATION PRIORITY DATA

December 21, 1970 Italy 33,329 A/70

Signed and sealed this 10th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.