United States Patent [19]

Shaw

[11] **3,775,985**

[45] **Dec. 4, 1973**

[54] **APPARATUS FOR LAYING SUBMARINE PIPELINES**

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[52] **U.S. Cl.** **61/72.1**, 61/72.3

[51] **Int. Cl.** **F16l 1/00**

[58] **Field of Search** 61/72.1, 72.3

[56] **References Cited**

UNITED STATES PATENTS

3,524,326 8/1970 Graste 61/72.3

FOREIGN PATENTS OR APPLICATIONS

1,492,277 7/1967 France 61/72.3

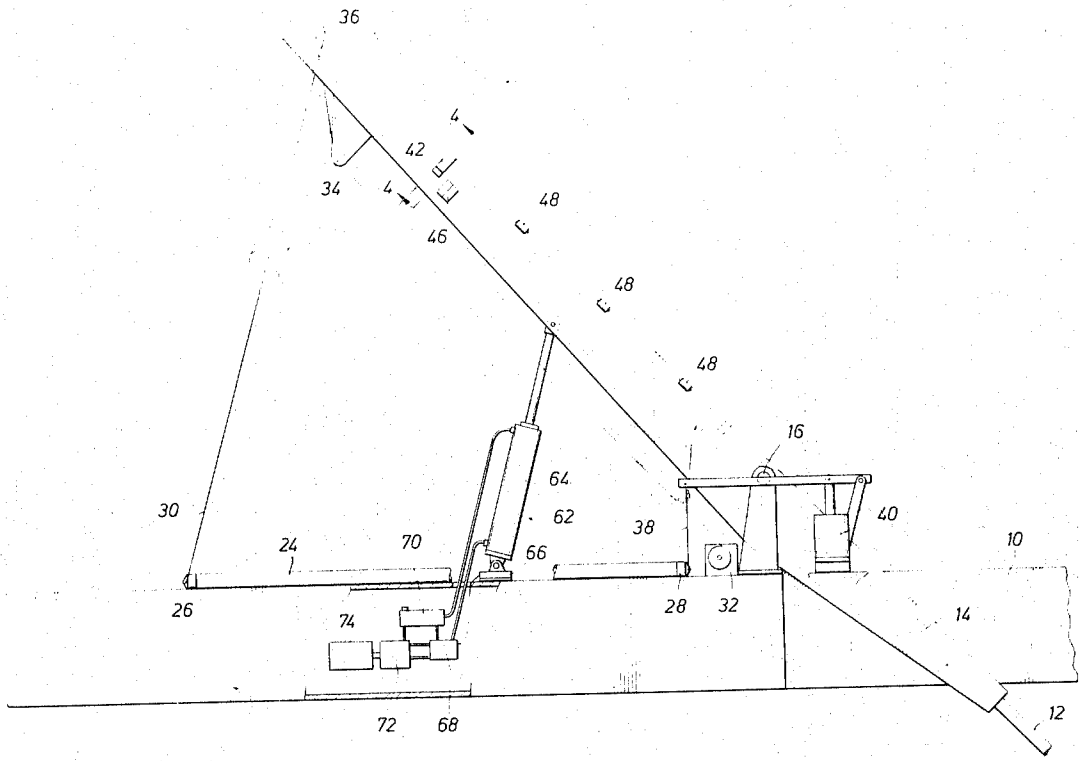
Primary Examiner—Jacob Shapiro

Attorney—Tom Arnold et al.

[57] **ABSTRACT**

On a submarine pipeline laying barge having a pivoted inclined ramp for paying out the pipe string in a single catenary manner, a dampener is provided to reduce the movement of the ramp relative to the barge. Means are also provided to lock the ramp relative to the barge when a new section of pipe is on the ramp. The new sections of pipe are handled by means of cables secured to removable swivel caps on each end and controlled from a single operator's console.

7 Claims, 6 Drawing Figures



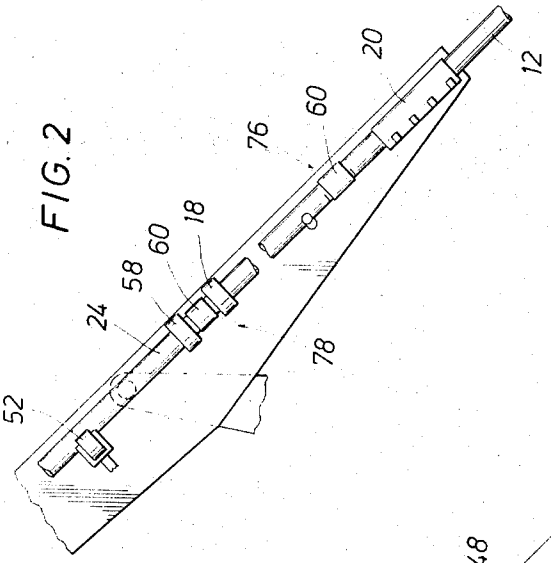

20
12
76
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FIG. 2

12
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48
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66
4
4
42
46
36
34
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30
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FIG. 1

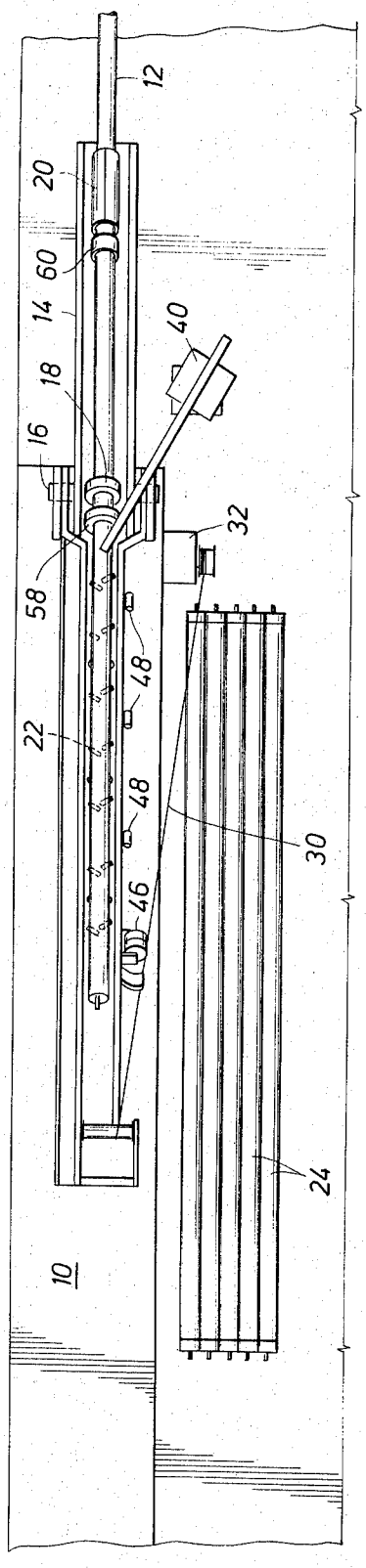

FIG. 3

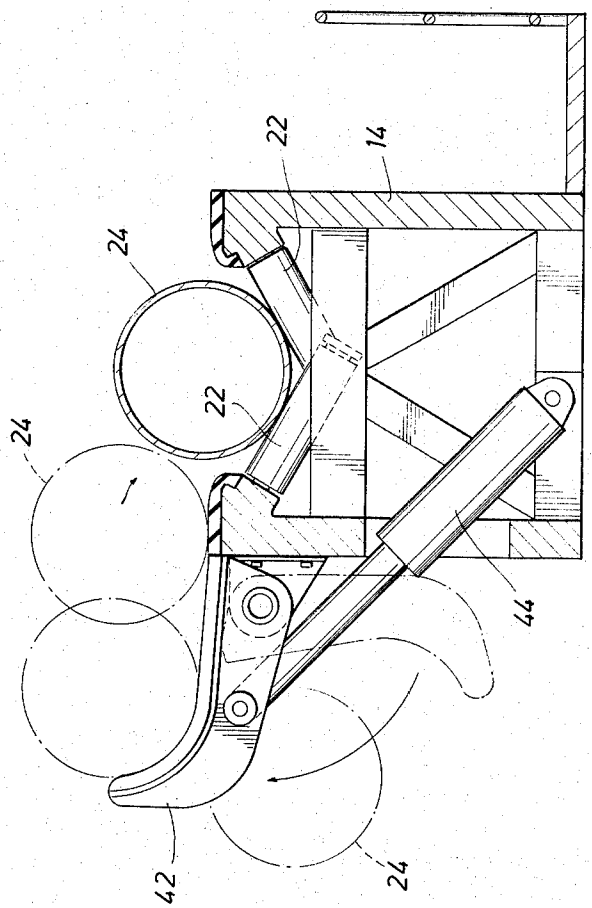

FIG. 4

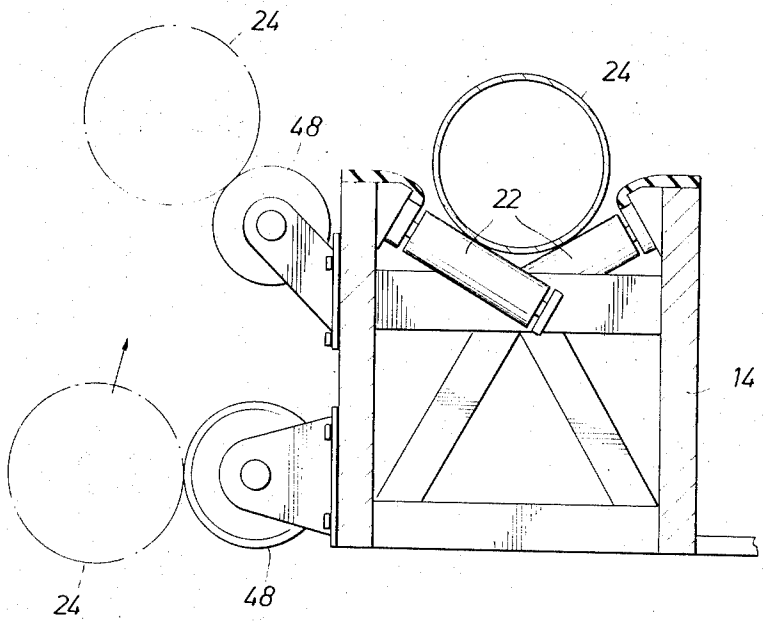

FIG. 5

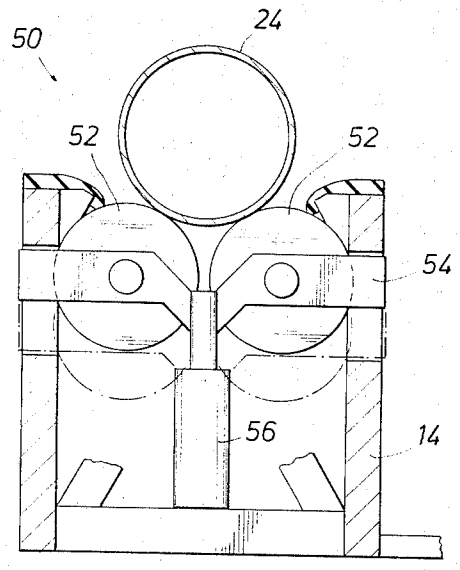

FIG. 6

APPARATUS FOR LAYING SUBMARINE PIPELINES

BACKGROUND OF THE INVENTION

This invention relates generally to apparatus for use in laying a submarine pipeline, and more particularly to apparatus especially suitable for laying a deep water submarine pipeline from a lay barge or other marine vessel.

As disclosed in United States patent application Ser. No. 207,477, filed by Charles E. Young on Dec. 13, 1971, now abandoned, for "Method and Apparatus for Laying Submarine Pipelines", there are, broadly speaking, three prior art techniques for laying submarine pipelines, which techniques are sometimes referred to as (1) the "double catenary" or "horizontal" technique, (2) the "vertical" technique, and (3) the "single catenary" or "inclined" technique, according to the configuration of the pipe string during the laying operation.

In the single catenary technique, the pipe string is payed out from the barge at an inclined angle with respect to the surface of the water, and the pipe string thus payed out will generally follow an inverted catenary from the barge to the bottom. For purposes of this invention, the single catenary or inclined technique shall mean a technique in which the suspended pipe string either follows a true inverted catenary or is like a flexed beam with the lower end tangential with the submerged bottom.

Examples of prior art apparatus for laying submarine pipelines according to the single catenary technique are U. S. Pat. No. 3,585,806, issued to Lawrence on June 22, 1971; U. S. Pat. No. 3,524,326, issued to Craste on Aug. 18, 1970; and U. S. Pat. No. 3,389,563, issued to Postlewaite on June 25, 1968.

The patent to Postlewaite discloses a freely pivotally mounted ramp to facilitate the joining of new sections of pipe to the pipe string already suspended from the barge. However, a floating or freely pivotally mounted ramp, such as disclosed in Postlewaite, is subject to excessive movement relative to the barge during rough water. Moreover, problems may be encountered when a new section of pipe is placed on a floating ramp since the weight of that section of pipe acting upon the ramp tends to apply a bending force on the upper end of the suspended pipe string. Also, the prior art mechanisms for loading a new section of pipe onto an inclined ramp on a submarine pipeline laying vessel are impractical.

SUMMARY OF THE INVENTION

Many of the problems of the prior art single catenary systems for laying a submarine pipeline may be solved by providing suitable dampening means on a pivotally mounted ramp. A further aspect of the present invention is to provide means for locking the ramp in place when a new section of pipe is resting thereon. A still further aspect of the present invention is to provide a unique cable system for loading new sections of pipe onto an inclined ramp on a submarine pipeline laying vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. **1** is an elevation view of a portion of a lay vessel including the present invention;

FIG. **2** is a detail elevation view of a portion of the present invention;

FIG. **3** is a plan view of a portion of a lay vessel including the present invention; and

FIGS. **4-6** are elevation detail views of certain aspects of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference characters designate identical or corresponding parts throughout the several views, and more particularly to FIGS. **1** and **3** thereof, there is shown a portion of a submarine pipeline laying vessel, such as a barge **10**, from which there is suspended a pipe string **12** secured at its upper end to the barge via a ramp **14** pivotally mounted thereon at **16**.

The pipe string is secured to the ramp primarily by means of a conventional slip elevator **18** secured to the ramp by any convenient means. A rubber-lined releasable pipe-gripping clamp **20** suitably secured to the ramp may also be used as a secondary means for holding the upper end of the suspended pipe string.

Disposed at spaced points along the upper portion of ramp **14** are a plurality of cradle rollers **22** freely rotatably mounted on the ramp as shown in greater detail in FIG. **5**. The cradle rollers provide the downward rolling support for a new section of pipe **24** on the ramp ready to be joined to the suspended pipe string.

According to the preferred embodiment, this invention contemplates the use of screw-threaded pipe, but it should be apparent that certain aspects of the present invention are equally applicable to other types of pipe couplings.

When it is desired to add a new section of pipe to the pipe string, the first step is to load the new section of pipe onto the ramp so that the new section can be joined to the upper end of the suspended pipe string. The first step is to screw first and second threaded swivel caps **26** and **28** to each end of the new pipe section **24**. A first cable **30** from a winch **32** secured to the deck of the barge is secured to swivel cap **26** after passing under roller **34** and around roller **36** at the upper end of the ramp. A second cable **38** is secured to cap **28** and a crane **40** secured to the deck of the barge. The controls for winch **32** and barge **40** are conveniently positioned adjacent one another so that a single operator may maneuver both devices and conveniently raise the new section of pipe for loading onto the ramp.

Although it is quite apparent that the lower end of the new section of pipe can be readily positioned onto the ramp by the crane, the upper end of the new section of pipe is positioned on the ramp in two phases. In the first phase, the upper end of the new section of pipe is raised to the approximate level of the upper end of the ramp. Then, as most clearly shown in FIG. **4**, an arm **42** pivotally mounted to the upper end of the ramp is hydraulically actuated by means of a hydraulic piston-cylinder mechanism, which is pivotally secured to the ramp and the arm, to roll the new section of pipe onto the ramp. As shown in FIGS. **1** and **3**, a suitably resilient bumper, such as rubber tires **46**, is secured to the ramp proximate arm **42** to prevent excessive impact be-

tween the ramp and the new section of pipe. As shown most clearly in FIGS. **1, 3,** and **5,** rollers **48** are positioned along the side of the ramp to aid in rolling the new section of pipe onto the ramp.

After the new section of pipe is positioned on the ramp, swivel cap **28** on the lower end thereof is removed therefrom; and the new section is held from rolling downward on cradle rollers **22** by means of winch **32** and cable **30.** Winch **32** is then actuated to lower the new section of pipe until it is in position to be joined to the suspended pipe string.

Positioned at spaced points along the upper end of the ramp are a plurality of transverse roller assemblies **50,** one of which is shown in FIG. **6.** Each roller assembly includes a plurality of rollers **52** freely rotatably secured to an upwardly movable frame **54** which is positioned by a hydraulic piston-cylinder mechanism **56.**

When the new section of pipe is lowered until it is in position to be joined to the suspended pipe string, the new section of pipe is raised off of rollers **22** by means of rollers **52,** and a conventional power tong **58** on the ramp is enclosed around the lower end of the new section of pipe. Then, the power tong is actuated to apply a torque on the new section of pipe to screw it into a pipe coupling **60.**

After the new section of pipe is screwed onto the upper end of the suspended pipe string and the connection is suitably tested, rollers **52** are lowered, slip elevator **18** and pipe-gripping clamp **20** are released, and the lengthened pipe string is payed out another section by means of winch **32** and cable **30.** Thereafter, the slip elevator and pipe-gripping clamp are actuated to secure the suspended pipe string, and swivel cap **26** may be removed from the upper end of the suspended pipe string and a new pipe coupler **60** may be secured thereon. Of course, the pipe couplers may also be applied to the lower end of each section of pipe at the mill or on the deck of the barge to minimize the possibility of damage to the threads as the lower end of a new section of pipe is seated on the ramp. Also, it is contemplated that conventional pin and box type connections may be used so that the couplers may be eliminated. If the pipe string is coated, a field joint may be applied to the threaded connection while another new section of pipe is being positioned on the ramp and secured to the suspended pipe string. Since the power tong **58** and the slip elevator **15** must grip directly on the steel pipe, the field joint to be coated is somewhat longer, on the order of seven feet, than that in other types of pipeline laying operations. Accordingly, it may be desirable to have the coating applied at a coating station **76** below the assembly station **78** as shown generally in FIG. **2,** in order to prevent the crowding of workers in the two sections.

Referring again to FIGS. **1** and **2,** it should be understood that, according to the preferred embodiment, the axis of rotation of the ramp passes through the axis of the upper end of the suspended pipe string, in order to minimize the movement in the ramp that may be occasioned by tension on the suspended pipe string. To further minimize that movement, a dampening means **62** is provided. Dampening means **62** includes a hydraulic piston-cylinder mechanism **64** pivotally secured at one end to the ramp and at the other end to the deck of the barge via a load sensor **66.** The dampening effect is produced by a restricting valve **68** fluidly connected to the cylinder below the piston and, via a fluid reservoir **70,** to the cylinder above the piston; however, when the load sensor indicates that a new section of pipe has been placed on the ramp, valve **68** is automatically closed so that the ramp is locked into place. When the weight on the ramp is reduced by lowering the pipe string, the output of the load sensor will be reduced, thereby opening valve **68** so that the ramp will be movable but dampened. A pump **72** and motor **74** may be provided, if desired, so that hydraulic piston-cylinder mechanism **64** may be used to initially raise the ramp to an approximate inclined position.

Of course, it should be understood that, according to the preferred embodiment, the pipe string is negatively buoyant in an amount selected for the current conditions where the pipe is being laid, and the pipe string is held under tension to prevent excessive bending of the pipe beyond its elastic limit. As is well recognized in the art, it is often desirable to hold the pipe string under a generally constant tension; hence, winch **32** should be a conventional constant tension winch so that the tension on the pipe string may be maintained generally constant as the barge advances and the pipe string is payed out the length of another section of pipe. After the paying out operation is completed, the forward movement of the barge is stopped, and the pipe string is again secured in the slip elevator, the tension on the pipe string may be held generally constant by the barge buoyancy plus the forward holding force on the barge, as is well known in the art.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for facilitating the joining of a section of pipe to a pipe string suspended from a marine vessel during the laying of a submarine pipeline in a body of water, comprising:

means mounted on the vessel forming laterally spaced apart horizontal bearings;

elongated ramp means substantially freely pivotally supported between said bearings for rotation in a vertical plane about a horizontal axis of rotation, said ramp means and apparatus mounted thereon being generally counterbalanced about said axis of rotation;

pipe gripping means mounted on said ramp means for securing the upper end of the pipe string to the vessel while a new section of pipe is being positioned on said ramp means and secured to the pipe string; and

dampening means secured between the vessel and said ramp means for dampening the rotational movement of said ramp means relative to the vessel.

2. The apparatus of claim **1** wherein said pipe gripping means comprises slip elevator means.

3. The apparatus of claim **1** further comprising:

transducer means mounted on said ramp means for sensing the load applied to said ramp means by the weight of a new section of pipe resting thereon; and

locking means responsive to said transducer means for locking said ramp means and apparatus thereon relative to the vessel when a new section of pipe is resting on said ramp means.

4. The apparatus of claim **1** further comprising powered tong means mounted on said ramp means for applying a torque to a new section of pipe on said ramp means.

5. The apparatus of claim **4** further comprising:

cradle roller means freely rotatably mounted generally longitudinally on said ramp means in a position to facilitate axial movement of a new section of pipe on said ramp means;

transverse roller means freely rotatably mounted generally transversely on said ramp means in at least one position to facilitate rotational movement of a new section of pipe on said ramp means; and

means for selectively moving said transverse roller means into and out of supporting engagement with a new section of pipe on said ramp means.

6. The apparatus of claim **5** further comprising:

swivel connector cap means adaptable to be removably connected to one end of a new section of pipe to be added to the pipe string;

pulley means mounted on said ramp means proximate the upper end thereof;

constant tension winch means;

cable means secured to and wrapped around said winch means and adapted to be payed out therefrom, wrapped around said pulley means, and connected to said cap means, whereby one end of a new section of pipe may be positoned on said ramp means and held thereon in substantially constant tension after it is connected to the pipe string and the pipe string is otherwise released; and

hoisting means for positioning the other end of a new section of pipe on said ramp means.

7. The apparatus of claim **6** further comprising:

loading carriage means mounted on said ramp means proximate the upper end thereof and movable between a first position adaptable for receiving and supporting the upper end of a new section of pipe proximate said ramp means and a second position adaptable for gently rolling the upper end of the new section of pipe onto said ramp means.

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