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Langner

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[54] **MOORING SYSTEM FOR PIPELAYING BARGES**

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[52] **U.S. Cl.**.....**61/72.3,** 114/144

[51] **Int. Cl.**.....**B63b 35/04,** B63b 21/16

[58] **Field of Search**.....61/72.3, 72.1, 72.4; 114/144 B, 230; 7/8

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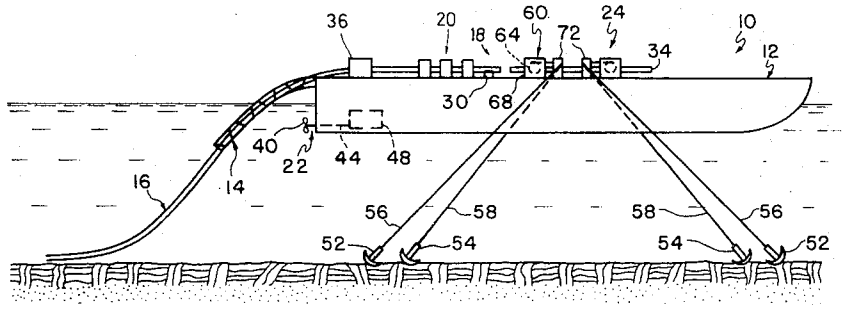
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[57] **ABSTRACT**

A pipelaying barge particularly adapted for use in intermediate water depths is disclosed. The barge has propellers which apply forward thrust to the barge, and a tension brake which grips the pipe and provides controlled relative motion between the pipe and the barge. Forward movement of the barge and tension in the pipe are controlled by the combined action of these propellers and the tension brake. Lateral movement of the barge is controlled by anchor systems operating off each side of the barge.

8 Claims, 2 Drawing Figures



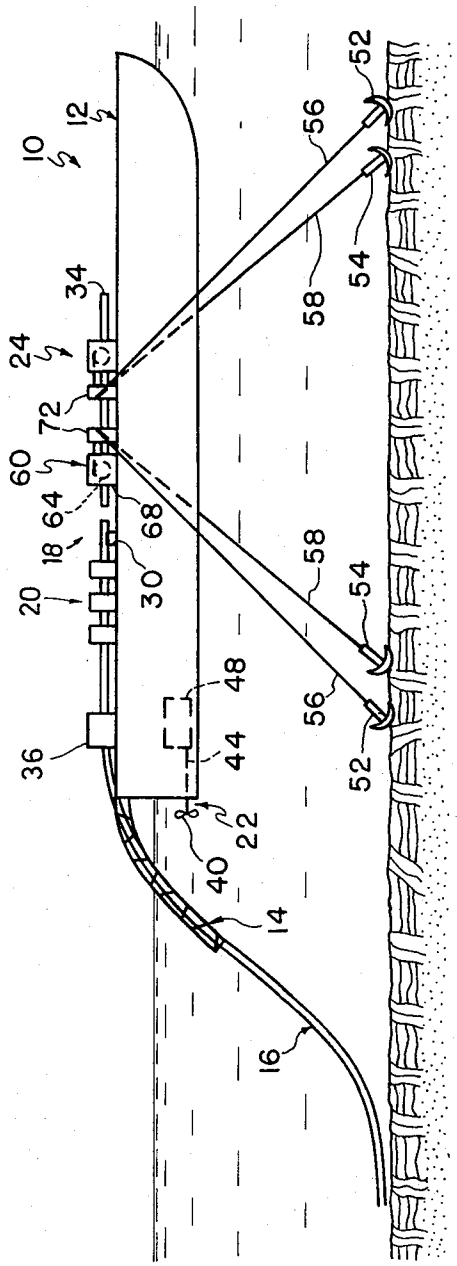


FIGURE 1

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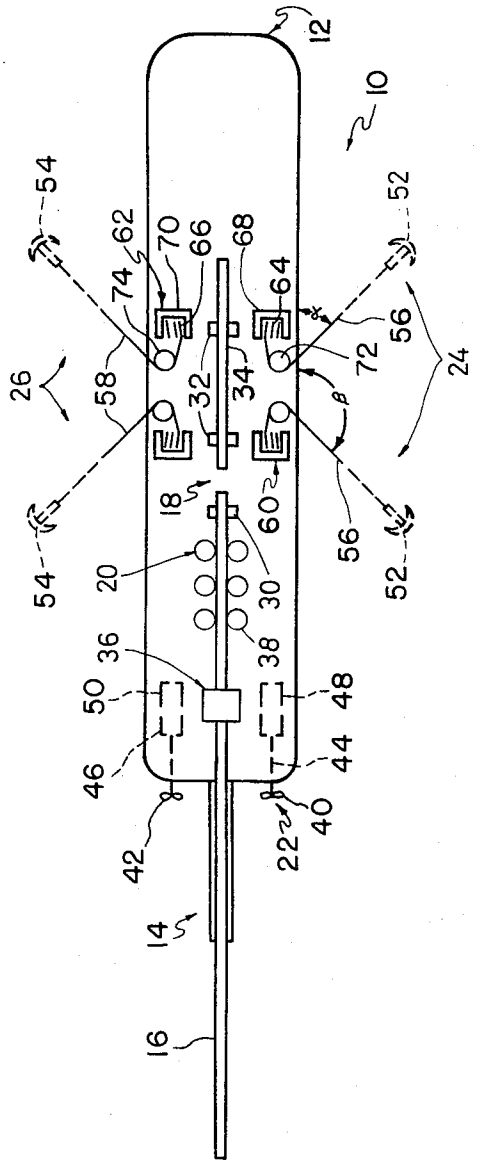


FIGURE 2

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MOORING SYSTEM FOR PIPELAYING BARGES

BACKGROUND OF THE INVENTION

In laying large diameter pipe on the floor of a body of water, the usual procedure is to join mill lengths of pipe together by butt welding and then launch the joints one at a time into the water from a floating barge. This is accomplished by moving the barge forward a distance equal to the length of the pipe joint last welded, stopping the barge and aligning and welding another joint. Smaller diameter pipe may be laid by unreeling a continuous length of pipe from a spool and launching the pipe into the water from a vessel which is moved continuously along the pipe laying path.

It is accordingly desirable to provide arrangements for positioning and moving a pipelaying barge with some facility. A spud barge is usable only in the shallowest of water and is propelled along its pipe laying path by intermittently applying force to the string of pipe to push the barge forward. The barge is stopped and held in a welding position by spuds which are dropped into the bottom.

An anchor barge is used in deeper water and comprises a large number, for example, eight cables, anchors and winches, with the cables fanning out from the bow and stern. It is apparent that an anchor barge can be moved along the pipe laying path and stopped for each pipe joint welding operation with considerable strength and precision.

One of the disadvantages of anchor barges is that the anchors must be periodically repositioned. Using the forward anchors as exemplary, the anchor lines are generally eight to ten times the water depth. Even though substantial amounts of line may be out, each anchor must typically be repositioned during every 5 or 6 hundred feet of advance of the pipe laying barge. When the angle between the anchor line and the bottom becomes excessive, the anchor no longer maintains an adequate bite thereon. When laying pipe at a relatively slow rate, e.g., one 40 foot joint every 15 minutes, each anchor needs to be repositioned every 3 or 4 hours which is not a task of undue difficulty for a single tube.

When laying pipe at much greater rates, as by the use of automatic welding machines, the repositioning of a multiplicity of anchors becomes a considerable task. The use of automatic welding equipment enables a barge to lay in the neighborhood of a thousand feet of pipe per hour which would require repositioning each anchor every 30 or 40 minutes. Thus the rate of pipe laying with a typical anchor barge is limited by the rate of repositioning anchors or by the expense of so doing.

Another disadvantage of the prior art anchor barges is the water depth in which such devices are usable. A major reason for this limitation is the amount of anchor line that must be carried by the barge. It will be apparent that many miles of anchor line represent not only a substantial expense but also requires a significant amount of storage space. It is apparent that the given available storage space is better used to store pipe, pipe coating material and other supplies consumed during the pipe laying operation.

Another disadvantage of the prior art anchor barges is the small but significant probability of buckling a pipe in shallow or intermediate water depths as a result of anchor slippage. Repair of a buckled offshore

pipeline is a costly operation which should be avoided by whatever possible means.

One proposal for overcoming the disadvantages of anchor barges is the use of rear and side mounted propellers for positioning and moving the barge as shown in U.S. Pat. No. 3,321,925. A propeller positioned barge has substantial advantages in deep water, e.g., 1,000 feet and deeper. At shallower depths, a propeller positioned barge has disadvantages which are uncompensated. In shallow water any motion of the barge other than the prescribed forward motion, if unrestrained, can damage the pipe. It will be apparent that engines of substantial size are required to move or position and hold the vessel against currents and waves acting on a side thereof.

At greater depths the pipe assumes a nearly vertical attitude as it sags to bottom. Consequently, the barge has greater freedom of movement before the pipe is endangered. Furthermore, the barge can be faced into the current during the pipe welding operation and turned across the current for movement while the pipe is paying out. This preferred orientation requires only a small fraction (typically one-sixteenth to one-third of the power required for positioning by thrustors as required by the side-on orientation. At shallower depths, the pipe does not assume a vertical attitude thereby requiring the barge to face in the direction of the pipe laying path which in general is not the preferred orientation. At shallower depths, the advantages of a propeller positioned barge are outweighed by the disadvantages.

SUMMARY OF THE INVENTION

A principal object of the invention is to provide an apparatus for laying pipe utilizing thruster or propulsion means in conjunction with a tension brake which grips the pipe to control movement of the barge in a forward direction and anchors and anchor lines to control the lateral position of the barge.

Another object of the invention is to provide an apparatus for laying pipe which maintains the pipe in tension regardless of anchor slippage and therefore prevents buckling of the suspended pipe.

Another object of the invention is to provide an apparatus for laying pipe in water of intermediate depth which combines the advantages of an anchor barge and a propulsion positioned barge.

In summary, a pipe laying apparatus of this invention comprises a buoyant barge, propulsion means operative on the barge and braking means operative on the pipeline for controlling tension in the pipe and for advancing the vehicle along the pipe laying path and anchor means for applying lateral forces to each side of the vehicle for controlling the lateral position thereof. The lateral positioning means of the invention comprises anchor means, flexible means connected thereto and means for guiding the flexible means over each side of the vessel and for retracting the flexible means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the pipe laying apparatus of this invention; and

FIG. 2 is a plan view of the device of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is shown a pipe laying apparatus **10** having as major components a buoyant vehicle or barge **12** having means **14** for guiding pipe **16** over the rear end of the vehicle **12**. The pipe laying apparatus **10** also comprises pipe handling equipment **18**, a pipe brake **20** and propulsion means **22**. First and second mooring means **24, 26** are provided for controlling the lateral position of the vehicle **12**.

The vehicle **12** comprises a barge or other suitable vessel preferably having sufficient storage area for pipe, pipe coating materials and the like. The pipe guiding means **14** comprises a suitable supporting structure or buoyant stinger for controlling the curvature of the pipe **16** as it is directed off the rear of the barge. The pipe handling equipment **18** may be of any desired type to prepare the pipe **16** for insertion into the water. The pipe handling equipment **18** is illustrated as comprising a cradle **30** for positioning the free end of the pipe **16** and a plurality of similar cradles **32** for holding an unwelded joint of pipe **34** in alignment with the free end of the pipe **16** for manual or machine butt welding. A coating applicator **36** is provided for applying bituminous coatings, kraft paper, epoxy, concrete and the like to the periphery of the assembled pipe **16**.

The pipe brake **20** may be of any suitable type but is illustrated as comprising a plurality of inflatable rubber tires **38** frictionally engaging the periphery of the pipe line **16**. A suitable pipe brake is illustrated in U.S. Pat. No. 3,321,925.

The propulsion means **22** comprises thrustor means of any suitable type, e.g., reaction motors or propellers. The propulsion means **22** is illustrated as comprising a propeller **40, 42** on each side of the barge **28** connected to shafts **44, 46** driven by engines **48, 50**. It will be apparent that a single thrustor may be used. It is also apparent that the thrustor means may be steerable as illustrated in U.S. Pat. No. 3,187,704. It will be seen that the barge can be steered upon movement thereof by running one of the motors **48, 50** faster than the other or by steering one of the propellers **40, 42**.

Tension on the pipe line **16** is controlled by adjusting the pipe brake **20** and/or by controlling the thrust provided by the propellers **40, 42**. When it is desired to move the barge and thereby direct another joint of pipe off of the rear thereof, the braking force provided by the brake **20** is decreased, as by rotating one or more of the tires **38**. The balance between the braking force and the thrust provided by the propellers **40, 42** is thereby upset to propel the barge along the pipe laying path. As the free end of the pipe line **16** approaches the cradle **30**, the force applied by the brake **20** is increased to stop the barge. Another joint of pipe is then positioned for welding to the free end of the pipe line **16**. It will accordingly be seen that there is provided means for controlling the tension in the pipe line **16** and for advancing the barge for moving the pipe line **16** through the guiding means **14**.

It is important to note that the thrust requirement for moving the barge to direct the pipe **16** off the rear end of the barge is not excessive. Even when laying large diameter pipe in deep water, the thrust requirement will seldom exceed 50,000 pounds. Two 1,000 horsepower thrusters will adequately provide 50,000 pounds of thrust. It will be apparent to those skilled in the art that one thousand horsepower thrusters are not of excessive size for marine application.

The first and second mooring means **24, 26** comprise anchor means **52, 54** connected by suitable flexible lines **56, 58** to winching and guiding means **60, 62**. The anchor means **52, 54** may be of any suitable type including conventional anchors, fluke anchors, weights, dead men or the like. The flexible lines **56, 58** may likewise be of any convenient type including marine rope, cable, chain or the like. The winching and guiding means **60, 62** comprise suitable drums **64, 66** connected to the barge by supports **68, 70** and driven by suitable motors (not shown) for retracting the lines **56, 58**. The winching and guiding means **60, 62** also comprise pulleys or posts **72, 74** for directing the flexible lines **56, 58** over the side of the barge. As shown best in FIG. **2**, the mooring means **24, 26** are positioned adjacent each side of the barge to provide a centrally located pipe handling station there between.

The operation of the pipe laying apparatus **10** should be apparent to those skilled in the art. After each joint **34** is welded onto the free end of the pipe line **16**, the brake **20** is relaxed to allow the thrusters **40, 42** to propel the barge **28** in the direction shown by the arrow in FIG. **2** along the pipe laying path. Contemporaneously, with the relaxation of the brake **20**, the reels **64, 66** are driven or released to take in or pay-out flexible line as required. Steering of the barge **26** may be affected by operation of the reels **64, 66**, manipulation of the thrusters **40, 42** or a combination thereof. As the free end of the pipe line **16** approaches the cradle **30**, the barge is stopped and a new joint of pipe is positioned for welding to the free end of the pipe line **16**.

There are several advantages of this invention over the typical anchor barge. The typical anchor barge has four mooring lines fanning out from the bow and four mooring lines from the stern of the barge. None of the lines approaches a 90° angle with respect to the barge so that the force vector tending to prevent lateral movement thereof is necessarily a small fraction of the tension in the mooring line. The mooring means **24, 26** of this invention extend away from the barge over each side thereof. The anchor lines **56, 58** accordingly describe a large angle with the sides of the barge **28** so that the lateral force vector tending to prevent movement of the barge is necessarily a larger fraction of the tension in the mooring lines.

One of the main disadvantages of the typical anchor barge is the necessity for moving the forward anchors at fairly frequent intervals during pipe laying. As the conventional anchor barge moves forwardly, the angle between the forward anchor lines and the bottom increases thereby impairing the ability of the anchor to bite into the bottom. As this angle increases, the probability of an anchor slipping and entirely losing its grip increases. Accidents have occurred when a forward anchor slipped thereby upsetting the balance between the tension in the pipe line and the tension in the mooring lines. The tension in the aft mooring lines and in the pipe line causes the barge to move rearwardly. As the barge overruns the pipe line, the pipe line breaks loose from the brake and other clamps and assumes a nearly

vertical attitude in the water. The barge continues to move rearwardly because of inertia and completely overruns the free end of the pipe line. The pipe line then falls to the bottom.

The necessity for frequent movement of the anchor lines in a prior art anchor barge is thus readily apparent. In the device of this invention, the propulsion means **22** is used to control forward movement of the barge against the braking force of the brake **20**. Furthermore, the barge does not move directly toward any of the anchors **52**, **54**. Consequently, for a given amount of forward movement, the angle between the foremost anchor lines and the bottom increases at a slower rate than in a conventional anchor barge. As the barge moves forward, the angle between the rearmost anchor lines and the bottom decreases thereby enabling the rear anchors to obtain an increasingly better bite on the bottom. It will accordingly be seen that the decreasing capacity of the foremost anchors to grasp the bottom is compensated for by the increasing capacity of the rearmost anchors.

It is preferred that the foremost anchors **52**, **54** of this invention be initially positioned so that the angle α is at least 45°. As the barge proceeds along the pipe laying path, the angle increases as the foremost anchor lines **56**, **58** are retracted. It is preferred that the foremost anchors **52**, **54** be shifted before the angle α exceeds 90°. The foremost anchor lines **56**, **58** accordingly define a nonobtuse angle with the front adjacent side of the barge.

It is preferred that the rearmost anchors **52**, **54** of this invention be positioned so that the angle β is at least 90°. As the barge proceeds along the pipe laying path, the angle increases as the rearmost anchor lines **56**, **58** are payed out. It is preferred that the rearmost anchors **52**, **54** be shifted before the angle β exceeds 135°. The rearmost anchor lines **56**, **58** accordingly define a nonacute angle with the front adjacent side of the barge.

I claim as my invention:

1. Apparatus for laying pipe in a body of water comprising

a buoyant vehicle movable in a forward direction and having means thereon for guiding pipe into the water to the rear thereof;

means for controlling tension in the pipe and for advancing the vehicle to move pipe through the guiding means comprising thrustor means on the vehicle for applying a force thereto tending to move the vehicle forwardly and brake means on the vehicle engageable with the pipe for retarding movement thereof; and

means for applying lateral force in one direction to the vehicle and means for applying lateral force in the other direction thereto for controlling lateral movement of the vehicle, the lateral force applying means comprising at least four anchors, flexible lines connected to each anchor, and means for guiding at least two of the flexible lines over each side of the vehicle and for retracting and paying out the flexible lines,

at least a first of the flexible lines on each side of the vehicle extending away therefrom at a nonobtuse angle with the front adjacent side thereof.

2. The pipe laying apparatus of claim **1** wherein the thrustor means comprise thrustors on the rear of the vehicle on opposite sides of the center thereof.

3. The pipe laying apparatus of claim **1** wherein the pipe guiding means comprises a supporting structure secured to the vehicle adjacent the rear end thereof for controlling the curvature of the pipe adjacent the water line.

4. The pipe laying apparatus of claim **1** wherein the lateral force applying means are positioned intermediate the ends of the vehicle.

5. The pipe laying apparatus of claim **4** wherein the buoyant vehicle includes a pipe handling station located intermediate the sides and ends of the vehicle; and

the lateral force applying means comprises first guiding and retracting means on one side of the pipe handling station and second guiding and retracting means on the other side thereof, said first and second guiding and retracting means each comprising a winch suitably connected to the vehicle and, separated therefrom, means for directing the flexible lines over the sides of the vehicle.

6. The pipe laying apparatus of claim **1** wherein the lateral force applying means comprises a first anchor and a third anchor, first and third flexible lines connected to each of the first and third anchors and guiding and retracting means for separately retracting and paying out the first and third flexible lines, the first and third anchors being on the same side of the vehicle, the first flexible line extending away from the vehicle at a nonobtuse angle with the front adjacent side thereof, the third flexible line extending away from the vehicle at a nonacute angle with the front adjacent side thereof.

7. The pipe laying apparatus of claim **1** one flexible line on each side of the vehicle extends away therefrom at a nonacute angle with the front adjacent side thereof.

8. The pipe laying apparatus of claim **1** wherein at least one of the flexible lines on each side of the vehicle extends away therefrom at an angle with the front adjacent side thereof greater than the nonobtuse angle at which the first of the flexible lines extends away therefrom.

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